



GENESIS ENGINEERING INC.

Suite 103 – 1433 Rupert St., North Vancouver, B.C., Canada V7J 1G1
Phone: (604) 986-0603 Fax: (604) 986-6039 Email: gesplin@telus.net

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Mr. Nigel Boast, Chief Executive Officer
ViroForce
6421 179 Street
Surrey, B.C. V3S 7J9

Subject: Cruise Ship Volendam Tests – May 24, 2006



Two ozone sterilization tests were carried out aboard the Volendam cruise ship on May 24, 2006. The objective was to determine the efficacy of ViroForce technology for destroying pathogens similar to the deadly Norfolk virus. This report summarizes the procedure that was used during the tests and the conditions to which the test viruses were exposed.

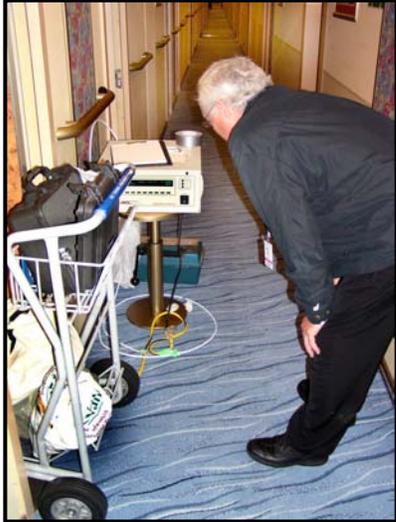


The ViroForce ozone generator/catalytic-scrubber prototype and the rapid humidifier prototype were placed on the floor within the cabin as shown in the photo to the left. Room vents were sealed off with duct tape to prevent any ozone from escaping the cabin. The cabin dimensions were measured and the cabin volume was calculated to be 1308 cubic feet.

The ozone generators/scrubber and humidifier were actuated via a timer after the test pathogens were placed in the room at random locations and the room was sealed. The ozone concentration, humidity and temperature within the sealed room were monitored from outside the sealed room (photo next page).

Test #1

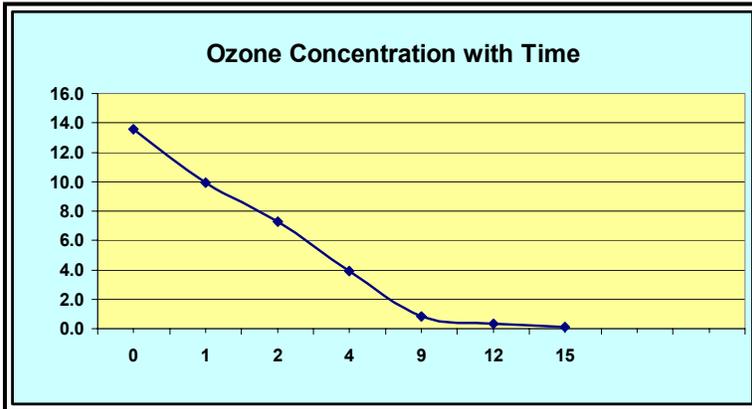
The test sequence for the first test was as follows:



1. Place pathogen samples within the room, then seal the room
2. Turn on the ozone generators for 30 minutes
3. Turn on the rapid humidifier for 4 minutes.
4. Let the room “soak” for 10 minutes (everything turned off).
5. Turn on the catalytic scrubber for 20 minutes.
6. Unseal the room and retrieve the pathogen samples.

The ozone generators flooded the room at a calculated rate of 11.5 g/hr of ozone. At the end of 30 minutes the ozone concentration within the room had attained a value of 31 ppm (see attached table). The ozone generators were then shut off and the rapid humidifier was turned on for 4 minutes. During this brief time the O₃ concentration went from 31 ppm down to 25 ppm and the relative humidity rose from 37.9% to 66%.

During the 10-minute “soak” period the ozone concentration within the room dropped



from 25 ppm down to 14 ppm, while the relative humidity went from 66% down to 52%. Following the soak period the catalytic scrubber was turned on and the ozone concentration was reduced from 14 ppm down to 0.2 ppm.

The moisture addition to the room air is calculated to be 237 grams of water, based upon the initial and final temperature and humidity readings. If it were assumed that roughly an equal amount condensed upon available surfaces during the test, then the condensed water “film” would be about two molecules thick.

Computer modeling and curve fitting of the data indicates that one of the two fans within the ozone catalytic scrubber was operational during the test. However, even with only one fan operational it took less than 15 minute to lower the ozone concentration down to a safe level (0.25 ppm), as shown in the above graph.

Test #2

The test sequence for the second test was as follows:

1. Place pathogen samples within the room, then seal the room
2. Turn on the ozone generators for 15 minutes
3. Turn on the rapid humidifier for 4 minutes.
4. Turn on the catalytic scrubber for 20 minutes.
5. Unseal the room and retrieve the pathogen samples.

The ozone concentration rose to 20.3 ppm in the 15-minute flood period. The relative humidity this time rose to 98% in 4 minutes. No soak period was allowed for this experiment. Again, it took less than 15 minutes for the scrubber to lower the ozone concentration down to a safe level. (The data for this test are appended to this report.)

The amount of water vapour added to the cabin air is calculated to be 498 grams, while another 702 grams condensed out on available surfaces. It is estimated that in this case the average thickness of the condensed water film was about 8 molecules. It is expected that some of the ozone was transferred to this water layer wherein it would be partially converted to the highly reactive hydroxyl radical, which is one of the most potent of germicidal agents available.

As in the first test, computer modelling indicated that only one of the two fans within the ozone catalytic scrubber was operational during the experiment.

While there were minor hardware glitches during the two experiments, the overall performance of the ViroForce hardware while deployed aboard a cruise ship was excellent and validated the engineering and design of the ViroForce ozone generator/scrubber prototype and rapid humidifier prototype.



Staff from Health Canada was present to inspect the ViroForce technology and to witness the test procedures for the first test.

Gordon Esplin, M.Sc., P.Eng.
Genesis Engineering Inc.
May 27, 2006

Volendam Test #1 - May 24, 2006			
Ozone Generators On			
Time (minutes)	Measured O₃ Concentration (ppm)	Room Temperature (C deg.)	Relative Humidity (%)
0	0.0	23.5	38.4
1	2.8		
2	5.6		
4	9.7		38.8
10	17.6		
20	25.5	23.7	38.1
30	31.1		
Rapid Humidifier On			
Time (minutes)	Measured O₃ Concentration (ppm)	Room Temperature (C deg.)	Relative Humidity (%)
0	31.1	23.7	37.9
1	29.0		45.6
2	27.6	23.9	62.4
3	26.2	24.0	65.7
4	24.8		66.0
Soak Period			
Time (minutes)	Measured O₃ Concentration (ppm)	Room Temperature (C deg.)	Relative Humidity (%)
0	24.8	24.0	66.0
1	23.1	24.0	61.6
2	11.2		59.2
3	21.0	24.0	
5	19.3		56.6
7	16.8		54.6
10	13.6		52.2
Scrubber On			
Time (minutes)	Measured O₃ Concentration (ppm)	Room Temperature (C deg.)	Relative Humidity (%)
0	13.6		52.2
1	10.7		50.1
2	7.2	24.0	48.7
4	3.6		
9	0.8		44.1
12	0.3		43.0
15	0.2		42.7

Volendam Test #2 - May 24, 2006			
Ozone Generators On			
Time (minutes)	Measured O₃ Concentration (ppm)	Room Temperature (C deg.)	Relative Humidity (%)
0	0.0	24.4	35.8
1	0.3		
2	3.1		
3	5.4		37.1
7	12.0		
13	18.8	24.4	38.4
15	20.3		38.5
Rapid Humidifier On			
Time (minutes)	Measured O₃ Concentration (ppm)	Room Temperature (C deg.)	Relative Humidity (%)
0	20.3	24.4	38.5
1	21.1	24.6	63.0
1.5	20.0		86.0
3	19.0		90.0
4	18.0		98.0
Scrubber On			
Time (minutes)	Measured O₃ Concentration (ppm)	Room Temperature (C deg.)	Relative Humidity (%)
0	18.0		98.0
1	16.1		99.0
2	10.3		95.6
4	6.3		81.9
6	3.8		
9	1.4		61.6
12	0.8		