TÜV NORD Systems

INDOOR AIR HYGIENE GROUP

TÜV NORD Systems GmbH & Co. KG
ISGBW Testing

Am TÜV 1
45307 Essen, Germany
+49 201 825 - 3204
GBTesting@tuev-nord.de

www.tuev-nord.de

TÜV®

Ref.-No.: KKL/1072/20
Order-No.: 81 18 52 83 25

Essen, 1 December 2020
GrV/DoKl

Report No.: TR-KKL-2020-102

Test on a Pleated Combi Filter Element

based on DIN 71460-1

Client	**Stadler Form AG** Chamerstr. 174 6300 Zug Switzerland
Testing object	Pleated Combi Filter Element ”Roger Dual Filter H12” Serial-No.: ---
Order	PO 4082
Date of order	30.09.2020
Arrival of the testing objects	06.10.2020
Content of order	Determination of the initial fractional efficiency according to Section 8.2 of DIN 71460-1
Standard of test	DIN 71460-1:2006
Test period	November 2020

The test report consists of 6 pages.

1 Introduction

The Pleated Combi Filter Element ”Roger Dual Filter H12” of Stadler Form is tested according to DIN 71460-1:2006, Section 8.2 and the standards cited therein. The examined value is the initial fractional efficiency. Chapter 2 provides a general overview of the test object and test conditions.

The tests are carried out in the Business Segment Refrigeration & Air Quality, DMT GmbH & Co. KG, in Essen. The results of the tests are listed in Chapter 3.

2 Testing object and test conditions

2.1 Description of the test object

Figure 1 and Figure 2 show photographs of the tested Pleated Combi Filter Element.

Figure 1: Upstream side of the Pleated Combi Filter Element – ”Roger Dual Filter H12”

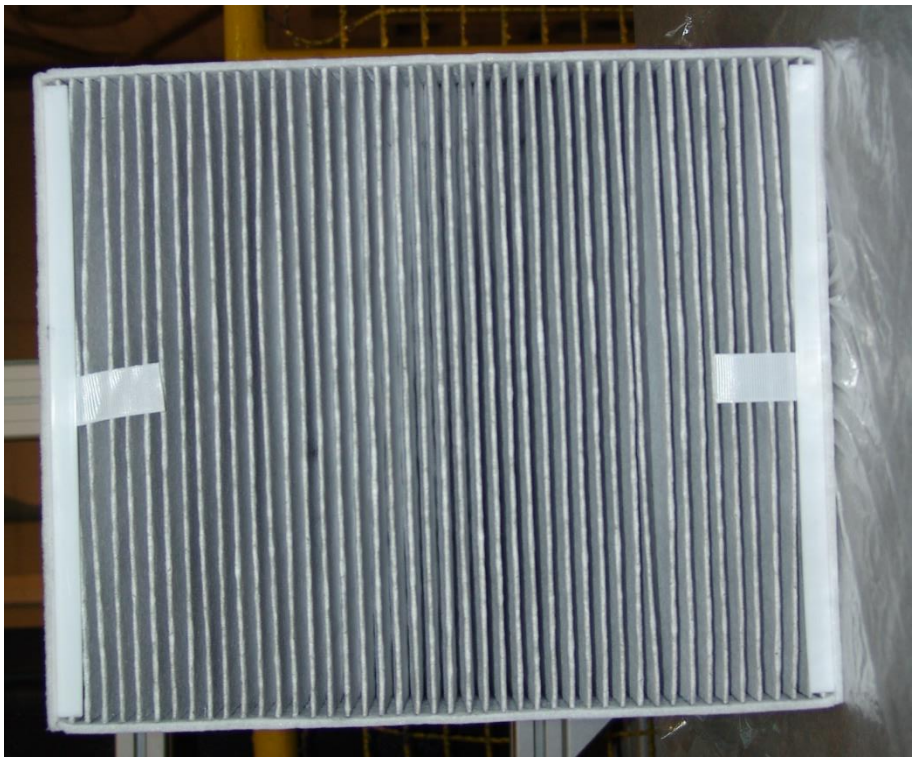

Figure 2: **Downstream side of the Pleated Combi Filter Element – ”Roger Dual Filter H12”**

Table 1: **Description of the testing object**

Characteristic	**Value**
Designation	”Roger Dual Filter H12”
Type	Combi filter (HEPA and activated carbon filter)
Length	322 mm
Width	268 mm
Depth	45 mm
Filter area	Not indicated Lab-measurement: approx. 0.09 m²
No. of pleats	42
Filter material	Not indicated
Serial-No.	Not indicated
Drawing-No.	Not indicated

Note: All technical data and general information according to client’s information.

2.2 Test conditions and procedure

Boundary condition of the test:

- Test volume flow: 290 m³/h
- Dust concentration: 75 ± 5 % mg/m³
- Test dust: A2 fine (ISO 12103-1)
- Air temperature: 23 ± 2 °C
- Air humidity: 50 ± 3 %
- Drying for 24 h in a climate cabinet at 60 °C.
- Equilibration inside the test channel at rated volume flow for 15 min

The determination of the differential pressure loss curve and the dust holding capacity were not part of the order.

2.3 Measurement equipment

Measurement equipment installedfor the test:

- Particle counter: “Welas 300” of Palas
- Particle disperser: “RBG 2000” of Palas
- Differential pressure: “ManoAir 500” of Schildknecht
- Rel. humidity/Temperature: “SD700” of Extech Instruments
- Dilution device: “VKL-10” of Palas
- Volume flow: “Inlet Nozzle” of Westenberg

3 Test results

Test conditions:

- Air temperature: 21 °C
- Relative air humidity: 48 %
- Air pressure (ambient): 1028 hPa
- Air volume flow: 290 m³/h
- Dust concentration: 75 ± 3,75 mg/m³
- Repeat measurements: 3
- Duration of measurement: 1 min each measurement
- Initial differential pressure: 79 Pa

Table 2: Fractional efficiency of the clean filter

X_m	Fractional efficiency	X_m	Fractional efficiency
µm	%	µm	%
0,255	100,00	2,212	100,00
0,295	99,07	2,555	100,00
0,341	99,53	2,950	100,00
0,393	100,00	3,407	100,00
0,454	100,00	3,934	100,00
0,525	100,00	4,543	100,00
0,606	100,00	5,247	100,00
0,700	100,00	6,059	100,00
0,808	100,00	6,996	100,00
0,933	100,00	8,079	100,00
1,077	100,00	9,330	100,00
1,244	99,05	10,774	100,00
1,437	100,00	12,442	100,00
1,659	100,00	14,367	100,00
1,916	100,00	16,591	100,00

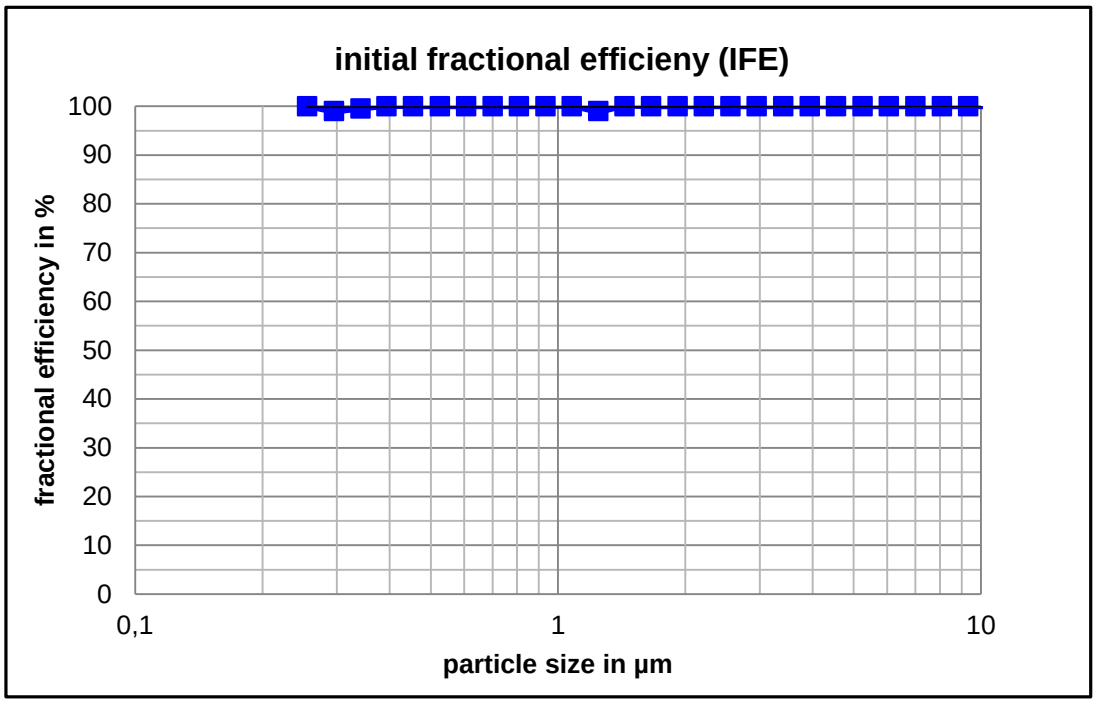

Figure 3: Fractional efficiency of the clean filter

Essen, 1 December 2020

Digital unterschrieben von Gräff Vera
Datum: 2020.12.01 11:57:49 +01'00'

Dipl.-Ing. Vera Gräff

Project manager Indoor Air Hygiene Group

Stadler Form
Chamerstrasse 174
6300 Zug

Burgdorf, 25.06.2020

Test order No. 2020-0883

Date of order:	15.06.2020
Responsible:	
Pages:	3

Method:

JIS L 1902	Quantitative analysis for determination of the bacteriostatic activity:

SANITIZED AG

Erich Rohrbach
Head Microbiology

The findings are valid for the tested object(s) only. Filing record of report and documentation is 10 years.

SANITIZED AG
Lyssachstrasse 95 | P.O. Box 1449 | 3401 Burgdorf | Switzerland
Phone +41 (0) 34 427 16 16 | Fax +41 (0) 34 427 16 19 | info@sanitized.com | www.sanitized.com

Results

Description of sample

Sample number:	**2020-0883-01**	Received:	15.06.2020
Business:	TEXTILE	Type:	QC
Identification:	Sample 1		
Main Component:	100% CO		
Field of Application:	Clean air device		
Sanitized Products:	Sanitized® T 11-15		
Declared quantity:	2%		

Pretreatment: 20x washings according to EN ISO 6330 (4M) 40°C

Test results of the SANITIZED-laboratory

Quantitative analysis for determination of the bacteriostatic activity:

Method	Test point	Activity	Reduction in %	Evaluation
JIS L 1902	Staphylococcus aureus ATCC 6538	>5.30	>99.99	Good effect

Results

Description of sample

Sample number:	**2020-0883-02**	Received:	15.06.2020
Business:	TEXTILE	Type:	QC
Identification:	Sample 2		
Main Component:	100% CO		
Field of Application:	Clean air device		
Sanitized Products:	Sanitized® T 11-15		
Declared quantity:	3%		

Pretreatment: 20x washings according to EN ISO 6330 (4M) 40°C

Test results of the SANITIZED-laboratory

Quantitative analysis for determination of the bacteriostatic activity:

Method	Test point	Activity	Reduction in %	Evaluation
JIS L 1902	Staphylococcus aureus ATCC 6538	>5.30	>99.99	Good effect

Customer Name	Stadler Form Aktiengesellsch
Customer Addres	Chamerstrasse, 174, 6300 Zug, Switzerland.
Contact	Thomas Becker
Test Requested	To assess the impact of the Influenza A (H1N1) virus in a
Sample Descripti	Roger Big
Number of Sampl	1
Date of Receipt	17 September 2020
ASC Code	ASC004019
Report Number	ASCR092437
Report Date	07 December 2020

Contents

1. Purpose

This report outlines the results following Stadler Form's Roger Big air purifier in removing airborne Influenza A (H_1N_1) from a 28 m^3 test chamber.

2. Test Item Description

The Roger Big air purifier was sent by Stadler Form for **airmid healthgroup** and was received 17th September (2020). Figure 2.1).

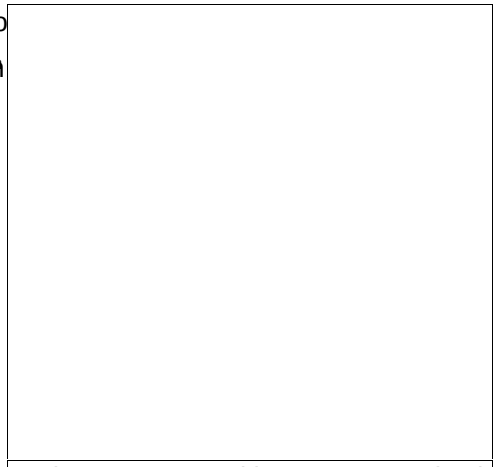

Figure 2.1 Stadler Form Roger Big air purifier tested at **airmid healthgroup**

3. Materials and Methods

3.1. Materials

- Influenza A (H_1N_1 PR8/34)
- Influenza A Virus Culture ELISA
- Influenza A Virus Transport Medium

3.2. Influenza A

Influenza virus infection is one of the most common infectious disease and it can occur in people of any age. Influenza A viruses are transmitted contact, indirect contact, large respiratory droplets and aerosols (droplet). Influenza viruses belong to the Orthomyxoviridae family and are divided C. Influenza types A and B are responsible for epidemics of respiratory associated with increased rates of hospitalization and death. During only influenza A subtypes that circulated extensively in humans were (H1N2); (H2N2) Asian Flu; and (H3N2) Hong Kong Flu. A H_1N_1 strain emerged in 2009 called Swine Flu as it originated in swine and

recently in 2013, a new strain of Avian Influenza A, H7N9 has infe
is believed to be from exposure to infected poultry.
All known subtypes of influenza type A viruses have been isolated from
a range of mammalian species. As with humans, the number of inf
have been isolated from other mammalian species is limited. Influe
exclusively infect humans.
In this case, influenza type A virus has been used for the testing

4. Protocol

4.1. Test Conditions

Testing of Standler Pro germair purifiers was conducted in a 28.5 m³ environmental test chamber. The chamber was preconditioned to 20 °C (±1 °C) and 50 % (±5 %) relative humidity before the commencement of the tests. After each test run was sterilised by operating a UV germicidal lamp, ceiling mounted in the chamber, for at least 60 minutes. Air was extracted from the test chamber through HEPA filters and filtered air was returned to the chamber via a blower. The chamber was cleaned by washing with 5% v/v Virkon purpose disinfectant solution.

4.2. Air Purifier Control and Test Runs

Six decay tests were performed in the environmental chamber consisting of:

- Three inactive control runs without the air purifier
- Three active test runs with the Breathe Pro air purifier operating at the max airflow

For the active test runs the purifier was placed on the floor in the centre of the chamber. For the inactive control runs, the procedure was performed in the absence of the air purifier. Three replicates per sample timepoint were collected during each run.

In both the active and inactive runs, viable Influenza A was aerosolised in the chamber for up to 20 minutes. The amount of Influenza A aerosolised was dependent on the virus stock used, however 10⁶ to 10⁷ pfu of virus was introduced to the test chamber for each run. The viral aerosol was mixed in the chamber by a circulating fan, at low speed for the duration of the test.

4.3. Sampling Time Points

Three SKC BioSamplers collected air samples at 1 m height for 10 minutes 11.8 l/min at the following time points:

- -10 to 0 min (AS-1)
- 05 to 15 min (AS-2)
- 20 to 30 min (AS-3)
- 50 to 60 min (AS-4)

Figure 4.1 Sampling scheme for airborne Influenza A. Air Sampling timepoints used throughout each active and inactive run.

For the active test runs, the air purifier was operated remotely at t=0 minutes and remained operating for the duration of the test (Figure 4.1). At the end of the test, the samples were removed from the BioSamplers and transferred to sterile 40 ml tubes that were placed on ice and then stored at -20 °C until laboratory analysis.

4.4. Sample Analysis

Influenza A quantification was performed by ELISA. The ELISA (Enzyme-Linked immunosorbent assay) is a plate-based assay technique that uses antibodies' specificity to detect and quantify substances, such as peptides and antigens. The NP-ELISA validated in animal health group detects and quantifies Influenza A nucleoprotein (NP). In this report, the abbreviation InfA is used to refer to the virus quantified by the ELISA as NP antigen. The concentration of InfA in each sample is reported in this report as ng per m³ of sampled air.

Virus reduction percentage was calculated according to the formula

5. Results and Discussion

The recovery concentrations of Inf A in the three control runs and in the three test runs are reported in Tables 5.1 and 5.2. Each result is the average of three replicates sampled at the indicated time. The Inf A concentration was determined by ELISA in ng/ml and converted into ng/m^3, i.e. nanograms of influenza A per cubic metre of air sampled by th BioSamplers.

	Table 5.1 Average Influenza A concentration me control runs (ng/m^3)			
Timepoint	Control 1	Control 2	Control 3	Average (n=3
-10 0	2729.1	3447.4	3900.1	3358.9
5 15	2099.3	1973.9	2770.5	2281.2
20 30	1546.7	1511.5	2294.5	1784.2
50 60	874.9	773.3	1386.7	1011.6

	Table 5.2 Average Influenza A concentration in test runs (ng/m^3)			
Timepoint	Test 1	Test 2	Test 3	Average (n=3
-10 0	4314.9	4288.8	3483.1	4028.9
5 15	181.6	95.3	46.5	107.8
20 30	9.1	<LOD	<LOD	3.0
50 60	<LOD	<LOD	<LOD	<LOD

<LOD: Less than the limit of detection

Figures 5.1 and 5.2 show the trend of Inf A levels over time in the th respective runs. The rapid reduction in Inf A concentration observed in the test not be attributed to natural decay due to forces exerted on the virus p In the three tests, between 50 and 60 minutes of the air purifier operation, the Inf A concentration had dropped below the detection limit of the assay used to quantify the virus. The differences among the same sampling timepoints in the runs can be ascribed to the virus stock used to perform the runs and the sampling process itself. As reported by Fabian e laboratory studies, SKC BioSamplers represent the most efficient airborne virus par tool in terms of virus infectivity preservation and collection efficiency. Despite this, th recovery efficiency is about 79% for particles sized > 0.3 µm, which collected concentrations of Inf A particles sized ~ 0.1 µm.

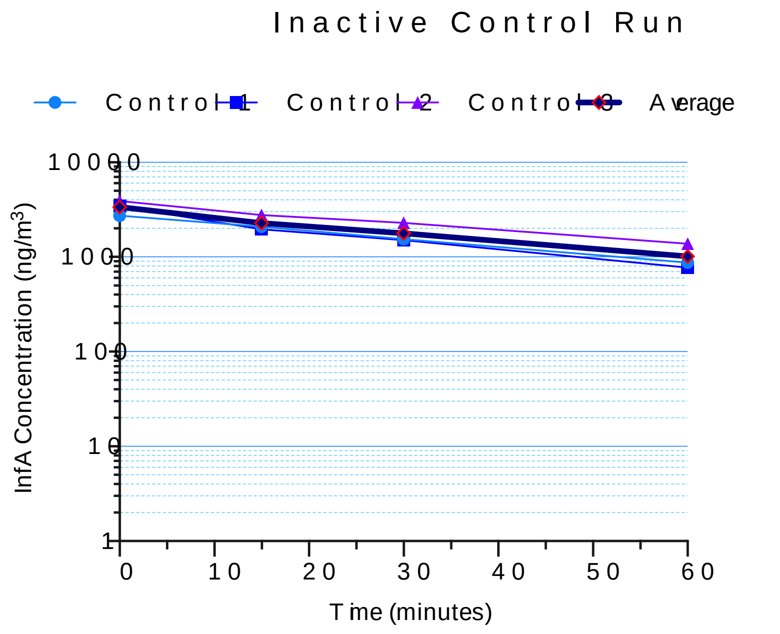

Figure 5.1
Influenza A conc
(represented on a l
scale) in the test
during inactive contr
with air purifier operatin
Each sampling poin
represents the av
three replicates.

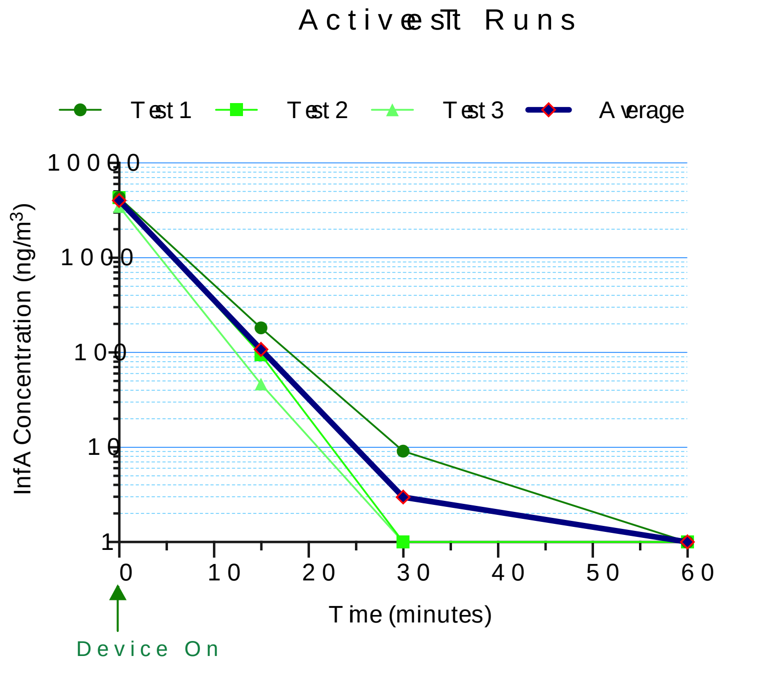

Figure 5.2
Influenza A conc
(represented on a l
scale) in the test
during active test ru
performed with Roger
air purifier operating.
sampling point repr
average of three replicate

The data presented show that in 60 minutes the Stadler Form Roger air purifier operating at the highest fan speed, the Influenza A concentration in the test chamber was reduc to less than 1.56 ng/m^3 (the detection limit of the assay performed to quantify collected airborne virus).

Figure 5.3 shows the percentage reduction in the Influenza A levels (calculated in Section 4) during the control and test runs. Virus concentrations were observed

during control runs. Statistical fluctuations are unavoidable, especia
described in this report. Several factors affect the result. The sampling process and
the assay bring their own variability, and one must not forget that the
survival environment of the aerosolized body, is an indoor space with certain ph
characteristics, where physical forces such as inertia and diffusion are applied c
throughout the test duration (Hind 1999, U.S. EPA 2010, Lee et al. 20
may also adhere to the chamber surfaces after a certain period and return to the chamber
with a lower or null concentration of virus, with a number of particles in ... i
collected by the SKC BioSampler period. In contrast, 99.9% decrease in Inf A
levels is observed in 60 minutes after the purifier is turned on.

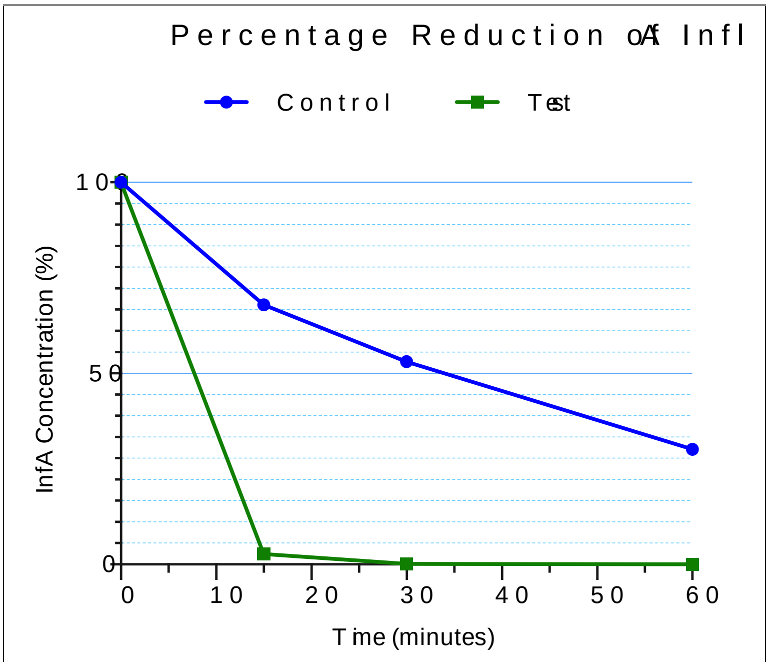

Figure 5.3. The average percent reduction of In
and control runs (n=3)

6. Conclusion

The Stadler Form Big air purifier was demonstrated to be effective in reducing Influenza A aerosols in the test chamber, achieving a reduction of 99.9% or more within 60 minutes of operation at the highest flow rate. These results indicate that in the presence of a unit the Influenza A concentration in the test chamber was reduced to below the detection limit of the assay performed to quantify the collected airborne virus.

7. References

Hinds (1999). Aerosol Technology. John Wiley & Sons, Inc New York / Brisbane / Singapore / Toronto.

Fabian P., McDevitt J.J., Houseman E.A., Milton D.K. (2009). Airborne optimized method to influenza virus and human rhinovirus from exhaled breath and the airbo 19(5): 421-431.

EPA/600/R-10/127 (2010). Development of a Methodology to Detect Viable Personal Aerosol Sample.

Lee I., Kim H., Lee D., Hwang G., Jung G., Lee M., Lim J. Lee B. (20 Distribution and Genetic Characteristics of Aerosolized Influenza A H1 Aerosol and Air Quality Research, 11, 230

Report written by:	Report reviewed by:
Jake Behan, BSc.	Vivienne Mahon, PhD
Head of Operations	Chief Scientist/Quality

End of Report