



# Lab Test Report

## Surface Particle Testing Project

Prepared for

ABC Widget Co.

City, State

07 Dec 2003

Without measurement, there is no control.



## Project Information

**Report prepared for (customer):**

Joe Example  
ABC Widget Co.  
1234 Main Street  
City, State 12345

**Report prepared by (supplier):**

John Doe  
Applications Engineer  
Particle Measuring Systems

**Completion date:** 07 Dec 2003

**Supplier part number:** 470000

**Qty of tests performed:** 18

**Supplier PCT Number:** 00104

## Description of Work

### Parts Tested

Three types of parts were tested, each with a quantity of 6 tests. Descriptions and ID numbers are listed in the table below.

Part Description	Part/ID number	Quantity
Widget F3 - White ABS plastic	1234567	6
Widget C2 - Black high-density polyethylene	2345678	6
Widget A5 - Passivated 304 stainless steel	3456789	6

### Test Overview and Objectives

The overall test objective is to compare the effectiveness of three different cleaning stations. The particle count determined for each part is used as the measure of the cleanliness of that part. The cleanliness of the parts is used as the measure of the effectiveness of the cleaning station.

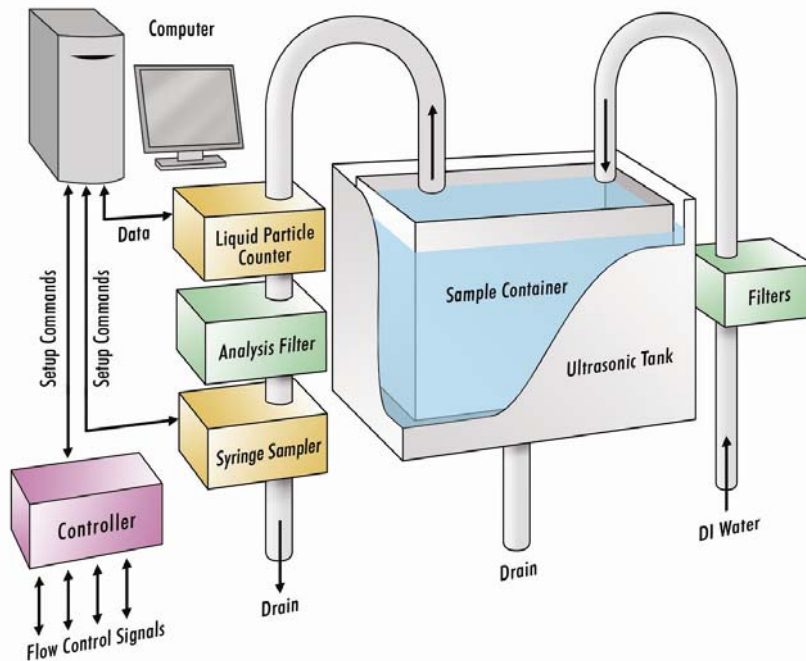
Recognizing that the part's size, shape, and material may have an impact on the effectiveness of the cleaning station, three different part types were tested. Quantities of 2 parts per type were tested per cleaning station. Therefore a total of 6 parts were cleaned and tested for each of the three stations (for a total of 18 parts overall).

# Test Method

## Equipment

All tests were performed with the SURFEX™ parts testing station, a system designed and manufactured by Particle Measuring Systems to count particles extracted from the surface of any shaped part. Surfex uniquely combines ultrasonic extraction, particle measurement, high-purity fluidics, and automated software control to provide a completely integrated system for highly accurate parts cleanliness testing.

The test part is submerged in a container of ultrapure DI water. An ultrasonic cleaning tank extracts surface particles with sonic energy emitted into the container. During extraction, a motorized stirring assembly ensures a consistent particle concentration per unit volume of water. After extraction, the contaminated water is drawn through a liquid particle counter. The volume of water is a known quantity, as it is drawn by a precision syringe sampler.



**Figure 1: Surfex system flow and control diagram (simplified)**

System fluidics are controlled by a PLC that is interfaced to a series of valves and other flow control devices. All test data is collected, displayed, and saved by a PC in the Surfex software. The PC also controls the PLC and syringe sampler and receives all status messaging.

The maximum concentration limit of the particle counter is 10,000 counts per mL. It has a zero count level of 50 counts per L. The 'sample view volume' is 100% (meaning that the sensor views 100% of each liquid sample, thus ensuring that no particles in the liquid are missed). All equipment used in testing is calibrated by following Particle Measuring Systems' ISO 9001:2000 standard work instructions and uses materials that are traceable to USA NIST.

## Setup

The following setup recipe in the Surfex software was used:

Item	Value *	Units
Ultrasonic frequency	72	kHz
Ultrasonic power	250	W
Ultrasonic duration	30	sec
Parts in container	1	N/A
Part surface area	327.0 (Widget F3) 10.7 (Widget C2) 2.7 (Widget A5)	cm <sup>2</sup>
Number of samples	6	N/A
Sample volume	10	mL
Tare volume	0	mL
Discard first sample	Yes	N/A
Container volume	2315 (Widget F3) 675 (Widget C2) 275 (Widget A5)	mL
Syringe volume	25	mL
Fill speed	20	mL/min
Drain speed	50	mL/min

The following limits were used for cleaning the sample container between tests:

Item	Value *	Units
Cleaning limit channel	0.5	µm
Cleaning stop limit	5.0	particles/mL cumulative

The following particle size thresholds were used for data collection (for each channel, the value listed means that channel includes all particles counted that are greater than that value):

Item	Value *	Units
Channel 1	0.5	µm
Channel 2	0.7	µm
Channel 3	1.0	µm
Channel 4	2.0	µm
Channel 5	5.0	µm
Channel 6	10.0	µm
Channel 7	15.0	µm
Channel 8	20.0	µm

\* The value listed for each item was used for all tests unless otherwise specified per setup item

## Procedure

### *Preparation*

1. Surfex instrumentation calibration is verified to be current and correct.
2. The system hardware is prepared for testing by verifying proper operation of all components.
3. The system software is prepared by entering the test recipes, particle size thresholds, sequence of operation, limits, and other setup parameters as defined above in the Setup section.
4. The method of holding the parts in the sample container is determined. For these tests, Widget C2 and A5 are placed into the sample container with cleaned tweezers. Widget F3 is suspended in the container by hanging the parts from the part fixturing gantry with nylon wire.

### *Testing*

Once the system was prepared for testing, the procedure described below was followed. Unless otherwise specified, the same procedure was followed for each test.

5. The water in the sample container is cleaned by the system filtration until the container has a particle count below 5 particles per mL at 0.5 microns and greater.
6. Once the container is clean, the test part is placed in the sample container according to the method described above.
7. With the motorized stirring assembly running, the ultrasonic tank is turned on and particles are extracted from part surfaces with ultrasonic energy for 30 seconds.
8. When ultrasonic extraction has concluded, the sampling begins. 10 mL of water is drawn from the sample container by the syringe sampler and run through the liquid particle counter. The first water sample is discarded and a second sample is drawn from the same container to take another particle count. 6 total samples are taken (again, with the first sample discarded).
9. The Surfex software on the PC collects all data from the particle counter. For each test, the data collected from each water sample (after the first discarded sample) is averaged to create a "series average". This data is displayed by the PC and recorded.
10. Once the data is collected and recorded, testing is complete and parts can be removed from the sample container to begin the next test (starting again with step 1 – cleaning the container).

# Test Results

## Numeric Test Data

All numeric test data is listed below in the Appendices and is organized as follows:

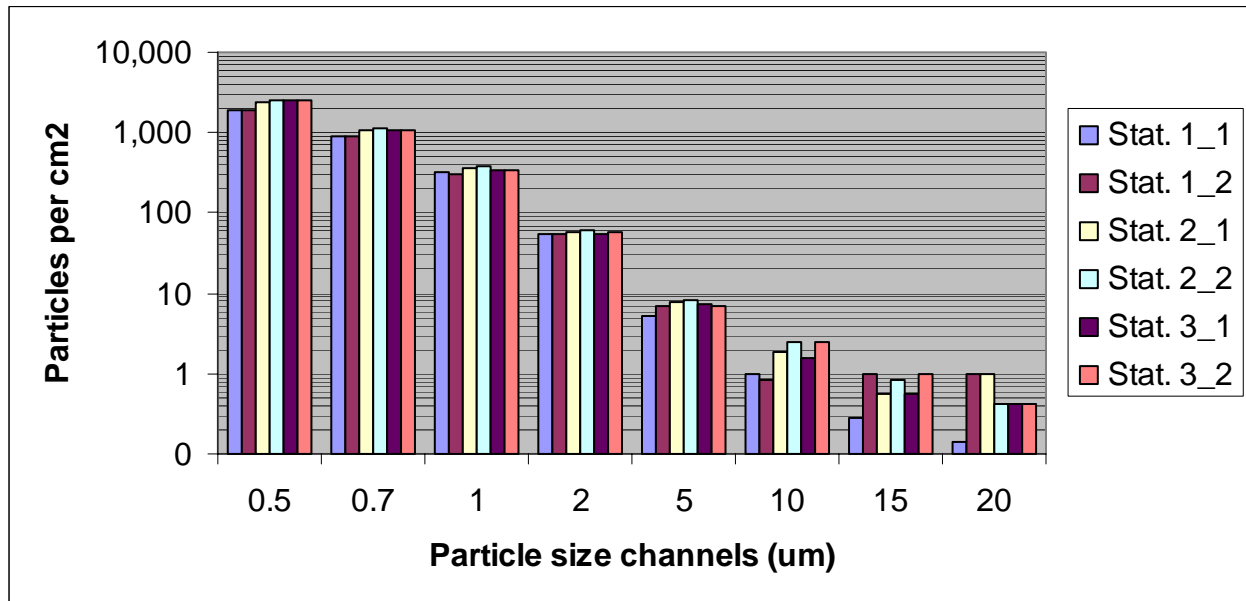
- **Appendix A: Raw Data**
  - The raw data imported from the Surfex system is shown, along with some of the key recipe setup items. The counts displayed for each size channel are the absolute number of particles counted per sample taken.
  - The data for every sample taken of every part is shown, as well as the series average for each group of samples per part.
  - Data is displayed in terms of differential particle counts. In other words, the count shown for each channel is the number of particles for that channel only, not the cumulative sum of that channel and all other larger channels.
  
- **Appendix B: Particles per cm<sup>2</sup>**
  - The total number of particles per square centimeter of the part for each size channel is determined by normalizing the raw count with the sample volume, container volume, number of parts in the container, and the total surface area of the part.
  - Data is displayed in terms of cumulative particle counts. Therefore, the count shown for each channel is the total number of particles for that size channel and larger.
  - Particles per cm<sup>2</sup> cumulative is calculated as:  
$$\frac{(\text{cum particle count})}{(\text{sample vol}) * (\text{container vol}) / (\text{num. parts in container}) / (\text{surface area per part})}$$
  
- **Appendix C: Particles per Part**
  - The total number of particles per part for each size channel is determined by normalizing the raw count with the sample volume, container volume, and number of parts in the container.
  - Data is displayed in terms of cumulative particle counts. Therefore, the count shown for each channel is the total number of particles for that size channel and larger.
  - Particles per Part cumulative is calculated as:  
$$\frac{(\text{cum particle count})}{(\text{sample vol}) * (\text{container vol}) / (\text{num. parts in container})}$$
  
- **Appendix D: Particles per mL**
  - The total number of particles per milliliter of water for each size channel is determined by normalizing the raw count with the sample volume.
  - Data is displayed in terms of cumulative particle counts. Therefore, the count shown for each channel is the total number of particles for that size channel and larger.
  - Particles per mL cumulative is calculated as:  
$$\frac{(\text{cum particle count})}{(\text{sample vol})}$$

NOTE: All particle size channels in the Appendices are listed in microns (µm).

## Charts and Summary Tables

Charts were created to compare the various groups of parts. Charts are plotted on a logarithmic scale for the vertical axis since the number of particles at the smaller size channels is exponentially greater than the number of particles at the larger size channels.

Data tables for each chart are shown below that chart. The first table below the chart shows the particles per cm<sup>2</sup> and the second table shows the particles per part.



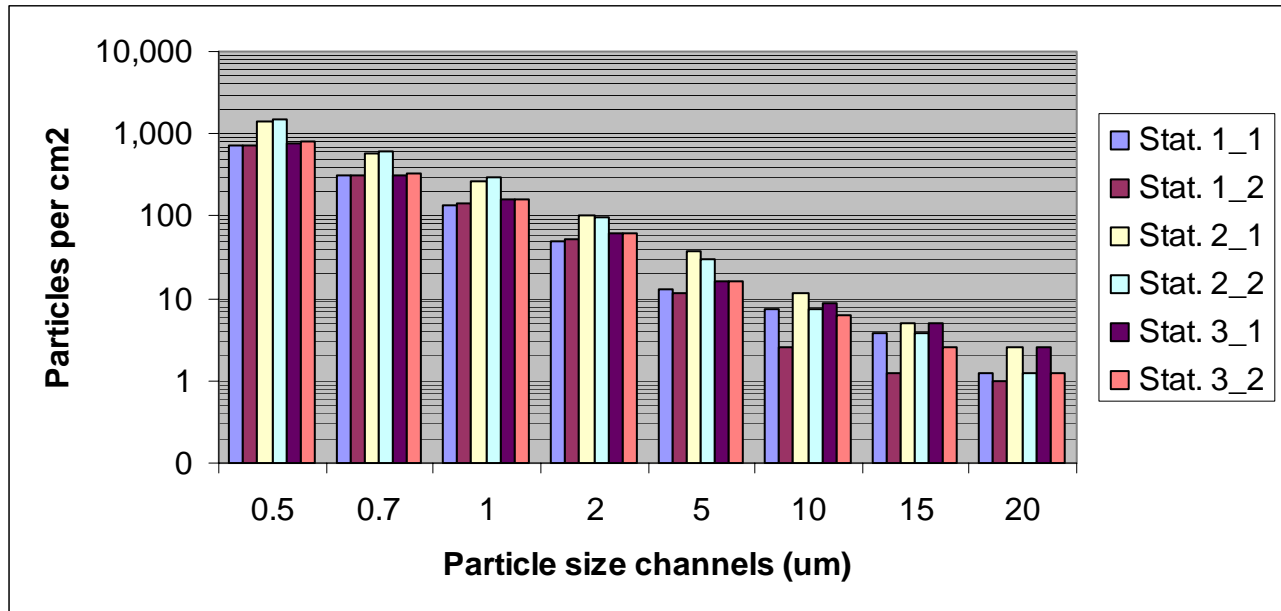
**Figure 2: Comparison of particle levels by cleaning station for Widget F3**

### Particles per cm<sup>2</sup>:

	0.5	0.7	1	2	5	10	15	20
Station 1 – 1	1,892	892	320	54	5	1	0	0
Station 1 – 2	1,913	886	303	56	7	1	0	0
Station 2 – 1	2,410	1,063	363	58	8	2	1	0
Station 2 – 2	2,505	1,136	384	59	8	2	1	0
Station 3 – 1	2,491	1,069	336	56	7	2	1	0
Station 3 – 2	2,537	1,078	346	57	7	2	1	0

### Particles per part:

	0.5	0.7	1	2	5	10	15	20
Station 1 – 1	618,522	291,783	104,731	17,548	1,667	324	93	46
Station 1 – 2	625,420	289,792	99,036	18,150	2,222	278	0	0
Station 2 – 1	788,211	347,667	118,667	18,890	2,593	602	185	0
Station 2 – 2	819,047	371,604	125,566	19,446	2,639	787	278	139
Station 3 – 1	814,649	349,611	109,963	18,289	2,361	509	185	139
Station 3 – 2	829,603	352,482	113,018	18,613	2,222	787	324	139



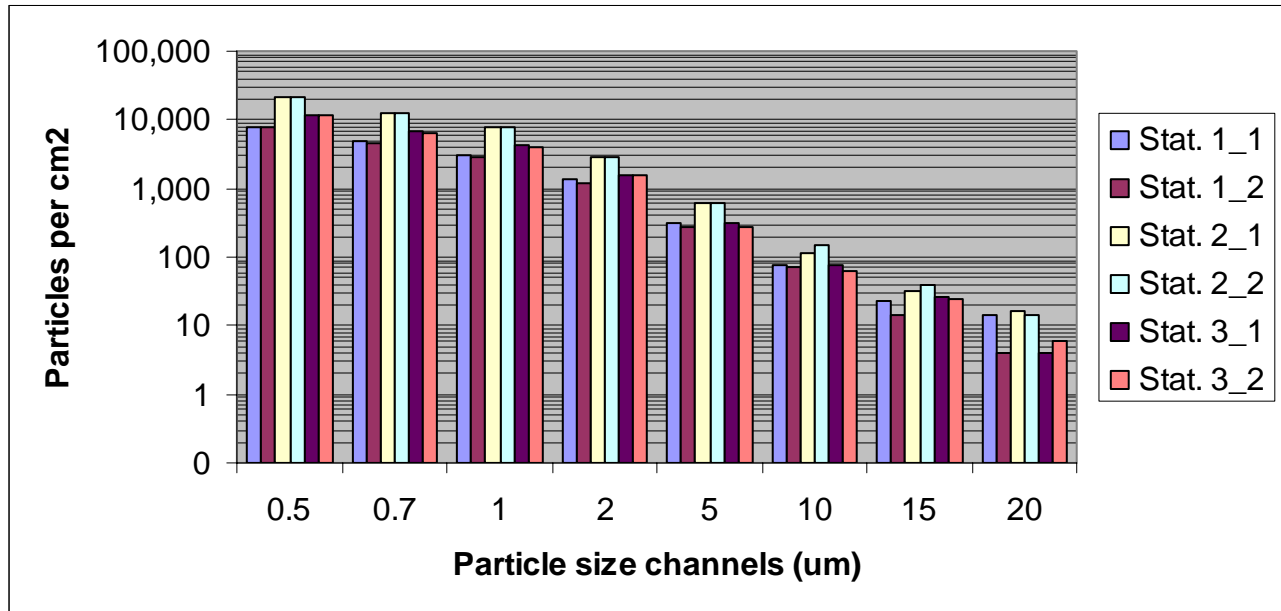
**Figure 3: Comparison of particle levels by cleaning station for Widget C2**

**Particles per cm<sup>2</sup>:**

	0.5	0.7	1	2	5	10	15	20
Station 1 – 1	717	305	138	49	13	8	4	1
Station 1 – 2	741	310	145	53	11	3	1	0
Station 2 – 1	1,442	575	266	103	38	11	5	3
Station 2 – 2	1,484	619	300	98	30	8	4	1
Station 3 – 1	784	310	163	63	16	9	5	3
Station 3 – 2	805	336	161	62	16	6	3	1

**Particles per part:**

	0.5	0.7	1	2	5	10	15	20
Station 1 – 1	7,668	3,267	1,472	527	135	81	41	14
Station 1 – 2	7,925	3,321	1,553	567	122	27	14	0
Station 2 – 1	15,431	6,156	2,849	1,107	405	122	54	27
Station 2 – 2	15,876	6,629	3,213	1,053	324	81	41	14
Station 3 – 1	8,384	3,321	1,742	675	176	95	54	27
Station 3 – 2	8,613	3,591	1,728	662	176	68	27	14



**Figure 4: Comparison of particle levels by cleaning station for Widget A5**

**Particles per cm<sup>2</sup>:**

	0.5	0.7	1	2	5	10	15	20
Station 1 – 1	8,063	4,763	3,102	1,379	310	75	22	14
Station 1 – 2	8,042	4,610	2,937	1,234	279	69	14	4
Station 2 – 1	21,481	12,277	7,716	2,935	599	118	33	16
Station 2 – 2	21,595	12,306	7,574	2,884	605	153	39	14
Station 3 – 1	11,599	6,665	4,147	1,558	318	77	26	4
Station 3 – 2	11,464	6,482	3,942	1,522	267	61	24	6

**Particles per part:**

	0.5	0.7	1	2	5	10	15	20
Station 1 – 1	21,769	12,859	8,377	3,724	836	204	61	39
Station 1 – 2	21,714	12,447	7,931	3,333	754	187	39	11
Station 2 – 1	57,998	33,149	20,834	7,926	1,617	319	88	44
Station 2 – 2	58,306	33,226	20,449	7,788	1,634	413	105	39
Station 3 – 1	31,317	17,996	11,198	4,208	858	209	72	11
Station 3 – 2	30,954	17,501	10,643	4,109	721	165	66	17

# Discussion of Results

## Validity of Test Data

The particle count distribution for the various size channels is consistent with the expected range from a normal particle test, with the number of particles exponentially decreasing for the larger size channels. This fact leads to the likely conclusion that the particle counter was not “saturated” by too many particles per sample volume and there was no coincidence loss. Also, there were no indications at any point during testing of any type of status error with the particle counter or any part of the Surfex testing system.

These facts indicate that all test data is valid.

## General Observations from Test Data

The objective of the parts cleanliness testing performed is to compare the effectiveness of three cleaning stations on three different part types. The observations below are made bearing this objective in mind. As agreed with the customer, the “Particles per cm<sup>2</sup>” count is used as the measure of effectiveness for all tests.

- For all three part types, Station 2 has the highest particle count for most or all size channels.
- For all three part types, Station 1 has the lowest particle count for most or all size channels, but the difference between Stations 1 and 3 is less than the difference between Stations 2 and 3.
- Widget C2 has the fewest particles per unit surface area, followed by Widget F3. The most particles per unit surface area were on Widget A5.
- For each of the stations and part types, there were two parts tested to give greater confidence in the reliability of the data (so that there is less chance of calling one individual part an “anomaly”). For all part types and stations, there was good correlation between the first and second part, with the differences typically being less than 10% between each sample.

**The complete list of numeric test data is in the Appendices below.**

## Appendix A: Raw Data

### Widget F3

#### Station 1

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_1	10	2315	1	327	1383	802	357	76	5	1	0	0
*DATA	WidF3_1	10	2315	1	327	1379	782	384	70	5	1	0	1
*DATA	WidF3_1	10	2315	1	327	1442	831	385	72	8	1	0	0
*DATA	WidF3_1	10	2315	1	327	1423	826	363	61	6	1	0	0
*DATA	WidF3_1	10	2315	1	327	1430	799	394	64	5	1	1	0
*AVERAGE	WidF3_1	10	2315	1	327	1411.4	808	376.6	68.6	5.8	1	0.2	0.2

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_2	10	2315	1	327	1499	790	389	75	6	2	0	0
*DATA	WidF3_2	10	2315	1	327	1399	825	350	75	7	1	0	0
*DATA	WidF3_2	10	2315	1	327	1535	893	331	62	8	1	0	0
*DATA	WidF3_2	10	2315	1	327	1401	780	334	60	11	2	0	0
*DATA	WidF3_2	10	2315	1	327	1415	832	343	72	10	0	0	0
*AVERAGE	WidF3_2	10	2315	1	327	1449.8	824	349.4	68.8	8.4	1.2	0	0

#### Station 2

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_3	10	2315	1	327	1824	953	447	70	9	1	1	0
*DATA	WidF3_3	10	2315	1	327	1918	1021	426	67	10	1	0	0
*DATA	WidF3_3	10	2315	1	327	1928	982	426	66	10	0	0	0
*DATA	WidF3_3	10	2315	1	327	1953	967	437	82	7	5	1	0
*DATA	WidF3_3	10	2315	1	327	1892	1023	419	67	7	2	2	0
*AVERAGE	WidF3_3	10	2315	1	327	1903	989.2	431	70.4	8.6	1.8	0.8	0

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_4	10	2315	1	327	1856	1079	470	68	4	0	1	0
*DATA	WidF3_4	10	2315	1	327	1904	1022	474	75	7	3	0	0
*DATA	WidF3_4	10	2315	1	327	1937	1052	448	76	10	2	1	0
*DATA	WidF3_4	10	2315	1	327	1950	1074	438	78	6	2	1	3
*DATA	WidF3_4	10	2315	1	327	2017	1087	462	66	13	4	0	0
*AVERAGE	WidF3_4	10	2315	1	327	1932.8	1062.8	458.4	72.6	8	2.2	0.6	0.6

#### Station 3

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_5	10	2315	1	327	1926	1085	394	61	11	0	0	0
*DATA	WidF3_5	10	2315	1	327	2016	1029	392	79	8	1	0	0
*DATA	WidF3_5	10	2315	1	327	2037	1046	419	66	8	2	0	0
*DATA	WidF3_5	10	2315	1	327	2011	1019	399	72	7	1	0	0
*DATA	WidF3_5	10	2315	1	327	2054	997	376	66	6	3	1	3
*AVERAGE	WidF3_5	10	2315	1	327	2008.8	1035.2	396	68.8	8	1.4	0.2	0.6

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_6	10	2315	1	327	2011	1019	399	72	7	1	0	1
*DATA	WidF3_6	10	2315	1	327	2054	997	376	66	6	3	1	0
*DATA	WidF3_6	10	2315	1	327	2053	1089	422	65	8	2	1	0
*DATA	WidF3_6	10	2315	1	327	2106	1041	426	71	4	3	1	0
*DATA	WidF3_6	10	2315	1	327	2081	1026	416	80	6	1	1	2
*AVERAGE	WidF3_6	10	2315	1	327	2061	1034.4	407.8	70.8	6.2	2	0.8	0.6

## Widget C2

### Station 1

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_1	10	675	1	10.7	67	26	15	10	2	1	1	1
*DATA	WidC2_1	10	675	1	10.7	60	25	10	8	1	1	0	0
*DATA	WidC2_1	10	675	1	10.7	61	30	15	5	0	0	0	0
*DATA	WidC2_1	10	675	1	10.7	70	21	14	2	0	0	0	0
*DATA	WidC2_1	10	675	1	10.7	68	31	16	4	1	1	1	0
*AVERAGE	WidC2_1	10	675	1	10.7	65.2	26.6	14	5.8	0.8	0.6	0.4	0.2

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_2	10	675	1	10.7	61	30	15	5	0	0	0	0
*DATA	WidC2_2	10	675	1	10.7	70	21	14	2	0	0	0	0
*DATA	WidC2_2	10	675	1	10.7	85	28	16	11	1	1	1	0
*DATA	WidC2_2	10	675	1	10.7	61	33	11	8	3	0	0	0
*DATA	WidC2_2	10	675	1	10.7	64	19	17	7	3	0	0	0
*AVERAGE	WidC2_2	10	675	1	10.7	68.2	26.2	14.6	6.6	1.4	0.2	0.2	0

### Station 2

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_3	10	675	1	10.7	140	47	21	9	5	1	0	0
*DATA	WidC2_3	10	675	1	10.7	136	47	20	13	5	1	0	0
*DATA	WidC2_3	10	675	1	10.7	125	46	30	10	5	1	0	0
*DATA	WidC2_3	10	675	1	10.7	148	50	32	12	4	1	1	0
*DATA	WidC2_3	10	675	1	10.7	138	55	26	8	2	1	1	2
*AVERAGE	WidC2_3	10	675	1	10.7	137.4	49	25.8	10.4	4.2	1	0.4	0.4

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_4	10	675	1	10.7	125	46	30	10	5	1	0	0
*DATA	WidC2_4	10	675	1	10.7	148	50	32	12	4	1	1	0
*DATA	WidC2_4	10	675	1	10.7	138	57	37	14	1	0	0	0
*DATA	WidC2_4	10	675	1	10.7	137	47	37	9	6	0	0	0
*DATA	WidC2_4	10	675	1	10.7	137	53	24	9	2	1	1	1
*AVERAGE	WidC2_4	10	675	1	10.7	137	50.6	32	10.8	3.6	0.6	0.4	0.2

### Station 3

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_5	10	675	1	10.7	72	27	15	12	1	2	1	1
*DATA	WidC2_5	10	675	1	10.7	83	26	19	7	0	1	0	0
*DATA	WidC2_5	10	675	1	10.7	76	22	13	9	3	0	0	0
*DATA	WidC2_5	10	675	1	10.7	74	21	16	5	2	0	0	0
*DATA	WidC2_5	10	675	1	10.7	70	21	16	4	0	0	1	1
*AVERAGE	WidC2_5	10	675	1	10.7	75	23.4	15.8	7.4	1.2	0.6	0.4	0.4

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_6	10	675	1	10.7	76	22	13	9	3	0	0	0
*DATA	WidC2_6	10	675	1	10.7	74	21	16	5	2	0	0	0
*DATA	WidC2_6	10	675	1	10.7	67	34	20	4	1	1	0	0
*DATA	WidC2_6	10	675	1	10.7	78	31	11	3	2	0	1	1
*DATA	WidC2_6	10	675	1	10.7	77	30	19	15	0	2	0	0
*AVERAGE	WidC2_6	10	675	1	10.7	74.4	27.6	15.8	7.2	1.6	0.6	0.2	0.2

## Widget A5

### Station 1

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_1	10	275	1	2.7	330	158	166	114	23	5	1	4
*DATA	WidA5_1	10	275	1	2.7	301	172	179	107	20	4	1	0
*DATA	WidA5_1	10	275	1	2.7	343	183	170	97	31	3	1	1
*DATA	WidA5_1	10	275	1	2.7	354	160	160	111	21	8	0	1
*DATA	WidA5_1	10	275	1	2.7	292	142	171	96	20	6	1	1
*AVERAGE	WidA5_1	10	275	1	2.7	324	163	169.2	105	23	5.2	0.8	1.4

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_2	10	275	1	2.7	343	183	170	97	31	3	1	1
*DATA	WidA5_2	10	275	1	2.7	354	160	160	111	21	8	0	1
*DATA	WidA5_2	10	275	1	2.7	343	151	179	86	17	4	0	0
*DATA	WidA5_2	10	275	1	2.7	321	165	173	85	23	4	1	0
*DATA	WidA5_2	10	275	1	2.7	324	162	154	90	11	8	3	0
*AVERAGE	WidA5_2	10	275	1	2.7	337	164.2	167.2	93.8	20.6	5.4	1	0.4

### Station 2

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_3	10	275	1	2.7	888	449	475	226	47	5	2	2
*DATA	WidA5_3	10	275	1	2.7	867	441	462	227	45	11	1	1
*DATA	WidA5_3	10	275	1	2.7	891	448	447	213	57	11	2	1
*DATA	WidA5_3	10	275	1	2.7	904	451	482	242	49	8	3	1
*DATA	WidA5_3	10	275	1	2.7	968	450	481	239	38	7	0	3
*AVERAGE	WidA5_3	10	275	1	2.7	903.6	447.8	469.4	229.4	47.2	8.4	1.6	1.6

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_4	10	275	1	2.7	891	448	447	213	57	11	2	1
*DATA	WidA5_4	10	275	1	2.7	904	451	482	242	49	8	3	1
*DATA	WidA5_4	10	275	1	2.7	938	463	486	226	34	12	3	1
*DATA	WidA5_4	10	275	1	2.7	967	481	447	211	37	19	2	3
*DATA	WidA5_4	10	275	1	2.7	860	480	440	227	45	6	2	1
*AVERAGE	WidA5_4	10	275	1	2.7	912	464.6	460.4	223.8	44.4	11.2	2.4	1.4

### Station 3

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_5	10	275	1	2.7	488	251	253	119	25	5	5	0
*DATA	WidA5_5	10	275	1	2.7	454	234	249	116	18	4	3	2
*DATA	WidA5_5	10	275	1	2.7	510	252	275	136	15	5	1	0
*DATA	WidA5_5	10	275	1	2.7	490	256	244	108	23	4	2	0
*DATA	WidA5_5	10	275	1	2.7	480	243	250	130	37	7	0	0
*AVERAGE	WidA5_5	10	275	1	2.7	484.4	247.2	254.2	121.8	23.6	5	2.2	0.4

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_6	10	275	1	2.7	510	252	275	136	15	5	1	0
*DATA	WidA5_6	10	275	1	2.7	490	256	244	108	23	4	2	0
*DATA	WidA5_6	10	275	1	2.7	476	254	228	128	26	2	2	0
*DATA	WidA5_6	10	275	1	2.7	479	241	225	137	17	1	2	0
*DATA	WidA5_6	10	275	1	2.7	491	244	216	107	20	6	2	3
*AVERAGE	WidA5_6	10	275	1	2.7	489.2	249.4	237.6	123.2	20.2	3.6	1.8	0.6

## Appendix B: Particles per cm2

### Widget F3

#### Station 1

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_1	10	2315	1	327	1,858	879	311	58	4	1	0	0
*DATA	WidF3_1	10	2315	1	327	1,856	880	326	55	5	1	1	1
*DATA	WidF3_1	10	2315	1	327	1,939	918	330	57	6	1	0	0
*DATA	WidF3_1	10	2315	1	327	1,897	890	305	48	5	1	0	0
*DATA	WidF3_1	10	2315	1	327	1,907	895	329	50	5	1	1	0
*AVERAGE	WidF3_1	10	2315	1	327	1,892	892	320	54	5	1	0	0

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_2	10	2315	1	327	1,955	893	334	59	6	1	0	0
*DATA	WidF3_2	10	2315	1	327	1,881	891	307	59	6	1	0	0
*DATA	WidF3_2	10	2315	1	327	2,004	917	285	50	6	1	0	0
*DATA	WidF3_2	10	2315	1	327	1,832	840	288	52	9	1	0	0
*DATA	WidF3_2	10	2315	1	327	1,892	890	301	58	7	0	0	0
*AVERAGE	WidF3_2	10	2315	1	327	1,913	886	303	56	7	1	0	0

#### Station 2

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_3	10	2315	1	327	2,340	1,048	374	57	8	1	1	0
*DATA	WidF3_3	10	2315	1	327	2,437	1,080	357	55	8	1	0	0
*DATA	WidF3_3	10	2315	1	327	2,416	1,051	355	54	7	0	0	0
*DATA	WidF3_3	10	2315	1	327	2,444	1,061	377	67	9	4	1	0
*DATA	WidF3_3	10	2315	1	327	2,416	1,076	352	55	8	3	1	0
*AVERAGE	WidF3_3	10	2315	1	327	2,410	1,063	363	58	8	2	1	0

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_4	10	2315	1	327	2,462	1,148	384	52	4	1	1	0
*DATA	WidF3_4	10	2315	1	327	2,467	1,119	396	60	7	2	0	0
*DATA	WidF3_4	10	2315	1	327	2,496	1,125	380	63	9	2	1	0
*DATA	WidF3_4	10	2315	1	327	2,515	1,134	374	64	8	4	3	2
*DATA	WidF3_4	10	2315	1	327	2,583	1,155	386	59	12	3	0	0
*AVERAGE	WidF3_4	10	2315	1	327	2,505	1,136	384	59	8	2	1	0

#### Station 3

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_5	10	2315	1	327	2,462	1,098	330	51	8	0	0	0
*DATA	WidF3_5	10	2315	1	327	2,496	1,068	340	62	6	1	0	0
*DATA	WidF3_5	10	2315	1	327	2,533	1,091	350	54	7	1	0	0
*DATA	WidF3_5	10	2315	1	327	2,484	1,061	339	57	6	1	0	0
*DATA	WidF3_5	10	2315	1	327	2,482	1,028	322	56	9	5	3	2
*AVERAGE	WidF3_5	10	2315	1	327	2,491	1,069	336	56	7	2	1	0

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_6	10	2315	1	327	2,485	1,061	340	57	6	1	1	1
*DATA	WidF3_6	10	2315	1	327	2,480	1,026	320	54	7	3	1	0
*DATA	WidF3_6	10	2315	1	327	2,577	1,124	353	54	8	2	1	0
*DATA	WidF3_6	10	2315	1	327	2,585	1,094	358	56	6	3	1	0
*DATA	WidF3_6	10	2315	1	327	2,558	1,085	358	64	7	3	2	1
*AVERAGE	WidF3_6	10	2315	1	327	2,537	1,078	346	57	7	2	1	0

## Widget C2

### Station 1

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_1	10	675	1	10.7	776	353	189	95	32	19	13	6
*DATA	WidC2_1	10	675	1	10.7	662	284	126	63	13	6	0	0
*DATA	WidC2_1	10	675	1	10.7	700	315	126	32	0	0	0	0
*DATA	WidC2_1	10	675	1	10.7	675	233	101	13	0	0	0	0
*DATA	WidC2_1	10	675	1	10.7	770	341	145	44	19	13	6	0
*AVERAGE	WidC2_1	10	675	1	10.7	717	305	138	49	13	8	4	1

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_2	10	675	1	10.7	700	315	126	32	0	0	0	0
*DATA	WidC2_2	10	675	1	10.7	675	233	101	13	0	0	0	0
*DATA	WidC2_2	10	675	1	10.7	902	366	189	88	19	13	6	0
*DATA	WidC2_2	10	675	1	10.7	732	347	139	69	19	0	0	0
*DATA	WidC2_2	10	675	1	10.7	694	290	170	63	19	0	0	0
*AVERAGE	WidC2_2	10	675	1	10.7	741	310	145	53	11	3	1	0

### Station 2

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_3	10	675	1	10.7	1,407	524	227	95	38	6	0	0
*DATA	WidC2_3	10	675	1	10.7	1,400	543	246	120	38	6	0	0
*DATA	WidC2_3	10	675	1	10.7	1,369	580	290	101	38	6	0	0
*DATA	WidC2_3	10	675	1	10.7	1,564	631	315	114	38	13	6	0
*DATA	WidC2_3	10	675	1	10.7	1,470	599	252	88	38	25	19	13
*AVERAGE	WidC2_3	10	675	1	10.7	1,442	575	266	103	38	11	5	3

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_4	10	675	1	10.7	1,369	580	290	101	38	6	0	0
*DATA	WidC2_4	10	675	1	10.7	1,564	631	315	114	38	13	6	0
*DATA	WidC2_4	10	675	1	10.7	1,558	688	328	95	6	0	0	0
*DATA	WidC2_4	10	675	1	10.7	1,489	625	328	95	38	0	0	0
*DATA	WidC2_4	10	675	1	10.7	1,438	574	240	88	32	19	13	6
*AVERAGE	WidC2_4	10	675	1	10.7	1,484	619	300	98	30	8	4	1

### Station 3

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_5	10	675	1	10.7	826	372	202	107	32	25	13	6
*DATA	WidC2_5	10	675	1	10.7	858	334	170	50	6	6	0	0
*DATA	WidC2_5	10	675	1	10.7	776	296	158	76	19	0	0	0
*DATA	WidC2_5	10	675	1	10.7	744	278	145	44	13	0	0	0
*DATA	WidC2_5	10	675	1	10.7	713	271	139	38	13	13	13	6
*AVERAGE	WidC2_5	10	675	1	10.7	784	310	163	63	16	9	5	3

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_6	10	675	1	10.7	776	296	158	76	19	0	0	0
*DATA	WidC2_6	10	675	1	10.7	744	278	145	44	13	0	0	0
*DATA	WidC2_6	10	675	1	10.7	801	379	164	38	13	6	0	0
*DATA	WidC2_6	10	675	1	10.7	801	309	114	44	25	13	13	6
*DATA	WidC2_6	10	675	1	10.7	902	416	227	107	13	13	0	0
*AVERAGE	WidC2_6	10	675	1	10.7	805	336	161	62	16	6	3	1

## Widget A5

### Station 1

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_1	10	275	1	2.7	8,158	4,797	3,188	1,497	336	102	51	41
*DATA	WidA5_1	10	275	1	2.7	7,985	4,919	3,168	1,344	255	51	10	0
*DATA	WidA5_1	10	275	1	2.7	8,444	4,950	3,086	1,355	367	51	20	10
*DATA	WidA5_1	10	275	1	2.7	8,301	4,695	3,066	1,436	306	92	10	10
*DATA	WidA5_1	10	275	1	2.7	7,425	4,451	3,005	1,263	285	81	20	10
*AVERAGE	WidA5_1	10	275	1	2.7	8,063	4,763	3,102	1,379	310	75	22	14

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_2	10	275	1	2.7	8,444	4,950	3,086	1,355	367	51	20	10
*DATA	WidA5_2	10	275	1	2.7	8,301	4,695	3,066	1,436	306	92	10	10
*DATA	WidA5_2	10	275	1	2.7	7,944	4,451	2,913	1,090	214	41	0	0
*DATA	WidA5_2	10	275	1	2.7	7,863	4,594	2,913	1,151	285	51	10	0
*DATA	WidA5_2	10	275	1	2.7	7,659	4,359	2,709	1,141	224	112	31	0
*AVERAGE	WidA5_2	10	275	1	2.7	8,042	4,610	2,937	1,234	279	69	14	4

### Station 2

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_3	10	275	1	2.7	21,328	12,283	7,710	2,872	570	92	41	20
*DATA	WidA5_3	10	275	1	2.7	20,931	12,100	7,608	2,903	591	132	20	10
*DATA	WidA5_3	10	275	1	2.7	21,083	12,008	7,445	2,893	723	143	31	10
*DATA	WidA5_3	10	275	1	2.7	21,796	12,589	7,995	3,086	621	122	41	10
*DATA	WidA5_3	10	275	1	2.7	22,265	12,406	7,822	2,923	489	102	31	31
*AVERAGE	WidA5_3	10	275	1	2.7	21,481	12,277	7,716	2,935	599	118	33	16

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_4	10	275	1	2.7	21,083	12,008	7,445	2,893	723	143	31	10
*DATA	WidA5_4	10	275	1	2.7	21,796	12,589	7,995	3,086	621	122	41	10
*DATA	WidA5_4	10	275	1	2.7	22,031	12,477	7,761	2,811	509	163	41	10
*DATA	WidA5_4	10	275	1	2.7	22,071	12,222	7,323	2,770	621	244	51	31
*DATA	WidA5_4	10	275	1	2.7	20,992	12,232	7,344	2,862	550	92	31	10
*AVERAGE	WidA5_4	10	275	1	2.7	21,595	12,306	7,574	2,884	605	153	39	14

### Station 3

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_5	10	275	1	2.7	11,672	6,702	4,145	1,569	356	102	51	0
*DATA	WidA5_5	10	275	1	2.7	11,000	6,376	3,993	1,456	275	92	51	20
*DATA	WidA5_5	10	275	1	2.7	12,161	6,967	4,400	1,599	214	61	10	0
*DATA	WidA5_5	10	275	1	2.7	11,479	6,488	3,881	1,395	295	61	20	0
*DATA	WidA5_5	10	275	1	2.7	11,682	6,794	4,319	1,772	448	71	0	0
*AVERAGE	WidA5_5	10	275	1	2.7	11,599	6,665	4,147	1,558	318	77	26	4

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_6	10	275	1	2.7	12,161	6,967	4,400	1,599	214	61	10	0
*DATA	WidA5_6	10	275	1	2.7	11,479	6,488	3,881	1,395	295	61	20	0
*DATA	WidA5_6	10	275	1	2.7	11,367	6,519	3,931	1,609	306	41	20	0
*DATA	WidA5_6	10	275	1	2.7	11,224	6,345	3,891	1,599	204	31	20	0
*DATA	WidA5_6	10	275	1	2.7	11,092	6,091	3,606	1,406	316	112	51	31
*AVERAGE	WidA5_6	10	275	1	2.7	11,464	6,482	3,942	1,522	267	61	24	6

## Appendix C: Particles per Part

### Widget F3

#### Station 1

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_1	10	2315	1	327	607,456	287,292	101,629	18,983	1,389	232	0	0
*DATA	WidF3_1	10	2315	1	327	606,993	287,755	106,722	17,826	1,621	463	232	232
*DATA	WidF3_1	10	2315	1	327	634,079	300,256	107,879	18,752	2,084	232	0	0
*DATA	WidF3_1	10	2315	1	327	620,420	290,996	99,777	15,742	1,621	232	0	0
*DATA	WidF3_1	10	2315	1	327	623,661	292,616	107,648	16,437	1,621	463	232	0
*AVERAGE	WidF3_1	10	2315	1	327	618,522	291,783	104,731	17,548	1,667	324	93	46

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_2	10	2315	1	327	639,172	292,153	109,268	19,215	1,852	463	0	0
*DATA	WidF3_2	10	2315	1	327	615,096	291,227	100,240	19,215	1,852	232	0	0
*DATA	WidF3_2	10	2315	1	327	655,145	299,793	93,063	16,437	2,084	232	0	0
*DATA	WidF3_2	10	2315	1	327	599,122	274,791	94,221	16,900	3,010	463	0	0
*DATA	WidF3_2	10	2315	1	327	618,568	290,996	98,388	18,983	2,315	0	0	0
*AVERAGE	WidF3_2	10	2315	1	327	625,420	289,792	99,036	18,150	2,222	278	0	0

#### Station 2

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_3	10	2315	1	327	765,108	342,852	122,232	18,752	2,547	463	232	0
*DATA	WidF3_3	10	2315	1	327	797,055	353,038	116,676	18,057	2,547	232	0	0
*DATA	WidF3_3	10	2315	1	327	789,878	343,546	116,213	17,594	2,315	0	0	0
*DATA	WidF3_3	10	2315	1	327	799,138	347,019	123,158	21,993	3,010	1,389	232	0
*DATA	WidF3_3	10	2315	1	327	789,878	351,880	115,056	18,057	2,547	926	463	0
*AVERAGE	WidF3_3	10	2315	1	327	788,211	347,667	118,667	18,890	2,593	602	185	0

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_4	10	2315	1	327	805,157	375,493	125,705	16,900	1,158	232	232	0
*DATA	WidF3_4	10	2315	1	327	806,778	366,002	129,409	19,678	2,315	695	0	0
*DATA	WidF3_4	10	2315	1	327	816,269	367,854	124,316	20,604	3,010	695	232	0
*DATA	WidF3_4	10	2315	1	327	822,288	370,863	122,232	20,835	2,778	1,389	926	695
*DATA	WidF3_4	10	2315	1	327	844,744	377,808	126,168	19,215	3,936	926	0	0
*AVERAGE	WidF3_4	10	2315	1	327	819,047	371,604	125,566	19,446	2,639	787	278	139

#### Station 3

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_5	10	2315	1	327	804,926	359,057	107,879	16,668	2,547	0	0	0
*DATA	WidF3_5	10	2315	1	327	816,038	349,334	111,120	20,372	2,084	232	0	0
*DATA	WidF3_5	10	2315	1	327	828,307	356,742	114,593	17,594	2,315	463	0	0
*DATA	WidF3_5	10	2315	1	327	812,334	346,787	110,889	18,520	1,852	232	0	0
*DATA	WidF3_5	10	2315	1	327	811,639	336,138	105,333	18,289	3,010	1,621	926	695
*AVERAGE	WidF3_5	10	2315	1	327	814,649	349,611	109,963	18,289	2,361	509	185	139

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_6	10	2315	1	327	812,565	347,019	111,120	18,752	2,084	463	232	232
*DATA	WidF3_6	10	2315	1	327	810,945	335,444	104,638	17,594	2,315	926	232	0
*DATA	WidF3_6	10	2315	1	327	842,660	367,391	115,287	17,594	2,547	695	232	0
*DATA	WidF3_6	10	2315	1	327	845,438	357,899	116,908	18,289	1,852	926	232	0
*DATA	WidF3_6	10	2315	1	327	836,410	354,658	117,139	20,835	2,315	926	695	463
*AVERAGE	WidF3_6	10	2315	1	327	829,603	352,482	113,018	18,613	2,222	787	324	139

## Widget C2

### Station 1

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_1	10	675	1	10.7	8,303	3,780	2,025	1,013	338	203	135	68
*DATA	WidC2_1	10	675	1	10.7	7,088	3,038	1,350	675	135	68	0	0
*DATA	WidC2_1	10	675	1	10.7	7,493	3,375	1,350	338	0	0	0	0
*DATA	WidC2_1	10	675	1	10.7	7,223	2,498	1,080	135	0	0	0	0
*DATA	WidC2_1	10	675	1	10.7	8,235	3,645	1,553	473	203	135	68	0
*AVERAGE	WidC2_1	10	675	1	10.7	7,668	3,267	1,472	527	135	81	41	14

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_2	10	675	1	10.7	7,493	3,375	1,350	338	0	0	0	0
*DATA	WidC2_2	10	675	1	10.7	7,223	2,498	1,080	135	0	0	0	0
*DATA	WidC2_2	10	675	1	10.7	9,653	3,915	2,025	945	203	135	68	0
*DATA	WidC2_2	10	675	1	10.7	7,830	3,713	1,485	743	203	0	0	0
*DATA	WidC2_2	10	675	1	10.7	7,425	3,105	1,823	675	203	0	0	0
*AVERAGE	WidC2_2	10	675	1	10.7	7,925	3,321	1,553	567	122	27	14	0

### Station 2

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_3	10	675	1	10.7	15,053	5,603	2,430	1,013	405	68	0	0
*DATA	WidC2_3	10	675	1	10.7	14,985	5,805	2,633	1,283	405	68	0	0
*DATA	WidC2_3	10	675	1	10.7	14,648	6,210	3,105	1,080	405	68	0	0
*DATA	WidC2_3	10	675	1	10.7	16,740	6,750	3,375	1,215	405	135	68	0
*DATA	WidC2_3	10	675	1	10.7	15,728	6,413	2,700	945	405	270	203	135
*AVERAGE	WidC2_3	10	675	1	10.7	15,431	6,156	2,849	1,107	405	122	54	27

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_4	10	675	1	10.7	14,648	6,210	3,105	1,080	405	68	0	0
*DATA	WidC2_4	10	675	1	10.7	16,740	6,750	3,375	1,215	405	135	68	0
*DATA	WidC2_4	10	675	1	10.7	16,673	7,358	3,510	1,013	68	0	0	0
*DATA	WidC2_4	10	675	1	10.7	15,930	6,683	3,510	1,013	405	0	0	0
*DATA	WidC2_4	10	675	1	10.7	15,390	6,143	2,565	945	338	203	135	68
*AVERAGE	WidC2_4	10	675	1	10.7	15,876	6,629	3,213	1,053	324	81	41	14

### Station 3

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_5	10	675	1	10.7	8,843	3,983	2,160	1,148	338	270	135	68
*DATA	WidC2_5	10	675	1	10.7	9,180	3,578	1,823	540	68	68	0	0
*DATA	WidC2_5	10	675	1	10.7	8,303	3,173	1,688	810	203	0	0	0
*DATA	WidC2_5	10	675	1	10.7	7,965	2,970	1,553	473	135	0	0	0
*DATA	WidC2_5	10	675	1	10.7	7,628	2,903	1,485	405	135	135	135	68
*AVERAGE	WidC2_5	10	675	1	10.7	8,384	3,321	1,742	675	176	95	54	27

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_6	10	675	1	10.7	8,303	3,173	1,688	810	203	0	0	0
*DATA	WidC2_6	10	675	1	10.7	7,965	2,970	1,553	473	135	0	0	0
*DATA	WidC2_6	10	675	1	10.7	8,573	4,050	1,755	405	135	68	0	0
*DATA	WidC2_6	10	675	1	10.7	8,573	3,308	1,215	473	270	135	135	68
*DATA	WidC2_6	10	675	1	10.7	9,653	4,455	2,430	1,148	135	135	0	0
*AVERAGE	WidC2_6	10	675	1	10.7	8,613	3,591	1,728	662	176	68	27	14

## Widget A5

### Station 1

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_1	10	275	1	2.7	22,028	12,953	8,608	4,043	908	275	138	110
*DATA	WidA5_1	10	275	1	2.7	21,560	13,283	8,553	3,630	688	138	28	0
*DATA	WidA5_1	10	275	1	2.7	22,798	13,365	8,333	3,658	990	138	55	28
*DATA	WidA5_1	10	275	1	2.7	22,413	12,678	8,278	3,878	825	248	28	28
*DATA	WidA5_1	10	275	1	2.7	20,048	12,018	8,113	3,410	770	220	55	28
*AVERAGE	WidA5_1	10	275	1	2.7	21,769	12,859	8,377	3,724	836	204	61	39

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_2	10	275	1	2.7	22,798	13,365	8,333	3,658	990	138	55	28
*DATA	WidA5_2	10	275	1	2.7	22,413	12,678	8,278	3,878	825	248	28	28
*DATA	WidA5_2	10	275	1	2.7	21,450	12,018	7,865	2,943	578	110	0	0
*DATA	WidA5_2	10	275	1	2.7	21,230	12,403	7,865	3,108	770	138	28	0
*DATA	WidA5_2	10	275	1	2.7	20,680	11,770	7,315	3,080	605	303	83	0
*AVERAGE	WidA5_2	10	275	1	2.7	21,714	12,447	7,931	3,333	754	187	39	11

### Station 2

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_3	10	275	1	2.7	57,585	33,165	20,818	7,755	1,540	248	110	55
*DATA	WidA5_3	10	275	1	2.7	56,513	32,670	20,543	7,838	1,595	358	55	28
*DATA	WidA5_3	10	275	1	2.7	56,925	32,423	20,103	7,810	1,953	385	83	28
*DATA	WidA5_3	10	275	1	2.7	58,850	33,990	21,588	8,333	1,678	330	110	28
*DATA	WidA5_3	10	275	1	2.7	60,115	33,495	21,120	7,893	1,320	275	83	83
*AVERAGE	WidA5_3	10	275	1	2.7	57,998	33,149	20,834	7,926	1,617	319	88	44

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_4	10	275	1	2.7	56,925	32,423	20,103	7,810	1,953	385	83	28
*DATA	WidA5_4	10	275	1	2.7	58,850	33,990	21,588	8,333	1,678	330	110	28
*DATA	WidA5_4	10	275	1	2.7	59,483	33,688	20,955	7,590	1,375	440	110	28
*DATA	WidA5_4	10	275	1	2.7	59,593	33,000	19,773	7,480	1,678	660	138	83
*DATA	WidA5_4	10	275	1	2.7	56,678	33,028	19,828	7,728	1,485	248	83	28
*AVERAGE	WidA5_4	10	275	1	2.7	58,306	33,226	20,449	7,788	1,634	413	105	39

### Station 3

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_5	10	275	1	2.7	31,515	18,095	11,193	4,235	963	275	138	0
*DATA	WidA5_5	10	275	1	2.7	29,700	17,215	10,780	3,933	743	248	138	55
*DATA	WidA5_5	10	275	1	2.7	32,835	18,810	11,880	4,318	578	165	28	0
*DATA	WidA5_5	10	275	1	2.7	30,993	17,518	10,478	3,768	798	165	55	0
*DATA	WidA5_5	10	275	1	2.7	31,543	18,343	11,660	4,785	1,210	193	0	0
*AVERAGE	WidA5_5	10	275	1	2.7	31,317	17,996	11,198	4,208	858	209	72	11

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_6	10	275	1	2.7	32,835	18,810	11,880	4,318	578	165	28	0
*DATA	WidA5_6	10	275	1	2.7	30,993	17,518	10,478	3,768	798	165	55	0
*DATA	WidA5_6	10	275	1	2.7	30,690	17,600	10,615	4,345	825	110	55	0
*DATA	WidA5_6	10	275	1	2.7	30,305	17,133	10,505	4,318	550	83	55	0
*DATA	WidA5_6	10	275	1	2.7	29,948	16,445	9,735	3,795	853	303	138	83
*AVERAGE	WidA5_6	10	275	1	2.7	30,954	17,501	10,643	4,109	721	165	66	17

## Appendix D: Particles per mL

### Widget F3

#### Station 1

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_1	10	2315	1	327	262.4	124.1	43.9	8.2	0.6	0.1	0.0	0.0
*DATA	WidF3_1	10	2315	1	327	262.2	124.3	46.1	7.7	0.7	0.2	0.1	0.1
*DATA	WidF3_1	10	2315	1	327	273.9	129.7	46.6	8.1	0.9	0.1	0.0	0.0
*DATA	WidF3_1	10	2315	1	327	268.0	125.7	43.1	6.8	0.7	0.1	0.0	0.0
*DATA	WidF3_1	10	2315	1	327	269.4	126.4	46.5	7.1	0.7	0.2	0.1	0.0
*AVERAGE	WidF3_1	10	2315	1	327	267.2	126.0	45.2	7.6	0.7	0.1	0.0	0.0

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_2	10	2315	1	327	276.1	126.2	47.2	8.3	0.8	0.2	0.0	0.0
*DATA	WidF3_2	10	2315	1	327	265.7	125.8	43.3	8.3	0.8	0.1	0.0	0.0
*DATA	WidF3_2	10	2315	1	327	283.0	129.5	40.2	7.1	0.9	0.1	0.0	0.0
*DATA	WidF3_2	10	2315	1	327	258.8	118.7	40.7	7.3	1.3	0.2	0.0	0.0
*DATA	WidF3_2	10	2315	1	327	267.2	125.7	42.5	8.2	1.0	0.0	0.0	0.0
*AVERAGE	WidF3_2	10	2315	1	327	270.2	125.2	42.8	7.8	1.0	0.1	0.0	0.0

#### Station 2

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_3	10	2315	1	327	330.5	148.1	52.8	8.1	1.1	0.2	0.1	0.0
*DATA	WidF3_3	10	2315	1	327	344.3	152.5	50.4	7.8	1.1	0.1	0.0	0.0
*DATA	WidF3_3	10	2315	1	327	341.2	148.4	50.2	7.6	1.0	0.0	0.0	0.0
*DATA	WidF3_3	10	2315	1	327	345.2	149.9	53.2	9.5	1.3	0.6	0.1	0.0
*DATA	WidF3_3	10	2315	1	327	341.2	152.0	49.7	7.8	1.1	0.4	0.2	0.0
*AVERAGE	WidF3_3	10	2315	1	327	340.5	150.2	51.3	8.2	1.1	0.3	0.1	0.0

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_4	10	2315	1	327	347.8	162.2	54.3	7.3	0.5	0.1	0.1	0.0
*DATA	WidF3_4	10	2315	1	327	348.5	158.1	55.9	8.5	1.0	0.3	0.0	0.0
*DATA	WidF3_4	10	2315	1	327	352.6	158.9	53.7	8.9	1.3	0.3	0.1	0.0
*DATA	WidF3_4	10	2315	1	327	355.2	160.2	52.8	9.0	1.2	0.6	0.4	0.3
*DATA	WidF3_4	10	2315	1	327	364.9	163.2	54.5	8.3	1.7	0.4	0.0	0.0
*AVERAGE	WidF3_4	10	2315	1	327	353.8	160.5	54.2	8.4	1.1	0.3	0.1	0.1

#### Station 3

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_5	10	2315	1	327	347.7	155.1	46.6	7.2	1.1	0.0	0.0	0.0
*DATA	WidF3_5	10	2315	1	327	352.5	150.9	48.0	8.8	0.9	0.1	0.0	0.0
*DATA	WidF3_5	10	2315	1	327	357.8	154.1	49.5	7.6	1.0	0.2	0.0	0.0
*DATA	WidF3_5	10	2315	1	327	350.9	149.8	47.9	8.0	0.8	0.1	0.0	0.0
*DATA	WidF3_5	10	2315	1	327	350.6	145.2	45.5	7.9	1.3	0.7	0.4	0.3
*AVERAGE	WidF3_5	10	2315	1	327	351.9	151.0	47.5	7.9	1.0	0.2	0.1	0.1

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidF3_6	10	2315	1	327	351.0	149.9	48.0	8.1	0.9	0.2	0.1	0.1
*DATA	WidF3_6	10	2315	1	327	350.3	144.9	45.2	7.6	1.0	0.4	0.1	0.0
*DATA	WidF3_6	10	2315	1	327	364.0	158.7	49.8	7.6	1.1	0.3	0.1	0.0
*DATA	WidF3_6	10	2315	1	327	365.2	154.6	50.5	7.9	0.8	0.4	0.1	0.0
*DATA	WidF3_6	10	2315	1	327	361.3	153.2	50.6	9.0	1.0	0.4	0.3	0.2
*AVERAGE	WidF3_6	10	2315	1	327	358.4	152.3	48.8	8.0	1.0	0.3	0.1	0.1

## Widget C2

### Station 1

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_1	10	675	1	10.7	12.3	5.6	3.0	1.5	0.5	0.3	0.2	0.1
*DATA	WidC2_1	10	675	1	10.7	10.5	4.5	2.0	1.0	0.2	0.1	0.0	0.0
*DATA	WidC2_1	10	675	1	10.7	11.1	5.0	2.0	0.5	0.0	0.0	0.0	0.0
*DATA	WidC2_1	10	675	1	10.7	10.7	3.7	1.6	0.2	0.0	0.0	0.0	0.0
*DATA	WidC2_1	10	675	1	10.7	12.2	5.4	2.3	0.7	0.3	0.2	0.1	0.0
*AVERAGE	WidC2_1	10	675	1	10.7	11.4	4.8	2.2	0.8	0.2	0.1	0.1	0.0

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_2	10	675	1	10.7	11.1	5.0	2.0	0.5	0.0	0.0	0.0	0.0
*DATA	WidC2_2	10	675	1	10.7	10.7	3.7	1.6	0.2	0.0	0.0	0.0	0.0
*DATA	WidC2_2	10	675	1	10.7	14.3	5.8	3.0	1.4	0.3	0.2	0.1	0.0
*DATA	WidC2_2	10	675	1	10.7	11.6	5.5	2.2	1.1	0.3	0.0	0.0	0.0
*DATA	WidC2_2	10	675	1	10.7	11.0	4.6	2.7	1.0	0.3	0.0	0.0	0.0
*AVERAGE	WidC2_2	10	675	1	10.7	11.7	4.9	2.3	0.8	0.2	0.0	0.0	0.0

### Station 2

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_3	10	675	1	10.7	22.3	8.3	3.6	1.5	0.6	0.1	0.0	0.0
*DATA	WidC2_3	10	675	1	10.7	22.2	8.6	3.9	1.9	0.6	0.1	0.0	0.0
*DATA	WidC2_3	10	675	1	10.7	21.7	9.2	4.6	1.6	0.6	0.1	0.0	0.0
*DATA	WidC2_3	10	675	1	10.7	24.8	10.0	5.0	1.8	0.6	0.2	0.1	0.0
*DATA	WidC2_3	10	675	1	10.7	23.3	9.5	4.0	1.4	0.6	0.4	0.3	0.2
*AVERAGE	WidC2_3	10	675	1	10.7	22.9	9.1	4.2	1.6	0.6	0.2	0.1	0.0

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_4	10	675	1	10.7	21.7	9.2	4.6	1.6	0.6	0.1	0.0	0.0
*DATA	WidC2_4	10	675	1	10.7	24.8	10.0	5.0	1.8	0.6	0.2	0.1	0.0
*DATA	WidC2_4	10	675	1	10.7	24.7	10.9	5.2	1.5	0.1	0.0	0.0	0.0
*DATA	WidC2_4	10	675	1	10.7	23.6	9.9	5.2	1.5	0.6	0.0	0.0	0.0
*DATA	WidC2_4	10	675	1	10.7	22.8	9.1	3.8	1.4	0.5	0.3	0.2	0.1
*AVERAGE	WidC2_4	10	675	1	10.7	23.5	9.8	4.8	1.6	0.5	0.1	0.1	0.0

### Station 3

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_5	10	675	1	10.7	13.1	5.9	3.2	1.7	0.5	0.4	0.2	0.1
*DATA	WidC2_5	10	675	1	10.7	13.6	5.3	2.7	0.8	0.1	0.1	0.0	0.0
*DATA	WidC2_5	10	675	1	10.7	12.3	4.7	2.5	1.2	0.3	0.0	0.0	0.0
*DATA	WidC2_5	10	675	1	10.7	11.8	4.4	2.3	0.7	0.2	0.0	0.0	0.0
*DATA	WidC2_5	10	675	1	10.7	11.3	4.3	2.2	0.6	0.2	0.2	0.2	0.1
*AVERAGE	WidC2_5	10	675	1	10.7	12.4	4.9	2.6	1.0	0.3	0.1	0.1	0.0

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidC2_6	10	675	1	10.7	12.3	4.7	2.5	1.2	0.3	0.0	0.0	0.0
*DATA	WidC2_6	10	675	1	10.7	11.8	4.4	2.3	0.7	0.2	0.0	0.0	0.0
*DATA	WidC2_6	10	675	1	10.7	12.7	6.0	2.6	0.6	0.2	0.1	0.0	0.0
*DATA	WidC2_6	10	675	1	10.7	12.7	4.9	1.8	0.7	0.4	0.2	0.2	0.1
*DATA	WidC2_6	10	675	1	10.7	14.3	6.6	3.6	1.7	0.2	0.2	0.0	0.0
*AVERAGE	WidC2_6	10	675	1	10.7	12.8	5.3	2.6	1.0	0.3	0.1	0.0	0.0

## Widget A5

### Station 1

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_1	10	275	1	2.7	80.1	47.1	31.3	14.7	3.3	1.0	0.5	0.4
*DATA	WidA5_1	10	275	1	2.7	78.4	48.3	31.1	13.2	2.5	0.5	0.1	0.0
*DATA	WidA5_1	10	275	1	2.7	82.9	48.6	30.3	13.3	3.6	0.5	0.2	0.1
*DATA	WidA5_1	10	275	1	2.7	81.5	46.1	30.1	14.1	3.0	0.9	0.1	0.1
*DATA	WidA5_1	10	275	1	2.7	72.9	43.7	29.5	12.4	2.8	0.8	0.2	0.1
*AVERAGE	WidA5_1	10	275	1	2.7	79.2	46.8	30.5	13.5	3.0	0.7	0.2	0.1

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_2	10	275	1	2.7	82.9	48.6	30.3	13.3	3.6	0.5	0.2	0.1
*DATA	WidA5_2	10	275	1	2.7	81.5	46.1	30.1	14.1	3.0	0.9	0.1	0.1
*DATA	WidA5_2	10	275	1	2.7	78.0	43.7	28.6	10.7	2.1	0.4	0.0	0.0
*DATA	WidA5_2	10	275	1	2.7	77.2	45.1	28.6	11.3	2.8	0.5	0.1	0.0
*DATA	WidA5_2	10	275	1	2.7	75.2	42.8	26.6	11.2	2.2	1.1	0.3	0.0
*AVERAGE	WidA5_2	10	275	1	2.7	79.0	45.3	28.8	12.1	2.7	0.7	0.1	0.0

### Station 2

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_3	10	275	1	2.7	209.4	120.6	75.7	28.2	5.6	0.9	0.4	0.2
*DATA	WidA5_3	10	275	1	2.7	205.5	118.8	74.7	28.5	5.8	1.3	0.2	0.1
*DATA	WidA5_3	10	275	1	2.7	207.0	117.9	73.1	28.4	7.1	1.4	0.3	0.1
*DATA	WidA5_3	10	275	1	2.7	214.0	123.6	78.5	30.3	6.1	1.2	0.4	0.1
*DATA	WidA5_3	10	275	1	2.7	218.6	121.8	76.8	28.7	4.8	1.0	0.3	0.3
*AVERAGE	WidA5_3	10	275	1	2.7	210.9	120.5	75.8	28.8	5.9	1.2	0.3	0.2

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_4	10	275	1	2.7	207.0	117.9	73.1	28.4	7.1	1.4	0.3	0.1
*DATA	WidA5_4	10	275	1	2.7	214.0	123.6	78.5	30.3	6.1	1.2	0.4	0.1
*DATA	WidA5_4	10	275	1	2.7	216.3	122.5	76.2	27.6	5.0	1.6	0.4	0.1
*DATA	WidA5_4	10	275	1	2.7	216.7	120.0	71.9	27.2	6.1	2.4	0.5	0.3
*DATA	WidA5_4	10	275	1	2.7	206.1	120.1	72.1	28.1	5.4	0.9	0.3	0.1
*AVERAGE	WidA5_4	10	275	1	2.7	212.0	120.8	74.4	28.3	5.9	1.5	0.4	0.1

### Station 3

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_5	10	275	1	2.7	114.6	65.8	40.7	15.4	3.5	1.0	0.5	0.0
*DATA	WidA5_5	10	275	1	2.7	108.0	62.6	39.2	14.3	2.7	0.9	0.5	0.2
*DATA	WidA5_5	10	275	1	2.7	119.4	68.4	43.2	15.7	2.1	0.6	0.1	0.0
*DATA	WidA5_5	10	275	1	2.7	112.7	63.7	38.1	13.7	2.9	0.6	0.2	0.0
*DATA	WidA5_5	10	275	1	2.7	114.7	66.7	42.4	17.4	4.4	0.7	0.0	0.0
*AVERAGE	WidA5_5	10	275	1	2.7	113.9	65.4	40.7	15.3	3.1	0.8	0.3	0.0

Data Type	Part ID	Samp Vol	Cont Vol	Parts	Area	0.5	0.7	1	2	5	10	15	20
*DATA	WidA5_6	10	275	1	2.7	119.4	68.4	43.2	15.7	2.1	0.6	0.1	0.0
*DATA	WidA5_6	10	275	1	2.7	112.7	63.7	38.1	13.7	2.9	0.6	0.2	0.0
*DATA	WidA5_6	10	275	1	2.7	111.6	64.0	38.6	15.8	3.0	0.4	0.2	0.0
*DATA	WidA5_6	10	275	1	2.7	110.2	62.3	38.2	15.7	2.0	0.3	0.2	0.0
*DATA	WidA5_6	10	275	1	2.7	108.9	59.8	35.4	13.8	3.1	1.1	0.5	0.3
*AVERAGE	WidA5_6	10	275	1	2.7	112.6	63.6	38.7	14.9	2.6	0.6	0.2	0.1



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