# **TEST REPORT**

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101890406MKS-001a Issue 2 Tennant Company – Floor cleaning systems ec-H2O<sup>™</sup> vs. ec-H2O NanoClean<sup>™</sup> performance comparison

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## CONTENTS

SECTI	ON		PAGE
INTRO	DUCTION		2
1	Initial ins	pection	4
2	Performa	ince measurements	5
3	Results		9
APPE		Quotation 500563324	
APPENDIX II CSET Setup		CSET Setup & soiling procedure	
APPENDIX III Example photographs of soiled		Example photographs of soiled and cleaned tiles	

# INTRODUCTION

Intertek were commissioned by Tennant Company to carry out comparative tests on two water treatment units designed to fit into the client's industrial floor cleaning machines. The test units, test rig and test consumables were all supplied by Tennant Company. The test method followed was also developed by the client. The tests were carried out at Intertek, Milton Keynes during December 2014 and January 2015.

The work was carried out in accordance with quotation 500563324. A copy of this quotation is provided in <u>Appendix I</u> of this report.

This Issue 2 report replaces Issue 1 and has been updated with additional results evaluations.

This report gives an overview of the tests carried out and the key results. It should be read in conjunction with the full test results in the separate Excel spreadsheet '101890406MKS-001 Results tables.xls Issue 2' which accompanies this report.

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The tests have been carried out in accordance with the quotation as well as the test methodology and information supplied by the client and as such, the results are only applicable to the sample tested and the conditions of the test. Sample variability and changes in test conditions could influence some results, and the result(s) as stated may not be representative of the mean result if a number of different samples were tested under a variety of test conditions.

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### Summary of Results – GEN1( ec-H2O<sup>™</sup>) v GEN2 (ec-H2O NanoClean<sup>™</sup>)

**Soil removal by weight** – The results obtained show that GEN2 outperforms GEN1 in terms of cleaning for all soils at the 95% confidence level. GEN2 tiles were between 5% and 36% cleaner for individual batches of soil and by a mean of 19% for all batches tested.

**Soil removal % by image analysis** – The results obtained show that GEN2 outperforms GEN1 in terms of cleaning for all soils at the 95% confidence level. GEN2 tiles were between 18% and 52% cleaner for individual batches of soil and by a mean of 35% for all batches tested.

**Panel assessment** – Visual assessment by a panel of three assessors showed that in 188 out of 189 assessments (99.5%) GEN2 tiles were considered the cleanest of weight matched pairs of tiles.

# 1. Initial inspection

## 1.1 Brand details

Two ec-H2O<sup>™</sup> units were supplied by the client, one GEN1 unit and one GEN2 unit. The units are shown mounted on the test rig in Figure 1.





Brand details and other comments for the two samples are shown in <u>Table 1</u> below.

### Table 1 – Sample details

Code	GEN1	GEN2
Client system name	ec-H2O™	ec-H2O NanoClean™
Client code	Gen 1	GEN-2
Brand	Tennant	Tennant
Serial no.	1049958	1207013
Other identifying no.	09/28/2011	12-23-2013
Comments	LED fitted but not working on	Fitted with functioning LED to
	arrival - it was verified that	indicate unit is operating.
	the cell was operating at the	
	correct current.	

## 2. Performance measurements

The performance test simulates the real industrial floor cleaning situation by substitution of the real life but variable circumstances with a more consistent artificial cleaning task. The test methodology was developed and supplied to Intertek by the client. The artificial cleaning task was created by applying soil to untreated Armstrong® Vinyl Composite Tile (VCT) floor tiles. Three different soils were tested under controlled conditions using a modified BYK® abrasion tester also supplied by the client and known as the "Cleaning Solution Efficiency Tester" or "CSET". The CSET and test rig enable cleaning action with minimal mechanical action in a laboratory setting and allows control of variables that might affect the test results.

The CSET test rig is shown in Figure 2 and Figure 3 below.



### Figure 2 - CSET Test rig (supplied by client)



Figure 3 – CSET Test rig showing tile in place

The CSET test rig was operated in accordance with the instructions and within the parameters provided by Tennant Company. Detailed test instructions for operation of the CSET are included in Appendix II of this report.

Artificially prepared water was supplied to the ec-H2O units via an electric pump with a variable output transformer. This enabled control over the flow rate and pressure at the spay nozzle on the CSET unit. The flow rate was adjusted as necessary to give a flow during tests of 0.227 +/- 0.02 l/m. Flow rate was checked before and after each batch of runs. A pressure gauge was also fitted which enabled monitoring and adjustments as needed during the test runs. It was noted during testing that pressure and flow through the GEN1 unit appeared to be more variable than through the GEN2 unit.(It was necessary to adjust the flow rate on the GEN1 unit throughout the tests – mainly due to steady increase in pressure in the system as the test progressed.)

The number of cycles that the CSET ran for was adjusted as necessary for each batch of soil. For each batch the GEN2 system was tested first as it was assumed that this system would have the higher cleaning performance. A soiled tile was placed on the CSET and cleaned until approximately half of the soil had been removed. The number of cycles was noted and programmed into the CSET so that all remaining tiles tested with both systems had the same number of cycle and time exposed to the treatments.

All testing took place in a controlled environment room with the following test conditions:

Air temperature:	23 +/- 2°C	
Relative humidity:	55 +/- 5%	
Voltage:	230 +/-2.3V	(Supply voltage to switched power supplies for test rig)
Frequency:	50 Hz	(60Hz supplied via frequency converter to test rig)
Supply water temperature:	15 +/- 2 °C	(supplied to tank stabilised at room temperature)

Water supplied for testing was prepared in accordance with IEC 60734 standard water method B: the addition of salts to demineralised water to achieve the specified water properties. The specification of the water used at the request of the client was Standard "medium hard" water as below.

Supply water hardness:	1.5 +/- 0.20 mmol/l (Ca <sup>2+</sup> /Mg <sup>2+</sup> )
Alkalinity:	2.00 +/- 0.20 mmol/l (HCO <sup>3-</sup> )
Conductivity (at 20°C):	450 +/- 100 μS/cm
pH (at 20°C):	7.5 to 7.9

Three soils were specified by Tennant Company. The soils were developed to replicate the types of soils found in "real world" situations that the floor cleaners would be used in such as food courts, shopping malls, food preparation areas etc. A detailed methodology for the preparation and application of the soils as supplied by Tennant Company is given in <u>Appendix II</u>. In summary, the mixed soil was applied to a prepared VCT tile using a template and "draw-down bar" to apply an even layer of the soil .The tile weight was recorded before and after applying soil to enable calculation of the weight of soil applied. Three separate batches of each soil were prepared and applied to VCT tiles. Sixteen tiles were soiled for each batch of soil and from these tiles seven matched pairs (by soil weight) were selected for cleaning, seven for GEN1 treatment and seven for GEN2 treatment. The remaining two tiles were prepared as spares in case of problems during the test runs.

Before cleaning the soiled tiles were scanned using a high resolution scanner and the images saved as high quality TIFF files. After cleaning and drying, the tiles were scanned again to produce a set of "before and after images" of the test results. Examples of the soiled and cleaned tiles for each soil type and cleaning solution are shown in <u>Appendix III</u>. Full sets of TIFF file images are supplied separately as electronic files. The tiles were also reweighed and the results recorded to allow calculation of the weight of remaining soil. A summary of the results of the tile and soil weight measurements are provided in <u>Table 3</u> on page 9 as well as in <u>Table 1</u> of the accompanying Excel results spreadsheet entitled '10890406MKS-001 Results tables. xls Issue 2'.

The materials used for preparing the soils were supplied by Tennant Company and are detailed in <u>Table 2</u> on the following page.

The soils were mixed in accordance with the instructions supplied by Tennant Company. However it was found that the Liquid Shortening component was higher in viscosity than the batch used by Tennant and therefore produced mixtures that were more viscous and less easy to work with than the specification. In agreement with Tennant, the proportion of Liquid Shortening was adjusted by adding 10g to the original weight specified so as to produce a more workable mixture.

Soil ingredient	Brand	Details	Food Court Soil	Kitchen (SP) Soil	Food Court plus Salt
			Quantity (g)	Quantity (g)	Quantity (g)
Ball clay	Black Charm	ball clay (anhydrous			
		aluminium silicate)	95	NA	95
Pancake mix	Bisquick	Lot 26DEC2015 KC20:48 1			
		(passed through 0.05mm			
		sieve before use)	15	110	15
Sodium chloride	Fischer Chemical	Crystalline NaCl	NA	NA	10
Shortening oil	Chef's Pride	Creamy liquid Shortening			
			95	60	95
Blue dye	Lone Star	Liquid candle dye	0.4	0.2	0.3
		(anthraquinone dye)	(20 drops)	(10 drops)	(15 drops)
"draw down" bar	Tennant	Metal plate for spreading			
	manufactured	soil	0.010"	0.010"	0.020"

Table 2 – Soil	mixture	ingredients	and s	pecifications

The soil mixtures were made up and blended for 10 minutes using a hand mixer on a medium setting. Each soil batch was prepared, applied and cleaned on the same day.

TIFF scanned images of the tiles were analysed using "ImageJ" (ImageJ v1.49m - National Institutes of Health USA Public Domain software) image processing and analysis software to count and analyse pixel data on the soiled and cleaned tiles. Greyscale BIN data was analysed on unsoiled and soiled tiles to enable differentiation of "clean" and "dirty" greyscale BINs (i.e. to determine where the "break point" between "clean" and "dirty" would be on a partially cleaned tile). The cleaned tiles were then analysed using the same "Region Of Interest" (ROI) for all tiles to produce BIN data. The cleaned tile BINs were then analysed in Excel to enable calculation of the number of clean and dirty pixels. From this the percentage cleaning data was calculated according to the following formula: %clean = 100 x Number of clean pixels in ROI

Total number of pixels in ROI

A summary of the percentage cleaning data for each of the soils tested is given in <u>Figure 4</u>, <u>Figure 11</u> and <u>Figure 18</u> in the results section of this report. Detailed BIN pixel count data for each batch of soil is given in <u>Tables 3,4 & 5</u>, <u>Tables 7, 8 & 9</u> and <u>Tables 11,12 & 13</u> of the separate Excel spreadsheet '101890406MKS-001 Results tables Issue 2.xls'

The percentage cleaning by weight and by image analysis was analysed statistically and full results of the analysis are alongside the results below.

In addition a visual "panel" assessment was carried out on all pairs of tiles (GEN1 v GEN2) by three assessors. Assessment was made on the basis of which tile of a matched pair looked "cleanest" by area of soil removal or by colour change .Identifying marks were obscured before presentation to the assessors so that the assessments were made as a single blind assessment. The order of presentation of the pairs was not randomised. A summary of these results is given in <u>Table 5</u> below. The detailed assessments for each soil are given in <u>Table 14</u> of the separate Excel spreadsheet '101890406MKS-001 Results tables.xls Issue 2' which accompanies this report.

# 3. RESULTS

### Soil removal by weight.

<u>Table 3</u> on page 10 gives a summary of the results of soil removal as a percentage removal by weight in grams. The results obtained show that for all soils and all batches of soil tested GEN2 removes more soil as a percentage than that removed by GEN1. Overall GEN2 removed an average of 19% more soil by weight than GEN1. More variation was noted with some soils and some batches of soil than others. This is probably due to the nature of the soils, the materials used to make them up and the manner in which the materials react to the cleaning process.

The results were subjected to statistical analysis for Oneway Analysis of the tile pairs. The results of this analysis are given in Figure 7, Figure 14 and Figure 21 on the following pages.

### **Food Court Soil**

For the Food Court Soil GEN2 has superior cleaning performance (out performs) GEN1 at the 95% confidence level.

There is some overlap in performance of GEN1 vs. GEN2 between batches and within individual batches. However, in weight matched pairs as tested, GEN2 always achieves superior cleaning performance to GEN1.

### Kitchen (SP) Soil

For the Kitchen (SP) Soil GEN2 has superior cleaning performance (out performs) GEN1 at the 95% confidence level.

There is some overlap in performance of GEN1 vs. GEN2 between batches and within individual batches. However, in weight matched pairs as tested, GEN2 always achieves superior cleaning performance to GEN1.

### Food Court plus Salt Soil

For the Food Court plus Salt Soil GEN2 has superior cleaning performance (out performs) GEN1 at the 95% confidence level.

There is some overlap in performance of GEN1 vs. GEN2 between batches and within individual batches. However, in weight matched pairs as tested, GEN2 always achieves superior cleaning performance to GEN1.

Soil Type	Batch 1	Batch 2	Batch 3	Average
				batches
Food Court				
GEN1 (1-8)				
Mean % soil removal	52.7	62.6	62.4	59.3
Standard deviation	4.9	4.8	5.4	
GEN2 (1-8)				
Mean % soil removal	71.8	69.1	72.7	71.2
Standard deviation	5.4	2.2	3.6	
Percentage difference	36%	10%	16%	20%
between GEN1 and GEN2				
Kitchen (SP)				
GEN1 (1-8)				
Mean % soil removal	78.5	66.3	70.6	71.8
Standard deviation	8.3	10.3	5.8	
GEN2 (1-8)				
Mean % soil removal	82.8	75.1	79.7	79.2
Standard deviation	4.8	6.7	5.2	
Percentage difference	5%	13%	13%	10%
between GEN1 and GEN2				
Food Court plus Salt				
GEN1 (1-8)				
Mean % soil removal	52.6	54.3	50.0	52.3
Standard deviation	4.2	3.6	3.4	
GEN2 (1-8)				
Mean % soil removal	64.7	64.9	67.9	65.8
Standard deviation	4.1	2.8	6.2	
-				
Percentage difference	23%	20%	36%	26%
between GEN1 and GEN2				

Table 3 - Summary of percentage soil removal by weight

### Percentage cleaning by image analysis

<u>Table 4 and Figure 4</u>, <u>Figure 11</u> and <u>Figure 18</u> on the following pages give a summary of the results of percentage cleaning by image analysis. These figures detail cleaning data derived from pixel counts of clean v. dirty for each soil type and batch tested. This data is also shown in graphical form as plots of % Cleaning vs. Solution for all batches in <u>Figure 8</u>, <u>Figure 15</u> and <u>Figure 22</u> and as plots of % Cleaning vs. Solution for each batch separately in <u>Figure 7</u>, <u>Figure 16</u> and <u>Figure 23</u>.

The results were subjected to statistical analysis for Oneway Analysis of the tile pairs. The results of this analysis are given in Figure10, Figure 17 and Figure 24 on the following pages.

### **Food Court Soil**

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#### Food Court plus Salt Soil

For the Food Court plus Salt Soil GEN2 has superior cleaning performance (out performs) GEN1 at the 95% confidence level.

There is some overlap in performance of GEN1 vs. GEN2 between batches and within individual batches. However, in weight matched pairs as tested, GEN2 always achieves superior cleaning performance to GEN1.

Soil Type	Batch 1	Batch 2	Batch 3	Average
				batches
Food Court				
GEN1 (1-7)				
Mean % cleaning by image analysis	46.8	51.8	42.9	47.2
Standard deviation	4.9	4.1	5.7	
GEN2 (1-7)				
Mean % cleaning by image analysis	71.2	64.2	60.8	65.4
Standard deviation	7.1	3.6	5.4	
Percentage difference between GEN1 and GEN2	52%	24%	42%	39%
 Kitchen (SP)				
GEN1 (1-7)				
Mean % cleaning by image analysis	48.0	40.2	43.0	43.7
Standard deviation	11.1	11.5	8.7	
Mean % cleaning by image analysis	56.8	54.2	62.2	57.7
Standard deviation	11.0	9.4	8.9	
Percentage difference between GEN1 and GEN2	18%	35%	45%	32%
Food Court plus Salt				
GEN1 (1-7)				
Mean % cleaning by image analysis	36.0	39.4	37.8	37.7
Standard deviation	3.9	3.2	3.8	
GEN2 (1-7)				
Mean % cleaning by image analysis	49.6	49.4	51.0	50.0
Standard deviation	6.1	3.8	6.2	
Percentage difference between GEN1 and GEN2	38%	25%	35%	33%

Table 4 – Soil removal by image analysis Summary Data

#### Panel visual assessment

### Table 5 – Summary of Panel Assessment ratings

	Food Court	SP (Blue)	Food Court plus Salt
Total assessments GEN1 cleanest	0	1	0
Total assessments GEN2 cleanest	63	62	63

When rated by three assessors, in 188 out of the possible 189 ratings made (99.5%), GEN2 was rated the cleanest of the tile pairs.

### Figure 4 – Food Court Soil Summary Data

#### <u>101890406 Tennant floor cleaning system comparison</u> <u>Food Court Cleaning Summary</u>

Soil mix: Oil, pancake mix, black ball clay, candle dye

Test Conditions						
Room temperature:	23 °C					
Relative humidity:	50 %					
Supply water hardness:	1.5 mmol/l					
Supply water conductivi	450 μS/cm					
Supply water pH: 7.7						
Water prepared to EN/IEC 60734 Method B						

FC1	GEN1 Run 1	GEN2 Run 1	GEN1	GEN2	per Pair
	% Cleaning	% Cleaning	Soil wt (g)	Soil wt (g)	Mean soil (g)
Run 1	36.26	78.79	3.12	3.10	3.11
Run 2	48.23	77.36	3.08	3.09	3.09
Run 3	50.40	81.46	2.83	2.76	2.80
Run 4	45.22	66.97	2.89	2.97	2.93
Run 5	45.70	62.48	3.20	3.22	3.21
Run 6	49.87	66.70	3.15	3.16	3.16
Run 7	52.09	64.90	2.99	2.97	2.98
Average	46.82	71.24	3.04	3.04	
SD	4.89	7.12	0.13	0.14	

FC3	GEN1 Run 2	GEN2 Run 2	GEN1	GEN2	per Pair
	% Cleaning	% Cleaning	Soil wt (g)	Soil wt (g)	Mean soil (g)
Run 1	52.63	61.46	3.07	3.00	3.04
Run 2	46.26	58.73	2.69	2.71	2.70
Run 3	48.54	63.86	2.57	2.66	2.62
Run 4	53.21	63.51	2.68	2.66	2.67
Run 5	52.38	68.38	2.87	2.83	2.85
Run 6	60.07	70.20	2.46	2.44	2.45
Run 7	49.55	63.29	2.79	2.79	2.79
Average	51.81	64.20	2.73	2.73	
SD	4.10	3.63	0.19	0.16	

FC4	GEN1 Run 3	GEN2 Run 3	GEN1	GEN2	per Pair
	% Cleaning	% Cleaning	Soil wt (g)	Soil wt (g)	Mean soil (g)
Run 1	41.09	61.18	2.02	2.06	2.04
Run 2	35.48	57.51	2.15	2.1	2.13
Run 3	35.42	58.57	2.22	2.24	2.23
Run 4	43.01	50.39	2.24	2.32	2.28
Run 5	45.11	65.21	2.00	2.01	2.01
Run 6	52.42	65.55	1.94	1.95	1.95
Run 7	47.48	66.92	1.72	1.81	1.77
Average	42.86	60.76	2.04	2.07	
SD	5.74	5.40	0.17	0.16	



Figure 5 – Food Court Soil: Graph of % Cleaning by weight by Solution for all batches







Figure 7 – Oneway Analysis of Cleaning % by weight by Solution – Food Court Soil

Solution	# Samples	Mean	Lower 95% Cl	Upper 95% Cl
Gen1	24	59.25	56.96	61.54
Gen2	24	71.21	68.92	73.50



Figure 8 – Food Court Soil: Graph of % Cleaning by image analysis vs. Solution for all batches

Figure 9 - Food Court Soil: Graph of % Cleaning vs. Solution for each batch







Solution	# Samples	Mean	Lower 95% CI	Upper 95% Cl
Gen1	21	47.16	44.29	50.04
Gen2	21	65.40	62.10	68.70

### Figure 11 – Kitchen (SP) Soil Summary Data

#### <u>101890406 Tennant floor cleaning system comparison</u> <u>SP (Blue soil) Cleaning Summary</u>

Soil mix: Oil, pancake mix, blue dye

Test Conditions					
Room temperature:	23 °C				
Relative humidity:	50 %				
Supply water hardness:	1.5 mmol/l				
Supply water conductivi	450 μS/cm				
Supply water pH:	7.7				
Water prepared to EN/IEC 60734 Method B					

SP1	GEN1 Run 1	GEN2 Run 1	GEN1	GEN2	per Pair
	% Cleaning	% Cleaning	Soil wt (g)	Soil wt (g)	Mean soil (g)
Run 1	42.06	53.27	1.99	2.04	2.02
Run 2	35.89	48.52	2.30	2.34	2.32
Run 3	34.04	44.41	2.42	2.48	2.45
Run 4	56.69	73.61	1.76	1.76	1.76
Run 5	65.65	72.55	1.65	1.72	1.69
Run 6	44.53	47.50	2.26	2.27	2.27
Run 7	57.30	57.92	1.92	1.92	1.92
Average	48.02	56.83	2.04	2.08	
SD	11.10	11.04	0.27	0.27	

SP2	GEN1 Run 2	GEN2 Run 2	GEN1	GEN2	per Pair
	% Cleaning	% Cleaning	Soil wt (g)	Soil wt (g)	Mean soil (g)
Run 1	49.57	66.64	2.00	1.95	1.98
Run 2	18.21	42.21	2.14	2.16	2.15
Run 3	38.77	46.63	2.16	2.23	2.20
Run 4	58.37	66.67	1.92	1.93	1.93
Run 5	37.07	57.19	1.95	1.94	1.95
Run 6	41.91	55.49	1.95	1.96	1.96
Run 7	37.77	44.40	2.08	2.08	2.08
Average	40.24	54.18	2.03	2.04	
SD	11.48	9.39	0.09	0.11	

SP3	GEN1 Run 3	GEN2 Run 3	GEN1	GEN2	per Pair
	% Cleaning	% Cleaning	Soil wt (g)	Soil wt (g)	Mean soil (g)
Run 1	34.10	63.14	1.85	1.91	1.88
Run 2	36.72	66.20	1.97	1.96	1.97
Run 3	46.42	65.42	1.95	1.94	1.95
Run 4	44.93	64.96	2.01	2.03	2.02
Run 5	34.06	43.85	2.04	2.06	2.05
Run 6	60.74	74.63	1.65	1.65	1.65
Run 7	43.95	57.19	2.08	2.08	2.08
Average	42.99	62.20	1.94	1.95	
SD	8.70	8.87	0.13	0.13	



Figure 12- Kitchen (SP) Soil: Graph of % Cleaning by weight vs. Solution for all batches







Figure 14 – Oneway Analysis of Cleaning % by weight by Solution – Kitchen Soil

Solution	# Samples	Mean	Lower 95% Cl	Upper 95% Cl
Gen1	24	71.79	68.49	75.10
Gen2	24	79.17	75.87	82.48



Figure 15 - Kitchen (SP) Soil: Graph of % Cleaning vs. Solution for all batches

Figure 16 - Kitchen (SP) Soil: Graph of % Cleaning vs. Solution for each batch







Solution	# Samples	Mean	Lower 95% Cl	Upper 95% Cl
Gen1	21	43.75	38.63	48.87
Gen2	21	57.73	52.90	62.57

### Figure 18 – Food Court plus Salt Soil Summary Data

### 101890406 Tennant floor cleaning system comparison Food Court plus Salt Cleaning summary

Soil mix: Oil, black ball clay, pancake mix, salt, candle dye

Test Conditions					
Room temperature:	23 °C				
Relative humidity:	50 %				
Supply water hardness:	1.5 mmol/l				
Supply water conductivi	450 μS/cm				
Supply water pH:	7.7				
Water prepared to EN/IEC 60734 Method B					

FC + salt	GEN1 Run 1	GEN2 Run 1	GEN1	GEN2	per Pair
	% Cleaning	% Cleaning	Soil wt (g)	Soil wt (g)	Mean soil (g)
Run 1	42.56	50.38	6.49	6.46	6.48
Run 2	41.03	42.57	6.52	6.52	6.52
Run 3	33.99	49.51	6.32	6.32	6.32
Run 4	33.03	61.98	6.30	6.20	6.25
Run 5	31.74	42.50	6.55	6.62	6.59
Run 6	33.50	48.87	6.36	6.37	6.37
Run 7	36.31	51.29	6.35	6.34	6.35
Average	36.02	49.59	6.41	6.40	
SD	3.89	6.06	0.10	0.13	

FC + salt	GEN1 Run 2	GEN2 Run 2	GEN1	GEN2	per Pair
	% Cleaning	% Cleaning	Soil wt (g)	Soil wt (g)	Mean soil (g)
Run 1	41.99	46.34	6.32	6.37	6.35
Run 2	43.52	48.47	6.21	6.20	6.21
Run 3	37.18	43.80	6.56	6.51	6.54
Run 4	40.06	47.80	6.58	6.61	6.60
Run 5	42.25	55.66	6.02	5.89	5.96
Run 6	34.70	53.36	6.08	6.16	6.12
Run 7	35.97	50.23	6.30	6.43	6.37
Average	39.38	49.38	6.30	6.31	
SD	3.19	3.77	0.20	0.23	

FC + salt	GEN1 Run 3	GEN2 Run 3	GEN1	GEN2	per Pair
	% Cleaning	% Cleaning	Soil wt (g)	Soil wt (g)	Mean soil (g)
Run 1	39.37	56.35	5.48	5.38	5.43
Run 2	44.36	45.70	5.33	5.34	5.34
Run 3	32.18	44.38	6.01	6.11	6.06
Run 4	37.55	58.06	4.93	4.99	4.96
Run 5	34.05	42.63	5.99	5.99	5.99
Run 6	36.62	52.32	5.60	5.67	5.64
Run 7	40.33	57.78	5.28	5.13	5.21
Average	37.78	51.03	5.52	5.52	
SD	3.76	6.19	0.36	0.39	



Figure 19 – Food Court plus Salt Soil: Graph of % Cleaning by weight vs. Solution for all batches







Figure 21 – Oneway Analysis of Cleaning % by weight by Solution – Food Court plus Salt Soil

Solution	# Samples	Mean	Lower 95% Cl	Upper 95% Cl
Gen1	24	52.30	50.52	54.07
Gen2	24	65.83	64.06	67.61



Figure 22 - Food Court plus Salt Soil: Graph of % Cleaning vs. Solution for all batches

Figure 23 - Food Court plus Salt Soil: Graph of % Cleaning vs. Solution for each batch





Figure 24 – Oneway Analysis of Cleaning % by Solution – Food Court plus Salt Soil

Solution	# Samples	Mean	Lower 95% Cl	Upper 95% Cl
Gen1	21	37.73	35.92	39.54
Gen2	21	50.00	47.43	52.57

## **APPENDIX I**

Quotation 500563324





04 November 2014

Mr. Chris Perrey Tennant Company 701 North Lilac Drive Minneapolis, MN 55422

Phone: (763) 513-1984 Fax: (763) 513-1722 E-mail: Chris.Perrey@tennantco.com

Quote No: 500563324

Dear Mr.Perrey

Intertek is the world's largest products and commodities testing organization, providing Global Compliance solutions that include product safety testing, EMC Testing, and performance verification. Intertek also now offers a full RoHS Compliance Solution. Contact your Account Manager for more information. We are pleased to present this proposal for evaluating your Eec-H20 Gen II. This proposal has been carefully prepared based upon the information Tennant Company provided to Intertek.

Service requested: Performance Testing

Performance Performance testing as described below \$21,727.00

Quote to cover Performance Testing of EcH20 Gen II Machine Vs EcH20 Gen I, Tap Water and Detergent.

Costs based on protocol provided by Tennant to Intertek using CSET unit to be shipped to intertek. Testng based on 3 soils and with the use of manufactured water: DI water with NaCl to a specific conductivity value of 250 microSiemens.

COSTS INCLUSIVE OF -Testing as per the protocol Photographic Imaging Subjective Panel Assessment of Images (using 3 assessors) Statistical Data Analysis Final Reporting

The costs are not inclusive of soils and test tiles which are to be supplied directly by Tennant to Intertek.

TIMELINES -W/C 3.11.14 - CSET, soild and tiles to be checked and prepared for shipping.

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Q500563324 Page 1 of 3



W/C 10.11.14 - CSET, soils and tiles to be shipped to Intertek Milton Keynes, UK.

W/C 17.11.14 - Tennant representative to visit Intertek Milton Keynes to set up and pilot testing

Testing to Commence towards the end of Novembner once piloting completed. Testing should be completed before the end of December with the analysis and final reporting to be supplied Jan 2015.

Costs not inclusive of shipping unit back to Tennant will be charged back accordingly. (at cost)

Subtotal (USD):	\$21,727.00
Total (USD) (Plus VAT where applicable):	\$21,727.00

100% on acceptance of report. We reserve the right to part invoice projects.

The name of Intertek cannot be used in association with the final results in any form of publicity, sales or marketing material without prior permission from Intertek.

Intertek's Terms and Conditions apply. See copy attached.

#### Authorisation to Proceed

If our proposal is acceptable, please sign below and send back to us as soon as possible. If you have any queries, please do not hesitate to contact us. Thank you for inviting us to quote. We look forward to working with you.

Yours sincerely,

Hannah Gibson

Intertek Testing and Certification Ltd Davy Avenue Knowlhill Milton Keynes MK5 8NL

Phone: +44 (0) 1908 857807 Email: hannah.gibson@intertek.com

Intertek Testing and Certification Ltd

Q500563324 Page 2 of 3 **APPENDIX II** 

CSET Setup & soiling procedure



# Method – CSET Procedure

### **Tip Cleaning Procedure**

- 1. Remove and clean the tips.
  - a. Remove the tip then remove the insert (inside) and remove Teflon tape.
  - b. Put in Ultrasonic Cleaner for 5 minutes.
  - c. Use a Q-tip wipe out inside of the tip.
  - d. Reinstall insert in the tip (hand tighten) and put on Teflon tape then install tip.
- 2. Set the tip height with Gage (1.75").

If needed, loosen screw to set height then tighten. making sure that the tip is straight.

- 3. Turn on the pump to desired flow (see #8 below).
- 4. Water flow should be checked when switching cells.

#### Sample Running Procedure:

- Connect and turn on the water supply for the reservoir. Flush the line before connection as needed to ensure stable water temperature during the test.
- 2. Inspect the trays and drainage line for cleanliness.
- 3. Make sure the ec-H2O<sup>TM</sup> module is hooked up correctly.
- If water is not plumbed to the tank, sure that there is enough water in the water tank to complete the experiment.
- 5. If a sink or floor drain are not used, insure the drainage bucket will not overflow.
- 6. Turn on the water pump and ec-H2O<sup>™</sup> cell.
- 7. Allow to run for 10 minutes.

Overspray can be minimized by placing cups underneath the nozzles.

8. 'Jog' the spray nozzle to the drainage end if needed

This protects the tile from spay as it is loaded

- Confirm that the cycle counter is programmed for the desired count, Set to a large number (e.g. 900) is the cycle time in not yet known
- Slide tile into positioning with the end against the stops and the side against the outside of the pan.
- 11. Clamp tile into place.
- 12. Press start button to begin the cleaning cycle.



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Page 1 of 2



- 13. Watch the tile to see when soil has been removed from half of the tile and an even number of cycles is run PBC: 250 cycles.
- 14. To stop manually, toggle the CSET OFF and ON to stop the run.
- 15. System Momentum may carry the sprayer over the tile at the end of the cycle.
  - As appropriate, stop the carriage by hand OR hold a cup under the nozzle until the tile can be removed.
- 16. Re-zero the cycle counter.
- 17. Repeat steps 8-15 for each tile.
- 18. Turn off the ec-H2O cell when testing is completed (turned on at Step 6).

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### Soil Mixing Procedure:

- Turn on scale and wait for scale to zero.
  Press units button as needed until the scale reads in grams.
- 3. Place beaker on the scale and tare weight.
- 4. Add first ingredient until desired weight is achieved.
- 5. Tare weight scale.
- Add the next ingredient until desired weight is achieved.
  Repeat steps 5-6 until all ingredients are added.
- 8. Mix all ingredients using a hand mixer for 10 minutes.

#### Ingredients:

Ingredient	Manufacturer	Product	Picture
Clay	H.C. Spinks	Ball Clay, Black Charm	
Pancake Mix	Bisquick	Original	AND
Salt	Fisher	Sodium Chloride ACS Reagent Grade or Equiv.	
Creamy Liquid Fry Shortening	Chef's Pride	Donut oil	

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			Come Star WARDER
Blue Candle Dye	Candle Wax Dye	131037	Blue/Sky Blue Liquid Dye S DR-005

### **Recipe:**

Soil mixture recipes for ~16 tiles:

- 1. Clay (Black Charm) 95 g
- Pancake Mix. 15 g.
- Sodium Chloride 10 g (Table Salt)
- 4. Shortening
- 5. Blue Candle Dye 15 drops (0.3 g).

#### Soil Applying Procedure:

- 1. Place tile into the stencil, making sure the tile is all of the way into the corner.
- 2. Attach binder clips to the far ends to hold the tile in place.

85 g.

- 3. Turn on scale and wait for scale to zero.
- 4. Press units button until the scale is set to grams.
- 5. Place tile onto the scale and tare the weight.



 Add approximately 2 g more soil to the tile than the desired end weight for the soil (end weight may vary by batch)

a. Oil 3.5±0.2g

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- Use the appropriate draw down bar for the soil, making sure to keep the pull down bar vertical
  - a. Oil 0.020" draw-down bar



- Slowly pull the soil back and forth, removing any lumps that cause streaking, until there is an even coating with consistent thickness.
- 9. Begin to scrape excess soil off of the pull down bar after each pull
- Make sure to make the last pass towards the bottom end to prevent a lip where the cleaned area originates



- Once all excess soil is removed and desired weight is achieved, remove binder clips and set tile on a level surface.
- 12. Clean any additional soil off of stencil before reusing.
- 13. Examples of coated tiles shown below:

Sample Coated Tiles:



14. Repeat steps 6-12 for additional tiles

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## **APPENDIX III**

Example photographs of soiled and cleaned tiles



### Typical Food Court tile scans







### Typical Food Court plus Salt soil tile scans

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