TURI SCL# 2012-19-326-0-4-C Test
Executive Summary

Test Overview:

Two cleaning effectiveness tests were conducted which compared the AutoVac module of the OmniFlex Crossover Cleaning system, a mainline floor scrubber and typical microfiber mopping system on VCT flooring. In Test #1, a grape solution was applied to the VCT flooring, and ATP (Adenosine Triphosphate) readings were then taken before and after cleaning to measure cleaning effectiveness. In Test #2, a similar grape solution along with an Escherichia coli 15597 solution was applied to the VCT flooring. For this test, cleaning effectiveness was measured with both ATP readings and bacteria plates before and after cleaning.

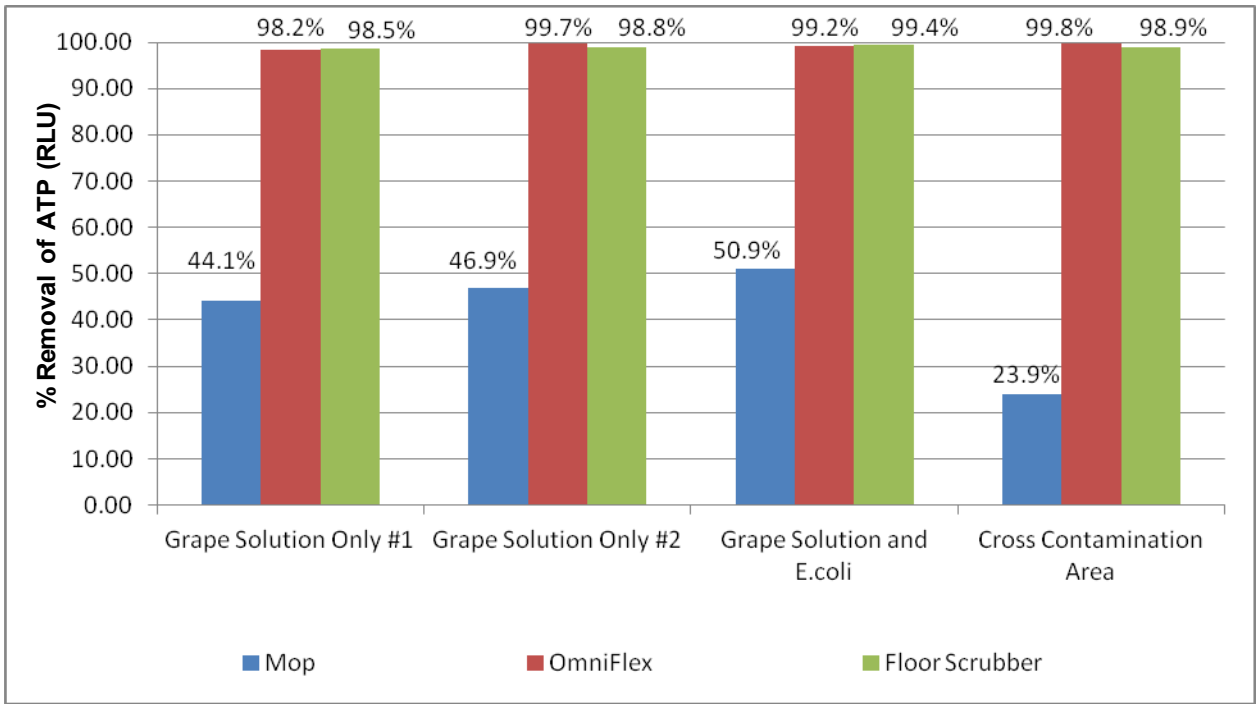
Results Summary:

The overall results of these two studies showed that the OmniFlex AutoVac system performed as well as or better than the floor scrubber as measured with ATP and bacteria plates. The mop was shown to be an ineffective method for removing bacteria from a hard surface. Both the mechanical units were shown to drastically reduce the amount of bacteria from the surface. Both the OmniFlex and floor scrubber had significant reduction in ATP levels (≥99%) on the VCT floor. The mop method had minimal reduction (23.9 - 50.9%) as the range of removal for all test areas.

In Test #2, the OmniFlex had the best performance in removing bacteria from the floor. The mop exhibited poor performance, with an average ATP reading of 4465 and too many E. coli colonies present to be counted after cleaning. In this test, OmniFlex AutoVac system and floor scrubber had significant reductions in bacteria where as the microfiber mopping system did not with too numerous to count (TNTC) results after cleaning.

Also, In Test #2, the use of the bacteria plates illustrated how the mop was dragging the bacteria from a dirty area into the clean areas, resulting in contamination of a previously clean area. When incorporating the ATP readings after passing the units through the bacteria, the effectiveness of the mop drops to 24% (see chart below “Post-Bacteria”). This implies that the bacteria are being dragged across the floor onto other areas of the floor. For the other two units tested, the ATP levels for the “Post-Bacteria” areas resulted in 99% removal, even after passing through the bacteria portion of the floor. This implies that removal via suction portion of the equipment is instrumental in eliminating the bacteria from the floor and minimizing cross-contamination.

ATP Cleaning Effectiveness Combined Test Results



TURI SURFACE SOLUTIONS LABORATORY EVALUATION SUMMARY

SCL #:	2012-19-326-0-4-C
DateRun:	5/8/2012
Experimenters:	Marshall;
ClientType:	Cleaning Equipment Mfr;
ProjectNumber:	2
Substrates:	Vinyl Composite Tiles;
Contaminants:	Food; Green Grape Juice
CleaningMethods:	Mechanical Agitation;
AnalyticalMethods:	ATP Measurement;
Purpose:	To determine the cleaning effectiveness of the Kaivac product, OmniFlex Crossover Cleaning System with AutoVac
ExperimentalProcedure:	The process involves cleaning flat, hard non-porous surface, specifically finished Vinyl Composite Tile. An 8'x4' VCT floor was sterilized prior to testing by using a steam-vapor unit and then squeegeed dry. Baseline measurements using a Hygiena ATP meter and swab. Measurements were made using a 4"x 4" template to draw swabbing area onto the floor surface. Twenty strokes were made (10 back & forth) in one direction moving across the area and rotating the swab as one moves across the area. A second 20 strokes were made perpendicular to the first direction in the same manner.

An ATP Soil Solution was made using 30 ML of freshly squeezed green seedless grape juice mixed with 32 oz of distilled water. The solution was applied to the surface at a rate of 4 oz/32 square feet using a hand held spray bottle. The soiled floor was then allowed to air dry at room temperature. A floor fan was utilized to reduce drying times. Once the floor was dry, two dirty ATP readings were made, one for the early cleaning path and toward the end of the cleaning path. A dilution of Kaivac Kaio was made at 4 oz per gallon using tap water at room temperature.

For the microfiber mop cleaning system, the mop cloth was immersed into the cleaning solution and wrung out. The mop cloth was attached to the mop handle. Cleaning started in one corner of the floor and cleaning proceeded along the long direction of the floor. At the end of the floor, the mop was swiveled to return back down the floor, offset by the width of the mop head. A total of 4 passes were completed in a serpentine pattern to clean the full test area. Each test area had a single pass (see diagram below for details) with the mop head following this up and back pattern. Once floor dried, final ATP readings were made to determine effectiveness of soil removal.

For the OmniFlex system, the floor was prepared in the exact method as the mop cleaning. The microfiber pad was presoaked in the clean solution and attached to the unit. The vacuum unit was turned on and the cleaning solution flow was set the predetermined rate ("5 o'clock" on the dial). The same walking rate was utilized from the mop cleaning process. A total of three passes were completed in the same serpentine pattern to clean the full test area. An additional ATP reading was made of the collected soil in system's dirty reservoir.

The floor scrubbing machine was operated at mid level for pressure and water flow. Fresh 3M pads were attached to the unit. The floor was prepared in the same manner as the previous processes. A total of three passes in a serpentine pattern were completed. An additional ATP reading was made of the collected soil in system's dirty reservoir.

Each surface of the floor was only cleaned once by each method. The number of passes completed is related to the size of the cleaning systems pathway. See illustrations at the end of the report. The circles represent the location of the ATP measurements. Final ATP readings were compared against dirty levels and baseline floor readings. Three runs were made for each cleaning method.

ChemistriesEvaluated: Microfiber mop; OmniFlex; Floor Scrubber

Figure 1. Mop Cleaning Path

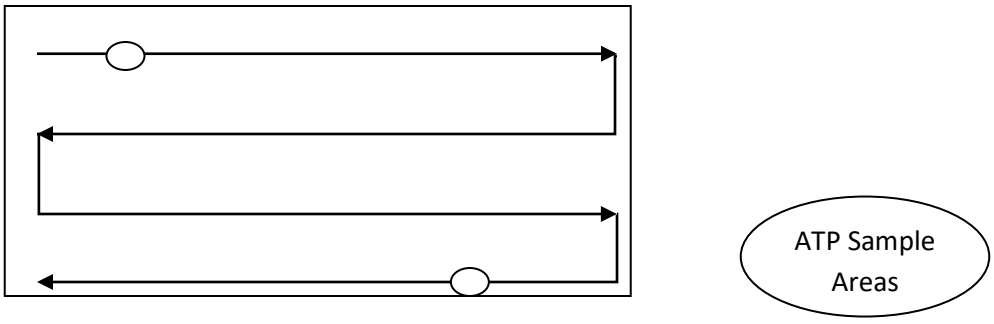
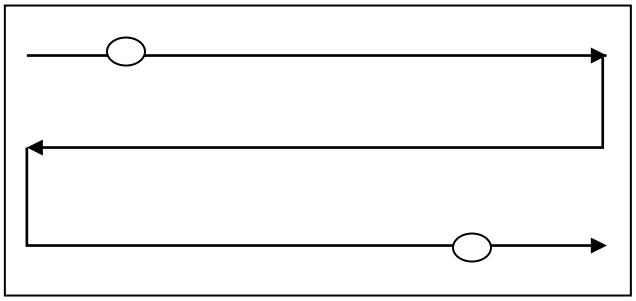


Figure 2. OmniFlex and Floor Scrubbing Paths



Results:

Average baseline level of ATP of the floor were calculated for each of three runs. The mop baseline averaged 96.7; the OmniFlex baseline was 195.3 and the floor scrubber baseline was 69.3. After applying the ATP soil mixture, the dirty readings ranged from 2915 to 8205. Average dirty readings for the three cleaning methods were 6439, 3902 and 6094 for the first cleaning area for mop, OmniFlex and floor scrubber. The second area had average readings of 7165, 6925 and 7191.

Cleaning reduced the ATP levels for all three methods at the first area. The mop had the least reduction in ATP level. Both the OmniFlex and floor scrubber had significant reduction of ATP. The second area had less reduction in ATP for the mop but the two machines had more reduction than the first section. When comparing the average reduction in ATP for both areas on the floor for each method, the OmniFlex had the most reduction followed closely by the floor scrubber. These two units resulted in a 98% reduction in ATP. The mop had an average removal of ATP of 44%.

The ATP level of the collected solution for OmniFlex was 575 and for floor scrubber 730.

The Table lists the ATP readings for each method and trial run.

Method	Run	Baseline	Area 1 dirty	Area 1 clean	Area 2 dirty	Area 2 clean
Mop	1	75	4640	2149	7788	7391
	2	73	7850	3543	7135	5401
	3	142	6827	1368	6572	2963
OmniFlex	1	212	4807	41	8205	37
	2	146	3985	153	6004	27
	3	228	2915	251	6565	52
Floor Scrubber	1	78	6574	84	7649	62
	2	78	7131	185	7981	58
	3	52	4578	82	5942	111
Mop	Ave	96.7	6439.0	2353.3	7165.0	5251.7
OmniFlex		195.3	3902.3	148.3	6924.7	38.7
Floor Scrubber		69.3	6094.3	117.0	7190.7	77.0

Summary

Method	Ave ATP Dirty	Ave ATP Clean	% Reduction
Mop	6802.0	3802.5	44.1
OmniFlex	5413.5	93.5	98.3
Floor Scrubber	6642.5	97.0	98.5

Both the OmniFlex and floor scrubbing methods had significant (98%) reduction in the levels of ATP on the VCT flooring. The mop method had minimal reduction in ATP, 44%. Additional testing will be conducted to evaluate the three processes on additional soil containing ATP and bacteria. Testing will be completed in the Clinical Laboratory and Nutritional Sciences Lab at UMass Lowell.

TURI - Clinical Laboratory and Nutritional Sciences Lab
EVALUATION SUMMARY

DateRun:	7/8/2012
Experimenters:	Goodyear;
ClientType:	Cleaning Equipment Mfr;
ProjectNumber:	2
Substrates:	Vinyl Composite Tiles;
Contaminants:	Food; Green Grape Juice; *Escherichia coli* 15597
CleaningMethods:	Mechanical Agitation;
AnalyticalMethods:	ATP Measurement; Bacteria Contact Plate
Purpose:	To determine the cleaning effectiveness of the Kaivac product, OmniFlex Crossover Cleaning System with AutoVac for bacteria removal

Floor preparation and baseline sampling
An 8 x 4' VCT floor was cleaned and sanitized prior to testing by using a steam-vapor unit followed by isopropyl alcohol to kill any remaining bacteria as well as dry the floor rapidly. Baseline measurements were taken using a Hygiena ATP meter and swab as well as contact plates to detect bacteria. Squares were drawn on the floor to delineate the sampling areas, 4" x 4" for the ATP meter and 3" x 3" for the contact plate. The meter sampling procedure was: 20 strokes , 10 back and forth in one direction moving across the area while rotating the swab. A second 20 strokes were made perpendicular to the first direction in the same manner.

Application of bacteria and ATP soil solution
Two center squares were removed from the floor and placed in the biological safety cabinet (BSC) for bacterial contamination with *Escherichia coli* 15597. The *E. coli* was grown overnight in a liquid medium; 100 μL were pipetted into each of the template areas and spread through the whole area. The tiles were left in the BSC to dry in order to avoid airborne contaminants. Once dry, grape juice was sprayed on the tiles as described below, and they were dried in the BSC until ready to test.

The main floor was sprayed with an ATP soil solution that was made using 30 mL of freshly squeezed green seedless grape juice mixed with 32 oz of distilled water. The solution was applied to the surface at a rate of 4 oz/32 square feet using a hand held spray bottle. The soiled floor was air dried at room temperature. A floor fan was utilized to reduce drying times. A dilution of Kaivac Kaio was made at 4 oz per gallon using dI water at room temperature.

Sampling of the dirty floor
The two tiles spotted with bacteria were replaced on the floor. Using both the ATP meter and a contact plate, a sample of the dirty floor was taken from the second of the two tiles that were spotted with bacteria (see diagram).

Sampling following cleaning
The floor was cleaned using each method (described below). Following cleaning, samples were taken at the following spots:
Pre-bacteria (cleaned before the tiles containing bacteria, representing grape juice only.)
Clean bacteria spot (the first of the two tiles that had bacteria on it, cleaned first in the cleaning pattern.)
Post-bacteria (the tile following both tiles with bacteria. No bacteria was spotted here, but if the cleaning method carried bacteria along and deposited them elsewhere on the floor, they would be detected here.)

Microfiber Mop Cleaning Method
The mop cloth was immersed in the cleaning solution and wrung out. The mop cloth was attached to the mop handle. Following cleaning, the mop cloth was rinsed in the solution again and re-wrung out.

OmniFlex Cleaning Method
The microfiber pad was presoaked in the cleaning solution and attached to the unit. The vacuum unit was turned on and the cleaning solution flow was set at the predetermined rate (5 o'clock on the dial). The same walking rate was utilized as the mop cleaning process.

Floor Scrubber Method
The floor scrubber was operated at mid level for pressure and water flow. Fresh 3M pads were attached to the unit.

Cleaning Pattern
Because of the presence of the bacteria, a single cleaning pass in a straight line was performed. The back-and-forth pattern would result in the wheels of the Omniflex and Floor Scrubber crossing the bacteria, potentially contaminating the laboratory floor. Each device was placed on the test floor before the pre-bacteria sampling area and centered.

Larger Box = ATP sampling area
Smaller Box = Contact plate sampling area

Sampling areas from left to right:
Pre-Bacteria: grape juice applied, no bacteria, first section of floor to be cleaned, sampled after cleaning
Clean: bacteria and grape juice applied, sampled after cleaning
Dirty: bacteria and grape juice applied, sampled before cleaning
Post-Bacteria: grape juice applied, no bacteria, last section of floor to be cleaned after crossing tiles with bacteria, sampled after cleaning to detect bacterial carryover by the cleaning device

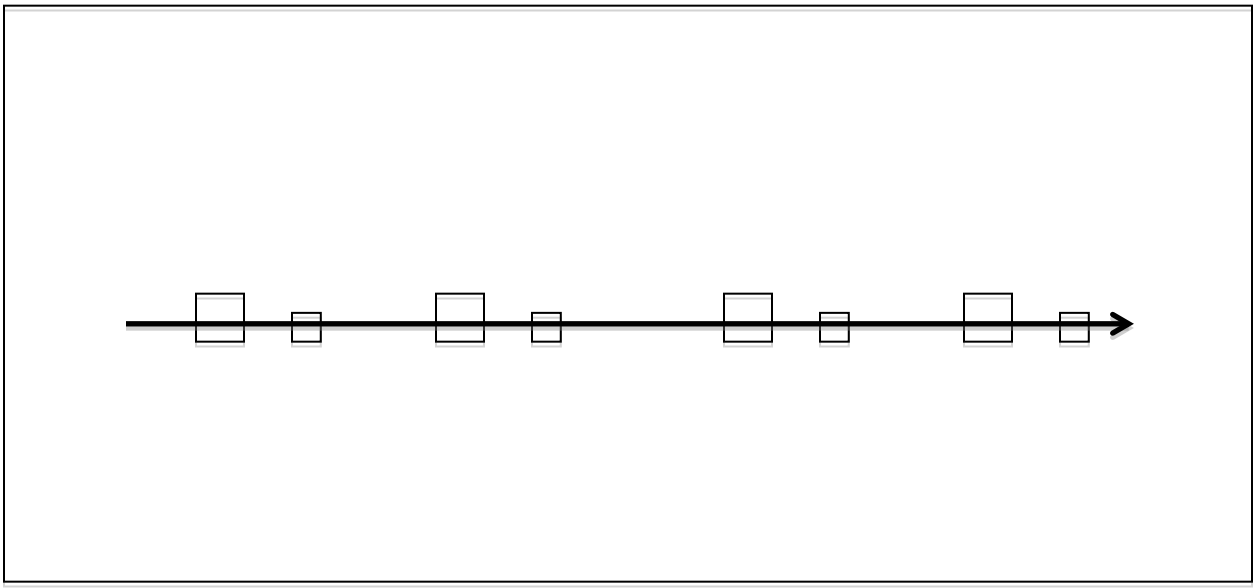


Figure 3. Floor Sampling Pattern

Results:

When looking at the data from the ATP meter, the mop had the lowest soil removal rate. When averaging all of the ATP readings collected the mop removed about 52% of the soils. To compare the results to the testing in the TURI Lab, the pre-Bacteria readings showed a removal rate of 47% (((5874-3118)/5875)*100) which was nearly the same as the ATP results from the TURI Lab test, 44%.

When incorporating the ATP readings after passing the units through the bacteria, the effectiveness of the mop drops to 24%. This implies that the bacteria are being dragged across the floor onto other areas of the floor. For the other two units tested, the ATP levels resulted in 99% removal, even after passing through the bacteria portion of the floor. This implies that removal via suction portion of the equipment is instrumental in eliminating the bacteria from the floor.

The table lists the ATP levels for the various locations on the floor before and after cleaning.

ATP Readings

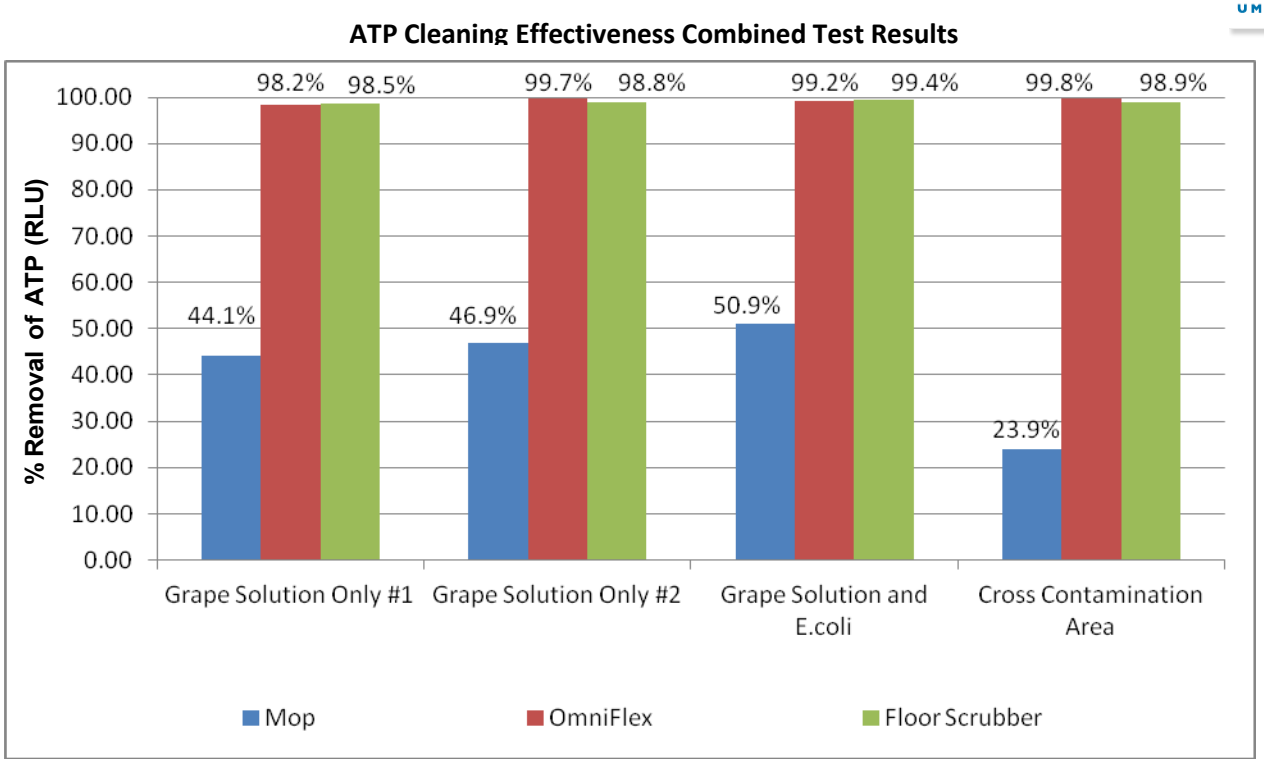
Method	Baseline	Dirty Bacteria	Pre-Bacteria	Clean Bacteria	Post-Bacteria
Mop #1	30	3758	3399	921	6276
Mop #2	18	6022	1431	5168	4321
Mop #3	6	7843	4525	2409	2799
Mop Average	**18**	**5874**	**3118**	**2883**	**4465**
OmniFlex #1	9	7396	25	27	5
OmniFlex #2	25	6100	8	94	3
OmniFlex #3	23	6552	25	24	23
OmniFlex Avg	**19**	**6683**	**19**	**48**	**10**
Floor Scrubber #1	23	6945	131*	45*	103*
Floor Scrubber #2	29	5797	52*	12*	52*
Floor Scrubber #3	9	4821	29*	49*	31*
Floor Scrub Avg	**20**	**5854**	**71***	**35***	**62***

*The Floor Scrubber unit was heavily contaminated with *Pseudomonas aeruginosa*. We were unable to completely remove the organism for testing. The presence of this organism will contribute to ATP readings, possibly resulting in a falsely elevated reading.

Percent Reductions

Mop	51.8% (includes before bacteria, after bacteria locations on the floor)
OmniFlex	99.3%
Floor Scrubber	99.4%*

The following graph compares the effectiveness for each piece of equipment for the type of contamination and location in the cleaning process.



Contact Plate Results

(Number of colonies of *E. coli*; TNTC = too numerous to count)

Method	Baseline	Dirty Bacteria	Pre-Bacteria	Clean Bacteria	Post-Bacteria
Mop #1	0	TNTC	0	TNTC	TNTC
Mop #2	0	TNTC	0	TNTC	TNTC
Mop #3	0	TNTC	0	TNTC	TNTC
Mop Average	**0**	**TNTC**	**0**	**TNTC**	**TNTC**
OmniFlex #1	0	TNTC	0	33	1
OmniFlex #2	0	TNTC	0	3	0
OmniFlex #3	0	TNTC	0	5	0
OmniFlex Avg	**0**	**TNTC**	**0**	**14**	**0.3**
Floor Scrubber #1	0	TNTC	0*	30*	0*
Floor Scrubber #2	0	TNTC	0*	9*	1*
Floor Scrubber #3	0	TNTC	0*	9*	1*
Floor Scrub Avg	**0**	**TNTC**	**0***	**16***	**0.7***

*The presence of contaminating *Pseudomonas aeruginosa* in the floor scrubber unit made interpretation of this data difficult. Although *E. coli* and *P. aeruginosa* can be differentiated on a plate, the presence of *P. aeruginosa* could impact the growth of the *E. coli*.

Percent Reduction

Both the OmniFlex and Floor Scrubber had significant reduction in ATP levels (≥99%) on the VCT floor. The mop method had minimal reduction (51.8%).

Bacteria removal

The OmniFlex had the best performance in removing bacteria from the floor and not leaving them on the floor 1 – 2 tiles away, with an average ATP reading of 10 and 0 – 1 colonies of *E. coli*. The mop had poor performance, with an average ATP reading of 4465 and too many *E. coli* colonies present to be counted.

Conclusions:

The minor differences that show up between the two labs can be attributed to the variability of ATP levels and the accuracy/precision of the ATP measurement device. As can be seen in the starting level of ATP from the grape juice, from run to run there is a wide range of variability. In the TURI lab the starting level of measured ATP ranged from 2900 to 7800 and in the Clinical Laboratory and Nutritional Sciences Lab the level ranged from 3750 to 7850. When comparing the order of magnitude changes, the results from both labs showed the same trends in the cleaning effectiveness of the mop, OmniFlex and floor scrubber units.

The use of contact plates verified the data collected from the ATP measurements. The mop was shown to be an ineffective method for removing bacteria from a hard surface. Both the mechanical units were shown to drastically reduce the amount of bacteria from the surface. The use of the plates also illustrated how the mop was dragging the bacteria from a dirty area into the clean areas, resulting in contamination of a previously clean area. In each method there was some of the cross-contamination occurring but the mop had areas going from a 0 level to a too numerous to count reading. The other two units had 14-16 colonies after the initial bacteria area and 0.3-0.7 colonies at the end of the cleaning zones.

The floor scrubbing unit was old and heavily contaminated with *Pseudomonas aeruginosa* and possibly other organisms. There was no way to adequately clean the solution tank or tubing other than attempting to rinse the unit with clean water. We were unable to eliminate the contaminant for testing. This level of contamination means that any post-cleaning reading may misrepresent the ideal performance as the *Pseudomonas* organisms in the cleaning solution would contribute to any ATP reading, and made interpretation of contact plates more difficult.