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13818 Oaks Avenue
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Result: COMPLETE

Report Date: 08-OCT-2012

Customer Name: AcornVac, Inc.
Location of Testing: NSF International, 789 N. Dixboro Rd., Ann Arbor, MI 48105
Tested To: Custom Testing - NSF Mechanical Plumbing Program
Description: Four toilet configurations: Cistern Flush Toilet, Flushometer Toilet, AcornVac Vacuum Flush Stainless Steel Toilet, AcornVac Vacuum Flush Porcelain Toilet
Test Type: Test Only
Job Number: J-00112672, J-00112673, J-00112674, and J-00112675
Project Number: 9130534 (ML01, PL01)
Project Manager: Amy Harrison

Executive Summary: Four types of toilets were filled with a solution of E.Coli and flushed using a standardized water supply. Three trials were performed on each toilet and the overspray was measured using an array of Petri dishes arranged around the toilet on the seat, floor and wall. Microbial analysis of the Petri dishes demonstrated that the two AcornVac vacuum toilets had non-detectable levels of overspray. The cistern toilet had measurable levels of bacteria on the toilet rim. The flushometer toilet had measurable levels of bacteria on the toilet rim and on the floor adjacent to the toilet.

Thank you for having your product tested by NSF International.

Please contact your Project Manager if you have any questions or concerns pertaining to this report.

Report Authorization: _____
Director, Microbiology Laboratory

Report Authorization: _____
Manager, Engineering Laboratory



Scope of Services

Four toilets were provided by the client for analysis of the overspray characteristics of each of the flushing mechanisms. The hypothesis was that the vacuum toilets introduce less overspray to the surrounding environment and are more sanitary. The toilets were plumbed to a standardized water supply and challenged with E.Coli bacteria. The overspray was collected on Petri dishes surrounding the toilets and analyzed for the presence of E.Coli colonies.

Test Setup

Culture Preparation

E. coli was reconstituted in 10 mL Tryptic Soy Broth and passed 2 times. The final passage was to Tryptic Soy Agar slants. All incubations were performed at 35°C for 24 hours. Slants were harvested with 5 mL sterile buffered dilution water (SBDW) each and the resulting culture was consolidated to constitute a final *E. coli* concentration of approximately 1×10^{10} CFU/mL. A diluted suspension of *E.coli* was prepared for each replicate test to target a final concentration of 1×10^7 CFU/mL in the toilet water. The diluted suspension of *E.coli* culture was delivered to Engineering staff for physical testing of the toilet.

Products Tested

The following products were evaluated:

- A. J-00112672 – Cistern Flush Toilet: *Two-piece high efficiency (1.28 GPF) porcelain toilet with elongated bowl, floor waste outlet and hinged seat with closed front.*
- B. J-00112673 – Flush Valve Toilet: *Wall hung elongated porcelain toilet bowl with top spud for exposed 1.6 GPF flush valve and hinged seat with open front.*
- C. J-00112674 – Vacuum Flush Stainless Steel Toilet: *AcornVac floor mounted elongated stainless steel vacuum toilet bowl with rear waste discharge, flush inlet for 0.5 GPF flush valve and hinged seat with open front.*
- D. J-00112675 – Vacuum Flush Porcelain Toilet: *AcornVac wall hung elongated porcelain vacuum toilet bowl with rear flush inlet for 0.5 GPF flush valve and hinged seat with open front.*

Toilet Installation

Each of the toilets was installed in a simulated bathroom stall (4'x4') consisting of a wooden floor and back wall and surrounded by plastic sheeting on the other three sides. A one-inch water supply was plumbed through a carbon filter to remove any chlorine. The water pressure on all toilets was regulated to 75 psi static and 65 psi flowing using booster pumps and pressure regulators as necessary.

Test Protocol

Physical Testing

For each replicate test, mEndo plates were positioned around the toilet set up with their covers still attached (see Figure 1 and 2). The prepared diluted suspension of E.coli was poured into the toilet and mixed with a sterile pipette for 15 seconds to homogenously suspend the bacteria. A 1mL volume of toilet water was collected to verify the concentration of E.coli. Following toilet water inoculation, agar plate covers were removed to expose the agar surface and the toilet was flushed. Five minutes post flushing, the agar plate surfaces were covered, collected from the test set up and sent to the microbiology lab for analysis.



Figure 1 - Vacuum Flush Stainless Steel Toilet - AcornVac

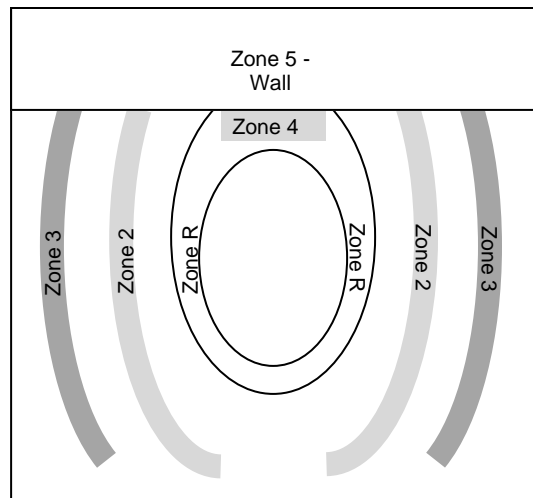


Figure 2 - mEndo plate layout

Microbial Analysis

mEndo settling plates for the detection of E. coli contaminated toilet water were collected from the test set up and incubated at $35 \text{ }^\circ \pm 2^\circ\text{C}$ for 48 hours. Challenge verification samples were diluted in SBDW, spread plated, and incubated in the same manner. mEndo settling plate results were reported out in “contaminated droplets per plate” to demonstrate the overspray which occurs upon flushing the test toilet, rather than reporting the number of organisms per plate which could vary depending on the droplet size. The number of droplets per zone was also calculated. Challenge verification for each replicate was reported out in CFU per mL to express the concentration of the E.coli culture in the toilet water prior to flushing.



Results

J-00112672 - Cistern Flush Toilet

Replicate	Total Contaminated Droplets per Zone						
	Zone R	Zone 2		Zone 3		Zone 4	Zone 5
		Left	Right	Left	Right		
1	3	ND	ND	ND	ND	ND	ND
2	ND	ND	ND	ND	ND	ND	ND
3	5	ND	1	ND	ND	ND	ND
Average	4	ND	0.3	ND	ND	ND	ND

J-00112673 - Flush Valve Toilet

Replicate	Total Contaminated Droplets per Zone						
	Zone R	Zone 2		Zone 3		Zone 4	Zone 5
		Left	Right	Left	Right		
1	8	4	11	ND	ND	ND	ND
2	18	ND	2	1	ND	ND	ND
3	7	ND	2	2	ND	ND	ND
Average	11	1.3	5	ND	ND	ND	ND

J-00112674 - Vacuum Flush Stainless Steel Toilet - AcornVac

Replicate	Total Contaminated Droplets per Zone						
	Zone R	Zone 2		Zone 3		Zone 4	Zone 5
		Left	Right	Left	Right		
1	ND	ND	ND	ND	ND	ND	ND
2	ND	ND	ND	ND	ND	ND	ND
3	ND	ND	ND	ND	ND	ND	ND
Average	ND	ND	ND	ND	ND	ND	ND

J-00112675 - Vacuum Flush Porcelain Toilet - AcornVac

Replicate	Total Contaminated Droplets per Zone						
	Zone R	Zone 2		Zone 3		Zone 4	Zone 5
		Left	Right	Left	Right		
1	ND	ND	ND	ND	ND	ND	ND
2	ND	ND	ND	ND	ND	ND	ND
3	ND	ND	ND	ND	ND	ND	ND
Average	ND	ND	ND	ND	ND	ND	ND

ND = Non-Detectable

Contamination Pictographs

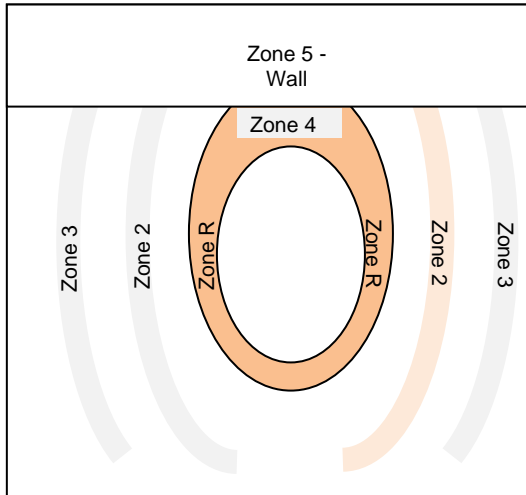


Figure 3 - Cistern Flush Toilet

Rim Zone Contamination (avg) = 4
Zone 2 Contamination (avg) = 0.3
Zone 3-5 Contamination = Non-detectable

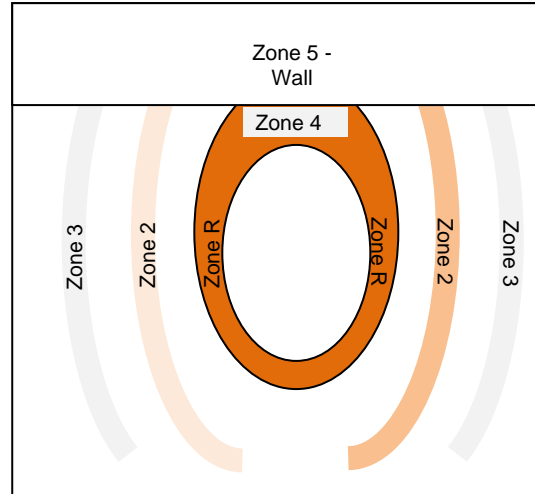


Figure 4 - Flush Valve Toilet

Rim Zone Contamination (avg) = 11
Zone 2 Contamination (avg) = 3
Zone 3-5 Contamination = Non-detectable

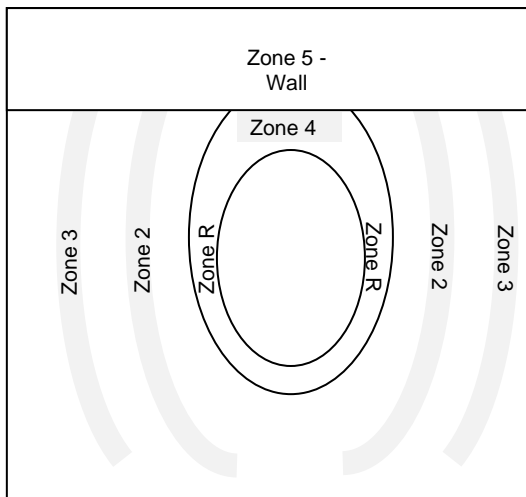


Figure 5 - AcornVac Vacuum Flush Stainless Steel Toilet

Rim Zone Contamination (avg) = Non-detectable
Zone 2 Contamination (avg) = Non-detectable
Zone 3-5 Contamination = Non-detectable

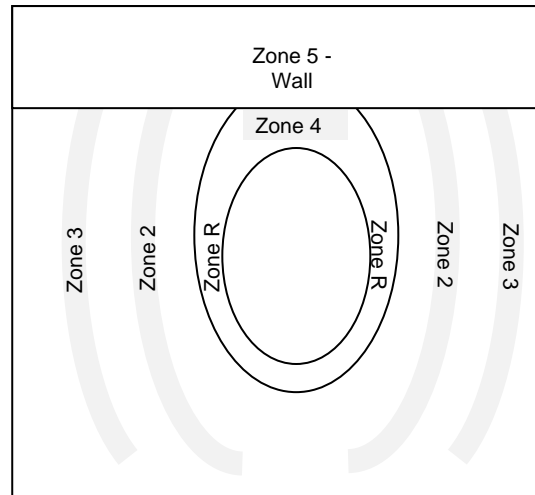


Figure 6 - AcornVac Vacuum Flush Porcelain Toilet

Rim Zone Contamination (avg) = Non-detectable
Zone 2 Contamination (avg) = Non-detectable
Zone 3-5 Contamination = Non-detectable

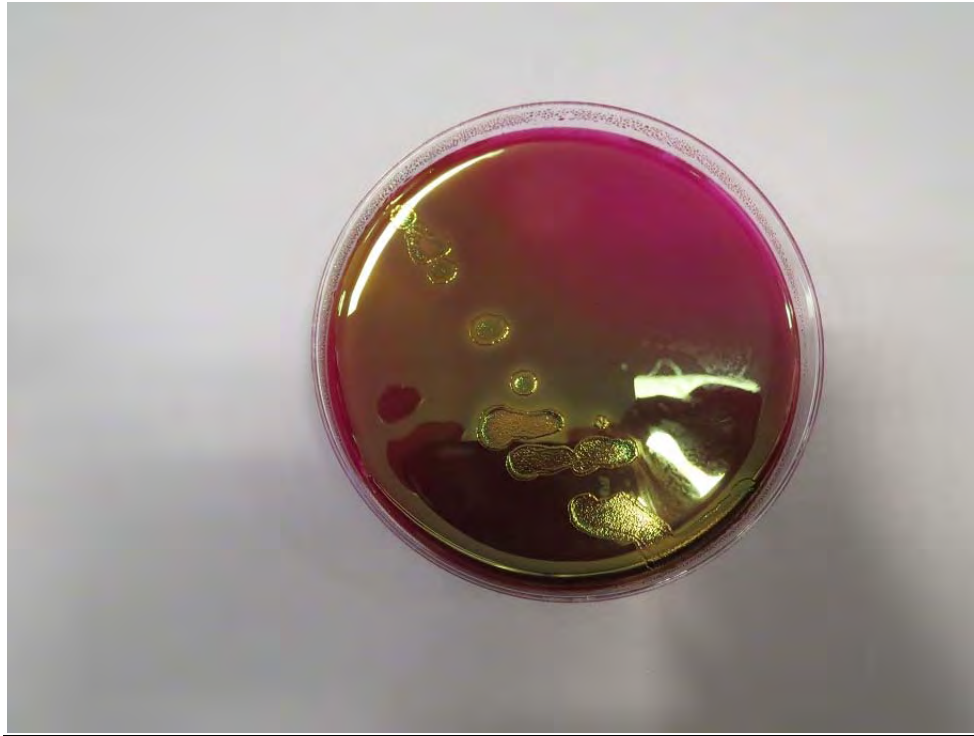


Figure 7 - Example mEndo agar test plate with E.coli ATCC 25922

Conclusion

Microbial analysis of the Petri dishes demonstrated that the two vacuum toilets had non-detectable levels of overspray. The cistern toilet had measurable levels of bacteria on the toilet rim. The flushometer toilet had measurable levels of bacteria on the toilet rim and on the floor adjacent to the toilet.

This report replaces report serial number FI20120925000010. The report is being re-issued to correct typographical issues in the sample descriptions. This does not change the overall pass fail status of the report.

J-00112672 – Cistern Flush Toilet

6/13/2012

ND = non-detectable
Challenge Organism: E.coli ATCC 25922

Replicate 1

Zone R		Zone 2		Zone 3		Zone 4		Zone 5		Challenge Verification
Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	CFU/ml of Toilet Water
1	ND	1R	ND	1L	ND	1R	ND	1L	ND	2.01E+07
2	ND	2R	ND	2L	ND	2R	ND	2L	ND	
3	ND	3R	ND	3L	ND	3R	ND	3L	ND	
4	2	4R	ND	4L	ND	4R	ND	4L	ND	
5	1	5R	ND	5L	ND	5R	ND	5L	ND	
6	ND	6R	ND	6L	ND	6R	ND	6L	ND	
7	ND	7R	ND	7L	ND	7R	ND	7L	ND	
8	ND	8R	ND	8L	ND	8R	ND	8L	ND	
9	ND									
10	ND									

Total Contaminated Droplets per Zone

3 ND ND ND ND ND ND

Replicate 2

Zone R		Zone 2		Zone 3		Zone 4		Zone 5		Challenge Verification
Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	CFU/ml of Toilet Water
1	ND	1R	ND	1L	ND	1R	ND	1L	ND	1.90E+07
2	ND	2R	ND	2L	ND	2R	ND	2L	ND	
3	ND	3R	ND	3L	ND	3R	ND	3L	ND	
4	ND	4R	ND	4L	ND	4R	ND	4L	ND	
5	ND	5R	ND	5L	ND	5R	ND	5L	ND	
6	ND	6R	ND	6L	ND	6R	ND	6L	ND	
7	ND	7R	ND	7L	ND	7R	ND	7L	ND	
8	ND	8R	ND	8L	ND	8R	ND	8L	ND	
9	ND									
10	ND									

Total Contaminated Droplets per Zone

ND ND ND ND ND ND ND

Replicate 3

Zone R		Zone 2		Zone 3		Zone 4		Zone 5		Challenge Verification
Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	CFU/ml of Toilet Water
1	ND	1R	ND	1L	ND	1R	ND	1L	ND	1.86E+07
2	1	2R	ND	2L	ND	2R	ND	2L	ND	
3	2	3R	ND	3L	ND	3R	ND	3L	ND	
4	1	4R	ND	4L	ND	4R	ND	4L	ND	
5	1	5R	ND	5L	ND	5R	ND	5L	ND	
6	ND	6R	ND	6L	ND	6R	ND	6L	ND	
7	ND	7R	ND	7L	1.00E+00	7R	ND	7L	ND	
8	ND	8R	ND	8L	ND	8R	ND	8L	ND	
9	ND									
10	ND									

Total Contaminated Droplets per Zone

5 ND 1 ND ND ND ND

Raw Data

J-00112673 – Flush Valve Toilet

6/13/2012

ND = non-detectable

Challenge Organism: *E. coli* ATCC 25922

Replicate 1

Zone R		Zone 2		Zone 3		Zone 4		Zone 5		Challenge Verification
Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	CFU/ml of Toilet Water
1	1	1R	ND	1L	ND	1R	ND	1L	ND	7.40E+06
2	1	2R	ND	2L	ND	2R	ND	2L	ND	
3	ND	3R	1	3L	ND	3R	ND	3L	ND	
4	1	4R	ND	4L	ND	4R	ND	4L	ND	
5	ND	5R	ND	5L	ND	5R	ND	5L	ND	
6	1	6R	1	6L	11	6R	ND	6L	ND	
7	ND	7R	ND	7L	ND	7R	ND	7L	ND	
8	1	8R	2	8L	ND	8R	ND	8L	ND	
9	1									
10	2									

Total Contaminated Droplets per Zone

8 4 11 ND ND ND ND

Replicate 2

Zone R		Zone 2		Zone 3		Zone 4		Zone 5		Challenge Verification
Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	CFU/ml of Toilet Water
1	1	1R	ND	1L	ND	1R	ND	1L	ND	1.13E+07
2	1	2R	ND	2L	ND	2R	1	2L	ND	
3	ND	3R	ND	3L	ND	3R	ND	3L	ND	
4	ND	4R	ND	4L	1	4R	ND	4L	ND	
5	ND	5R	ND	5L	1	5R	ND	5L	ND	
6	ND	6R	ND	6L	ND	6R	ND	6L	ND	
7	ND	7R	ND	7L	ND	7R	ND	7L	ND	
8	5	8R	ND	8L	ND	8R	ND	8L	ND	
9	6									
10	5									

Total Contaminated Droplets per Zone

18 ND 2 1 ND ND ND

Replicate 3

Zone R		Zone 2		Zone 3		Zone 4		Zone 5		Challenge Verification
Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	CFU/ml of Toilet Water
1	1	1R	ND	1L	ND	1R	2	1L	ND	2.51E+07
2	ND	2R	ND	2L	ND	2R	ND	2L	ND	
3	1	3R	ND	3L	ND	3R	ND	3L	ND	
4	1	4R	ND	4L	ND	4R	ND	4L	ND	
5	ND	5R	ND	5L	1	5R	ND	5L	ND	
6	ND	6R	ND	6L	1	6R	ND	6L	ND	
7	1	7R	ND	7L	ND	7R	ND	7L	ND	
8	1	8R	ND	8L	ND	8R	ND	8L	ND	
9	1									
10	1									

Total Contaminated Droplets per Zone

7 ND 2 2 ND ND ND

J-00112674 – Vacuum Flush Stainless Steel Toilet - AcornVac

6/13/2012

ND = non-detectable
Challenge Organism: E.coli ATCC 25922

Replicate 1

Zone R		Zone 2				Zone 3				Zone 4		Zone 5		Challenge Verification
Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	CFU/ml of Toilet Water
1	ND	1R	ND	1L	ND	1R	ND	1L	ND	1	ND	1	ND	3.33E+07
2	ND	2R	ND	2L	ND	2R	ND	2L	ND	2	ND	2	ND	
3	ND	3R	ND	3L	ND	3R	ND	3L	ND	3	ND			
4	ND	4R	ND	4L	ND	4R	ND	4L	ND	4	ND			
5	ND	5R	ND	5L	ND	5R	ND	5L	ND					
6	ND	6R	ND	6L	ND	6R	ND	6L	ND					
7	ND	7R	ND	7L	ND	7R	ND	7L	ND					
8	ND	8R	ND	8L	ND	8R	ND	8L	ND					
9	ND													
10	ND													

Total Contaminated Droplets per Zone

ND ND ND ND ND ND ND

Replicate 2

Zone R		Zone 2				Zone 3				Zone 4		Zone 5		Challenge Verification
Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	CFU/ml of Toilet Water
1	ND	1R	ND	1L	ND	1R	ND	1L	ND	1	ND	1	ND	2.03E+07
2	ND	2R	ND	2L	ND	2R	ND	2L	ND	2	ND	2	ND	
3	ND	3R	ND	3L	ND	3R	ND	3L	ND	3	ND			
4	ND	4R	ND	4L	ND	4R	ND	4L	ND	4	ND			
5	ND	5R	ND	5L	ND	5R	ND	5L	ND					
6	ND	6R	ND	6L	ND	6R	ND	6L	ND					
7	ND	7R	ND	7L	ND	7R	ND	7L	ND					
8	ND	8R	ND	8L	ND	8R	ND	8L	ND					
9	ND													
10	ND													

Total Contaminated Droplets per Zone

ND ND ND ND ND ND ND

Replicate 3

Zone R		Zone 2				Zone 3				Zone 4		Zone 5		Challenge Verification
Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	CFU/ml of Toilet Water
1	ND	1R	ND	1L	ND	1R	ND	1L	ND	1	ND	1	ND	2.20E+07
2	ND	2R	ND	2L	ND	2R	ND	2L	ND	2	ND	2	ND	
3	ND	3R	ND	3L	ND	3R	ND	3L	ND	3	ND			
4	ND	4R	ND	4L	ND	4R	ND	4L	ND	4	ND			
5	ND	5R	ND	5L	ND	5R	ND	5L	ND					
6	ND	6R	ND	6L	ND	6R	ND	6L	ND					
7	ND	7R	ND	7L	ND	7R	ND	7L	ND					
8	ND	8R	ND	8L	ND	8R	ND	8L	ND					
9	ND													
10	ND													

Total Contaminated Droplets per Zone

ND ND ND ND ND ND ND

J-00112675 – Vacuum Flush Porcelain Toilet - AcornVac
6/13/2012

ND = non-detectable
Challenge Organism: E.coli ATCC 25922

Replicate 1

Zone R		Zone 2				Zone 3				Zone 4		Zone 5		Challenge Verification
Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	CFU/ml of Toilet Water
1	ND	1R	ND	1L	ND	1R	ND	1L	ND	1	ND	1	ND	6.40E+07
2	ND	2R	ND	2L	ND	2R	ND	2L	ND	2	ND	2	ND	
3	ND	3R	ND	3L	ND	3R	ND	3L	ND	3	ND			
4	ND	4R	ND	4L	ND	4R	ND	4L	ND	4	ND			
5	ND	5R	ND	5L	ND	5R	ND	5L	ND					
6	ND	6R	ND	6L	ND	6R	ND	6L	ND					
7	ND	7R	ND	7L	ND	7R	ND	7L	ND					
8	ND	8R	ND	8L	ND	8R	ND	8L	ND					
9	ND													
10	ND													

Total Contaminated Droplets per Zone

ND ND ND ND ND ND ND

Replicate 2

Zone R		Zone 2				Zone 3				Zone 4		Zone 5		Challenge Verification
Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	CFU/ml of Toilet Water
1	ND	1R	ND	1L	ND	1R	ND	1L	ND	1	ND	1	ND	7.20E+07
2	ND	2R	ND	2L	ND	2R	ND	2L	ND	2	ND	2	ND	
3	ND	3R	ND	3L	ND	3R	ND	3L	ND	3	ND			
4	ND	4R	ND	4L	ND	4R	ND	4L	ND	4	ND			
5	ND	5R	ND	5L	ND	5R	ND	5L	ND					
6	ND	6R	ND	6L	ND	6R	ND	6L	ND					
7	ND	7R	ND	7L	ND	7R	ND	7L	ND					
8	ND	8R	ND	8L	ND	8R	ND	8L	ND					
9	ND													
10	ND													

Total Contaminated Droplets per Zone

ND ND ND ND ND ND ND

Replicate 3

Zone R		Zone 2				Zone 3				Zone 4		Zone 5		Challenge Verification
Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	Position	Contaminated Droplet per plate	CFU/ml of Toilet Water
1	ND	1R	ND	1L	ND	1R	ND	1L	ND	1	ND	1	ND	9.80E+07
2	ND	2R	ND	2L	ND	2R	ND	2L	ND	2	ND	2	ND	
3	ND	3R	ND	3L	ND	3R	ND	3L	ND	3	ND			
4	ND	4R	ND	4L	ND	4R	ND	4L	ND	4	ND			
5	ND	5R	ND	5L	ND	5R	ND	5L	ND					
6	ND	6R	ND	6L	ND	6R	ND	6L	ND					
7	ND	7R	ND	7L	ND	7R	ND	7L	ND					
8	ND	8R	ND	8L	ND	8R	ND	8L	ND					
9	ND													
10	ND													

Total Contaminated Droplets per Zone

ND ND ND ND ND ND ND