NOVAERUS

Laboratory & Clinical Research Summary

In independent laboratory studies Novaerus products, powered by NanoStrike technology, have been shown to safely and effectively reduce bacteria, viruses, allergens, volatile organic compounds, and particulate matter.

In clinical settings, Novaerus products have been demonstrated to reduce airborne pathogens, surface bacteria, infections, antibiotic use, and odours.

NanoStrike technology

NOVAERUS

The First Line of Protection Against Airborne Viruses and Bacteria

NanoStrike is the core, patented technology that powers all Novaerus portable air dis-infection devices.

Our plasma-based nanotechnology kills all airborne microorganisms on contact providing the first line of protection against viruses and bacteria.

- Patented technology harnessing multiple pathogen inactivation processes in one powerful strike
- Kills and deactivates at the DNA level in a sub-second time frame
- Uniquely bursts the pathogen cell, preventing self-healing
- Multiple pathogen inactivation processes guarantee no future antimicrobial resistance can develop
- Lowest total cost of ownership of any air purification technology
- Powerful but gentle for 24/7 use around the most vulnerable of people
- Independently tested and proven

Developed by the Novaerus team of scientists and engineers, NanoStrike utilizes an atmospheric plasma discharge — the same type of discharge found in lightning strikes — to kill and deactivate harmful airborne microorganisms.

NanoStrike plasma coils provide a deadly strike, made up of multiple concurrent processes, that work to rapidly destroy airborne pathogens.

Escherichia coli (E. coli) Deactivation

Laboratory Name:	**NASA Ames Research Center**
Laboratory Location:	**Moffett Field, Mountain View, CA**
Date:	**February 2016**
Device Tested:	**NV200**
Space Treated:	**.51 m^3**

Objective

To explore the morphological and chemical modification of the cell structure of aerosolized *Escherichia coli (E. coli)* treated with a dielectric barrier discharge (DBD).

Methodology

The NV200 was placed inside a biosafety cabinet, and a compressor nebulizer was attached to the input of the system in order to aerosolize the bacterial particles for testing.

Summary of Results

The bacteria underwent physical distortion to varying degrees, resulting in deformation of the bacterial structure. The electromagnetic field around the DBD coil caused severe damage to the cell structure, possibly resulting in leakage of vital cellular materials. The bacterial reculture experiments confirm inactivation of airborne *E. coli* upon treating with DBD.

Healthy bacteria

Bacteria after NanoStrike treatment

Staphylococcus epidermidis and *Aspergillus niger* Reduction

Laboratory Name:	**NASA Ames Research Center**
Location:	**Moffett Field, Mountain View, CA**
Date:	**October 17, 2016**
Device Tested:	**NV200**
Space Treated:	**.51 m³**

Objective

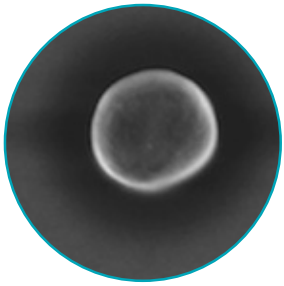
To explore the efficacy of the atmospheric pressure dielectric barrier discharge (DBD) technology on inactivating airborne pathogens, specifically *Staphylococcus epidermidis*, a surrogate for methicillin-resistant *Staphylococcus aureus* (MRSA), and *Aspergillus niger*.

Methodology

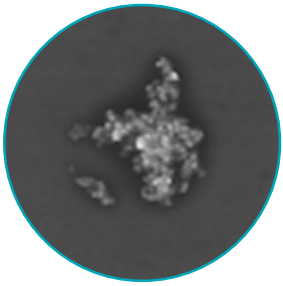
The NV200 was placed inside a biosafety cabinet, and a nebulizer was attached to the input of the system in order to aerosolize the bacterial particles for testing. All the DBD system vents, except the top one, were sealed to prevent any undesired microorganism from getting into the system.

Summary of Results

It is concluded that the DBD caused severe size and shape change of the cell structure, possibly resulting in destruction of cellular components and eventually to cell death. A similar effect was also found on the fungal spores, indicating the versatility of the equipment toward a range of microorganisms.



Healthy bacteria



Bacteria after NanoStrike treatment

SARS-CoV-2 Reduction

Laboratory Name:	**Aerosol Research and Engineering Laboratories**
Laboratory Location:	**Olathe, Kansas**
Date:	**April 2020**
Device Tested:	**NV1050**
Space Treated:	**16 m^3**

Objective

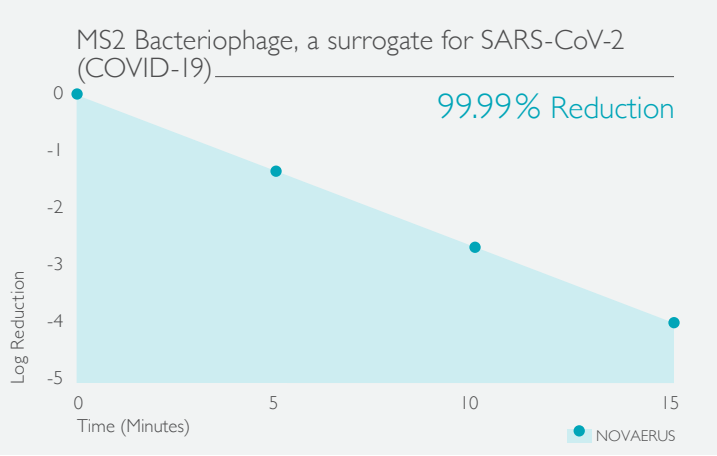
To evaluate the efficacy of the NV1050 at reducing aerosolized MS2 bacteriophage, a surrogate for SARS-CoV-2, the virus causing COVID-19.

Methodology

MS2 bacteriophage was aerosolized into a 16 m^3, sealed environmental bioaerosol chamber containing the NV1050. AGI impingers were used to sample the chamber bioaerosol concentrations. Chamber control trial data was subtracted from the NV1050 trial data to yield net LOG reduction in the chamber for the bioaerosol challenges.

Summary of Results

The NV1050 was shown to reduce MS2 bacteriophage by 99.99% in 15 minutes.



Measles Virus Reduction

Laboratory Name:	**Airmid Health Group Ltd**
Laboratory Location:	**Dublin, Ireland**
Date:	**August 1, 2019**
Device Tested:	**NV1050**
Space Treated:	**28.5 m^3**

Objective

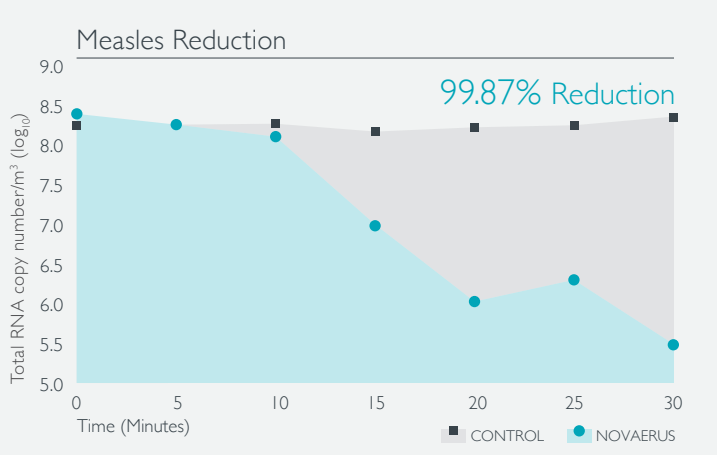
To assess the performance of the NV1050 in removing aerosolised Human parainfluenza type 3 (HPIV3) (renamed human respirovirus 3), a surrogate for Measles virus.

Methodology

The impact of Novaerus (NV1050) air purifier on aerosolised HPIV3 (strain MK-3) was conducted in a 28.5 m^3 environmental testing chamber. The test chamber was preconditioned to 20 ± 3 °C and 55 ± 5% relative humidity. During testing, the chamber air handling unit was shut down, which reduces the number of air changes to as close to zero as possible.

Summary of Results

The results achieved during the testing show that the NV1050 was able to reduce the concentration of HPIV3 by 99.87% in 20 - 30 minutes.



Influenza A Reduction

Laboratory Name:	**Airmid Health Group Ltd.**
Laboratory Location:	**Dublin, Ireland**
Date:	**April 25, 2018**
Device Tested:	**NV1050**
Space Treated:	**28.5 m^3**

Objective

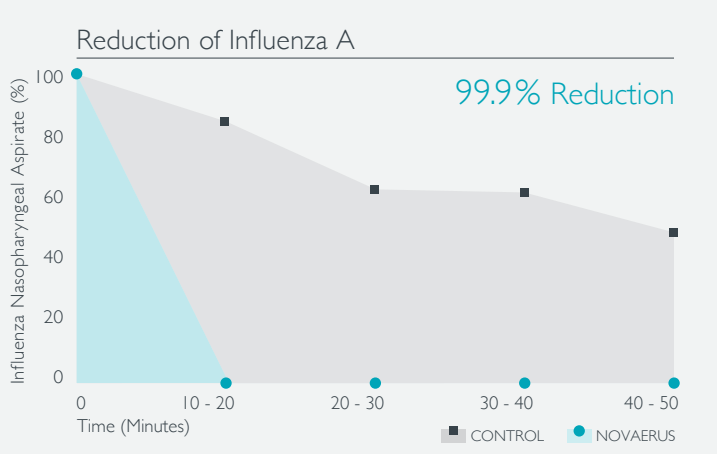
To evaluate the efficacy of the NV1050 on removing Influenza A.

Methodology

Testing of the NV1050 was conducted in a 28.5 m^3 environmental test chamber. The chamber was preconditioned to 20±3 °C and 50±10% relative humidity prior to commencement of the tests. For the test runs, the NV1050 was placed on the floor in the centre of the chamber.

Summary of Results

The NV1050 was effective in reducing airborne Influenza A aerosols in the test chamber, reaching 99.9% airborne virus reduction within the first 10 – 20 minutes of operation at max speed.



Bioaerosols Reduction

Laboratory Name:	**Aerosol Research and Engineering Laboratories**
Laboratory Location:	**Olathe, Kansas**
Date:	**December 7, 2016**
Device Tested:	**NV800**
Space Treated:	**16 m^3**

Objective

To evaluate the efficacy of the NV800 on neutralizing four aerosolized biologicals; *Staphylococcus epidermidis* (a surrogate for methicillin-resistant *Staphylococcus aureus* (MRSA)), MS2 bacteriophage (a surrogate for influenza, norovirus and coronaviruses), *Aspergillus niger* fungus, and *Bacillus subtilis* endospores.

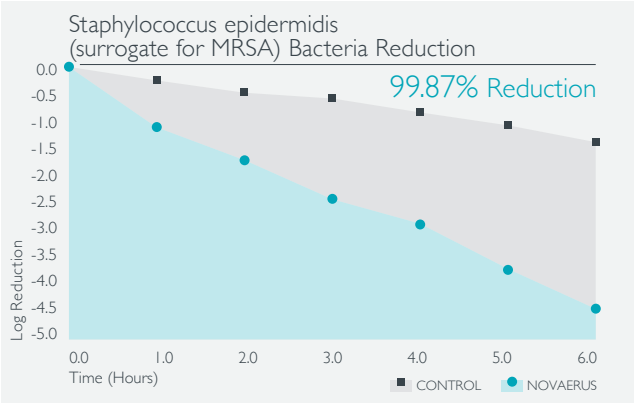
Methodology

A large sealed aerosol test chamber was used to replicate a potentially contaminated room environment and to contain any potential release of aerosols into the surrounding environment.

Summary of Results

Test results show the NV800 was extremely effective at reducing viability of bioaerosols in all conducted studies:

- *Staphylococcus epidermidis* by 99.87%
- *Aspergillus niger* by 99.10%
- MS2 bacteriophage by 99.99%
- *Bacillus subtilis* by 86.63%



Mycobacterium tuberculosis Bacteria Reduction

Laboratory Name:	**Airmid Health Group Ltd.**
Laboratory Location:	**Dublin, Ireland**
Date:	**July 6, 2018**
Device Tested:	**NV1050**
Space Treated:	**30 m³**

Objective

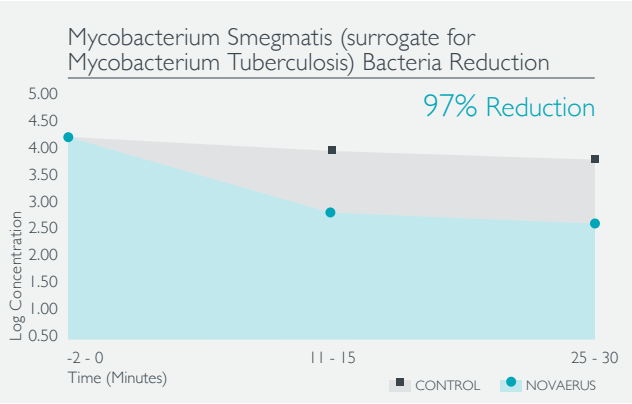
To assess the performance of the NV1050 in removing aerosolised *Mycobacterium smegmatis*, a surrogate for *Mycobacterium tuberculosis*.

Methodology

The impact of Novaerus (NV1050) air purifier on aerosolised *M. smegmatis* was conducted in a 30 m³ environmental testing chamber. The test chamber was preconditioned to 20 ± 3 °C and 55 ± 5% relative humidity. These conditions were maintained throughout the test and control runs. Prior to each run, the test chamber was decontaminated by scrubbing the walls and surfaces.

Summary of Results

The results achieved during the testing show that the NV1050 was able to reduce the concentration of *M. smegmatis*, a surrogate for *Mycobacterium tuberculosis*, artificially aerosolised by 95% within the first 15 minutes and this rose to 97% after 30 minutes of A/C operation.



Staphylococcus epidermidis Bacteria Reduction

Laboratory Name:	**Novaerus Research and Development Labs**
Laboratory Location:	**Dublin, Ireland**
Date:	**June 27, 2018**
Device Tested:	**NV1050**
Space Treated:	**30 m³**

Objective

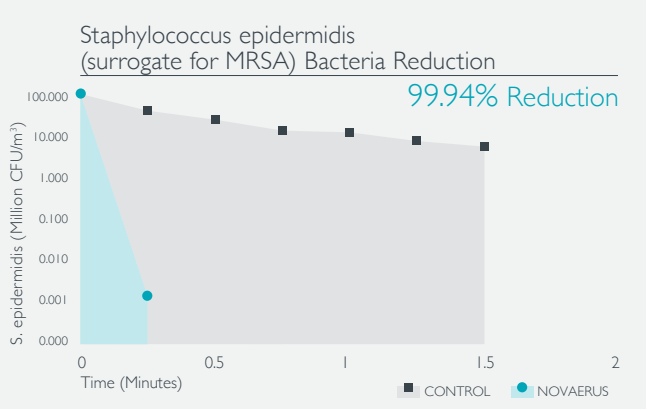
To evaluate the efficacy of the NV1050 in reducing airborne *Staphylococcus epidermidis* bacteria, a surrogate for methicillin-resistant *Staphylococcus aureus* (MRSA).

Methodology

The test environment was a 30 m³ test chamber, located in the Novaerus microbiology laboratory. During the testing, the NV1050 device was placed inside the chamber at the centre, with the air inlet facing towards the door of the chamber. The NV1050 device was tested at maximum airflow, speed setting 5. The test chamber was controlled for temperature and humidity at 25 °C and 50% relative humidity.

Summary of Results

The NV1050 achieved a microbial cell reduction of 99.94% of *Staphylococcus epidermidis*, a surrogate for methicillin-resistant *Staphylococcus aureus* (MRSA), within 15 minutes of operation.



Clostridium difficile Bacteria Spore Reduction

Laboratory Name:	**Airmid Health Group Ltd.**
Laboratory Location:	**Dublin, Ireland**
Date:	**February 8, 2019**
Device Tested:	**NV1050**
Space Treated:	**28.5 m³**

Objective

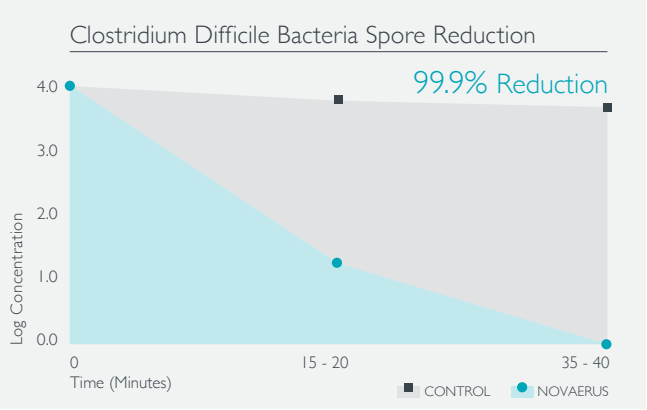
To assess the performance of the NV1050 in removing aerosolized *Clostridium difficile* spores.

Methodology

A 28.5 m³ environmental test chamber was preconditioned to 20 ± 3 °C and 55 ± 5% relative humidity. During the test runs the air purifier was placed in the centre of the test chamber and operated at full speed mode. During the control runs the air purifier was switched off. The *C. difficile* spores were nebulised into the chamber for a fixed time and mixed with a ceiling fan.

Summary of Results

The NV1050 demonstrated to be effective in reducing the airborne *C. difficile* by 99.6% within the first 20 minutes and this increased to > 99.9% after 40 minutes.



Methicillin-resistant *Staphylococcus aureus* (MRSA) Bacteria Reduction

Laboratory Name:	**Microbac Laboratories, Inc.**
Laboratory Location:	**Wilson, NC**
Date:	**January 20, 2016**
Device Tested:	**NV800**
Space Treated:	**1 m³**

Objective

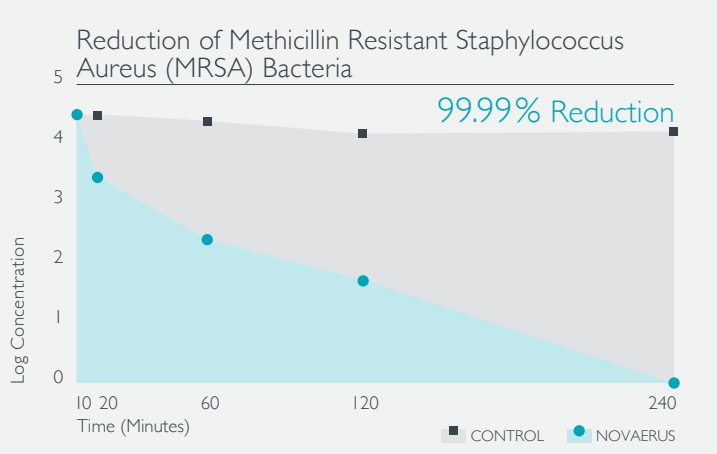
To evaluate the efficacy of the NV800 in reducing methicillin-resistant *Staphylococcus aureus* (MRSA).

Methodology

The challenge bacteria were aerosolized using a six-jet collision nebulizer under high pressure air and introduced into the chamber with the NV800.

Summary of Results

The NV800 reduced 99.99% of methicillin-resistant *Staphylococcus aureus* (MRSA) bacteria over the course of four hours.



Staphylococcus epidermidis Reduction

Laboratory Name:	**University of Huddersfield**
Laboratory Location:	**Huddersfield, England**
Date:	**May 27, 2014**
Device Tested:	**NV800**
Space Treated:	**1 m³**

Objective

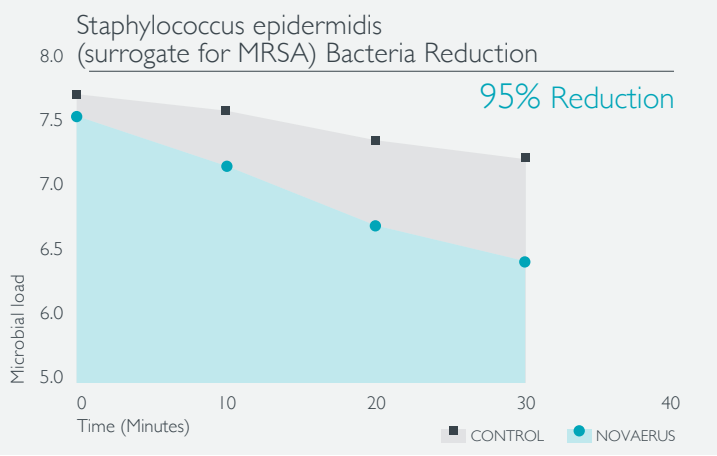
To evaluate the efficacy of the NV800 in reducing *Staphylococcus epidermidis* aerosols, a surrogate for methicillin-resistant *Staphylococcus aureus* (MRSA).

Methodology

A 1.0 m³ air tight perspex chamber was fitted with an internal fan to maintain mixing, sampling and injection ports, and the NV800. The fan and the NV800 were activated from outside of the chamber as and when required.

Summary of Results

In over 30 minutes of sampling, the NV800 reduced 95% of *Staphylococcus epidermidis* aerosols, a surrogate for methicillin-resistant *Staphylococcus aureus* (MRSA). Both the rate of removal and the final log reduction were greater in the presence of the NV800.



Mycobacterium tuberculosis Inactivation

Laboratory Name:	**Qualilife Diagnostics**
Laboratory Location:	**Mumbai, India**
Date:	**December 10, 2016**
Device Tested:	**NV200**
Space Treated:	**68 litres**

Objective

To evaluate the efficacy of the NV200 on reducing *Mycobacterium tuberculosis*.

Methodology

The NV200 unit was placed inside a 68-litre plastic enclosure. The plastic enclosure and test set up was placed inside a biosafety cabinet. Clinical isolate of *Mycobacterium tuberculosis* was aseptically transferred into a sterile mycobacteria growth indicator tube (MGIT) and Lowenstein-Jensen (LJ) medium.

Summary of Results

The air sample collected from the test after being exposed to the NV200 showed no growth of *Mycobacterium tuberculosis*. This shows that the device has effectively rendered all airborne *Mycobacterium tuberculosis* non-viable.

Aspergillus niger Spore Reduction

Laboratory Name:	**Aerosol Research and Engineering Laboratories**
Laboratory Location:	**Olathe, Kansas**
Date:	**May 28, 2018**
Device Tested:	**NV1050**
Space Treated:	**16 m^3**

Objective

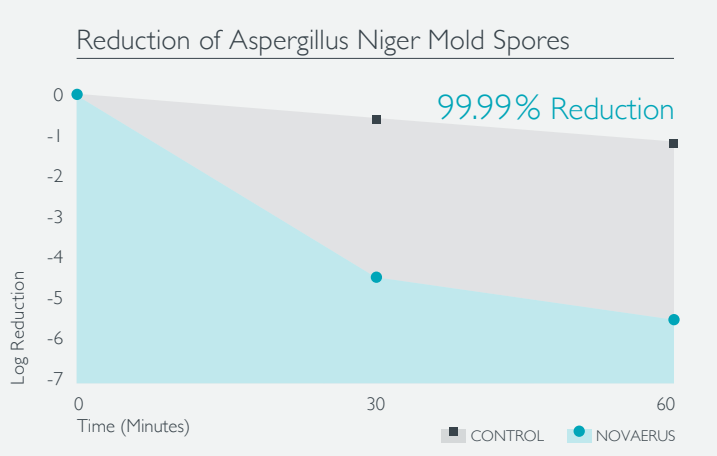
To evaluate the efficacy of the Novaerus NV1050 system against aerosolized *Aspergillus niger* spores.

Methodology

A. niger spores were aerosolized into a sealed bioaerosol chamber using a dry powder disseminator. AGI impingers were used to capture chamber bioaerosol concentrations.

Summary of Results

The average net LOG reduction of the NV1050 system at 30 minutes showed a 4.10 LOG. The net LOG reduction at 60 minutes showed a 4.28 LOG due to reaching detection limit. The actual LOG reduction is theoretically much higher at 60 minutes in a small room environment.



Nitrogen Dioxide Reduction

Laboratory Name:	**Aerosol Research & Engineering Laboratories**
Laboratory Location:	**Olathe, Kansas**
Date:	**July 27, 2018**
Device Tested:	**NV1050**
Space Treated:	**16 m^3**

Objective

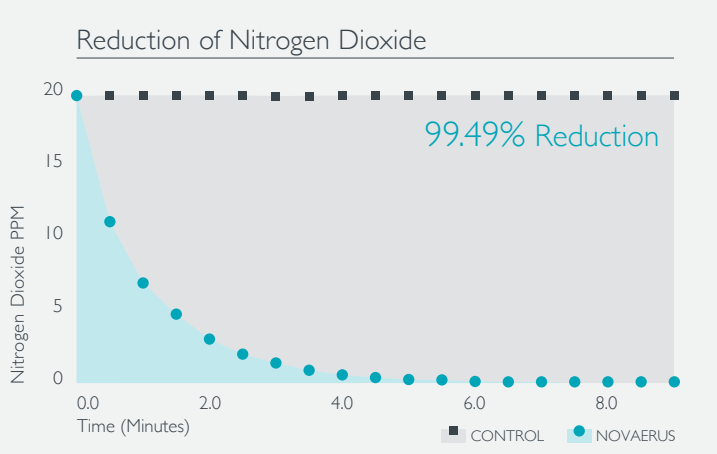
To evaluate the efficacy of the Novaerus NV1050 system on eliminating nitrogen dioxide (NO_2).

Methodology

NO_2 gas was released into a 16 m^3 sealed chamber while the monitoring of the concentration was logged with specialized detectors. For the control trial, the NV1050 remained outside the chamber, and the gases were allowed to dissipate naturally over time.

Summary of Results

The NV1050 showed an average 99.49% reduction of NO_2 in 7.2 minutes.



Formaldehyde Reduction

Laboratory Name:	**Aerosol Research & Engineering Laboratories**
Laboratory Location:	**Olathe, Kansas**
Date:	**July 27, 2018**
Device Tested:	**NV1050**
Space Treated:	**16 m^3**

Objective

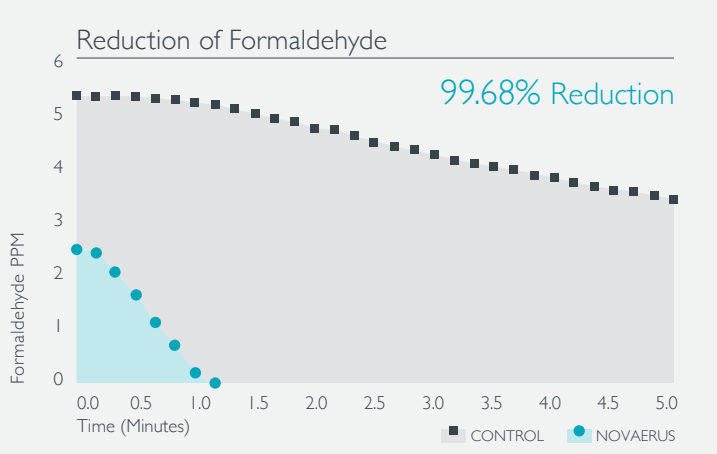
To evaluate the efficacy of the Novaerus NV1050 system on eliminating formaldehyde.

Methodology

Formaldehyde gas was released into a 16 m^3 sealed chamber while the monitoring of concentration was logged with specialized detectors. For the control trial, the NV1050 remained outside the chamber, and the gas dissipated naturally over time.

Summary of Results

The NV1050 showed an average 99.68% reduction of formaldehyde in 1.1 minutes.



Formaldehyde Reduction

Laboratory Name:	**Avomeen Analytical Services**
Laboratory Location:	**Ann Arbor, MI**
Date:	**May 27, 2014**
Device Tested:	**NV800**
Space Treated:	**1 m^3**

Objective

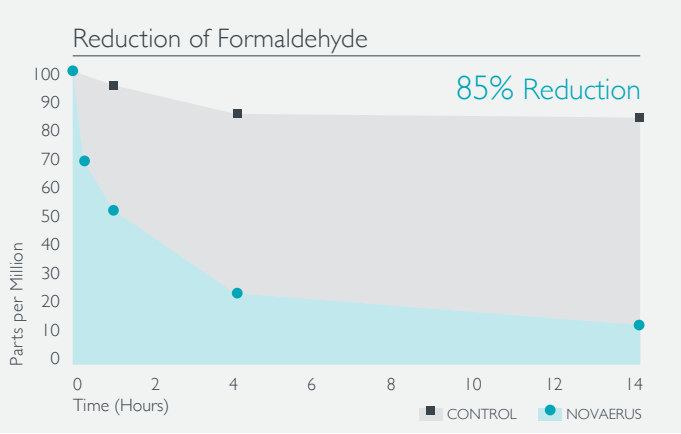
To evaluate the efficacy of the NV800 on reducing formaldehyde.

Methodology

A plexiglass chamber was built for formaldehyde testing of the NV800. This chamber was also equipped for proper ventilation and interior air circulation. A calculated amount of formaldehyde solution was evaporated in an aluminum pan heated to 120 degrees Celsius with a constant temperature hot plate.

Summary of Results

The NV800 reduced formaldehyde from 100 ppm to around 13 ppm during a 14-hour testing experiment, an 85% reduction.



Toluene VOC Reduction

Laboratory Name:	**Camfil Laboratories – Tech Center**
Laboratory Location:	**Trosa, Sweden**
Date:	**April 25, 2018**
Device Tested:	**NV1050**
Space Treated:	**19.72 m^3**

Objective

To evaluate the particulate and molecular efficiency of the NV1050 in a test chamber using Toluene, a volatile organic compound (VOC).

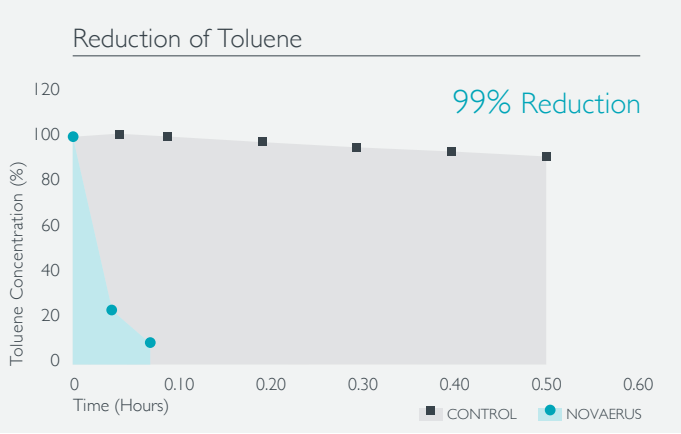
Methodology

Test method: CADR

Toluene was generated in the laskin nozzle and injected into a room until a pre-set concentration was achieved then the air cleaner was turned on. The results were then compared to the normal reduction of particles over time in the test chamber.

Summary of Results

The NV1050 produced a VOC CADR of 351 CFM. On the high speed, the NV1050 was shown to remove 90% of the toluene within 6 minutes and 99% within 9.1 minutes. On the low speed, the NV1050 was shown to remove 90% within 16 minutes.



PM1 and PM2.5 Reduction

Laboratory Name:	**Camfil Laboratories – Tech Center**
Laboratory Location:	**Trosa, Sweden**
Date:	**April 25, 2018**
Device Tested:	**NV1050**
Space Treated:	**19.72 m^3**

Objective

To evaluate the particulate and molecular efficiency of the NV1050 in a test chamber using DEHS.

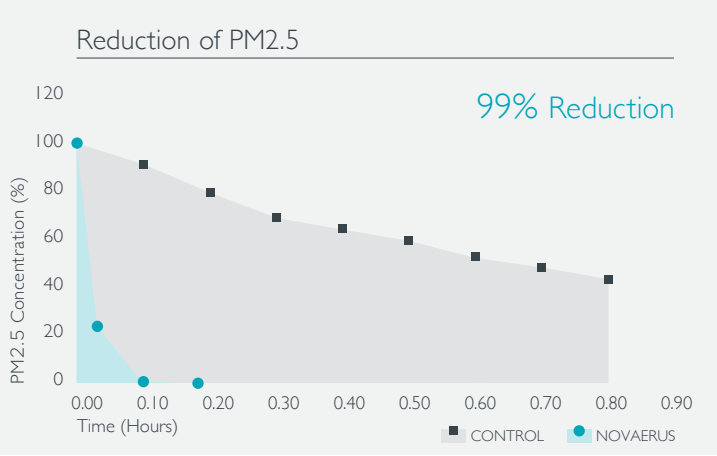
Methodology

Test method: CADR

DEHS was generated in the laskin nozzle and injected into a room until a pre-set concentration was achieved then the air cleaner was turned on. The results were then compared to the normal reduction of particles over time in the test chamber.

Summary of Results

The NV1050 produced a CADR of 513 CFM against PM2.5 and a CADR of 507 CFM against PM1. It removed 99% of PM2.5 within 6.26 minutes and 99% of PM1 within 6.33 minutes.



Allergens Reduction

Laboratory Name:	**Indoor Biotechnologies Ltd.**
Laboratory Location:	**Cardiff, UK**
Date:	**September 9, 2016**
Device Tested:	**NV800**
Space Treated:	**1 m³**

Objective

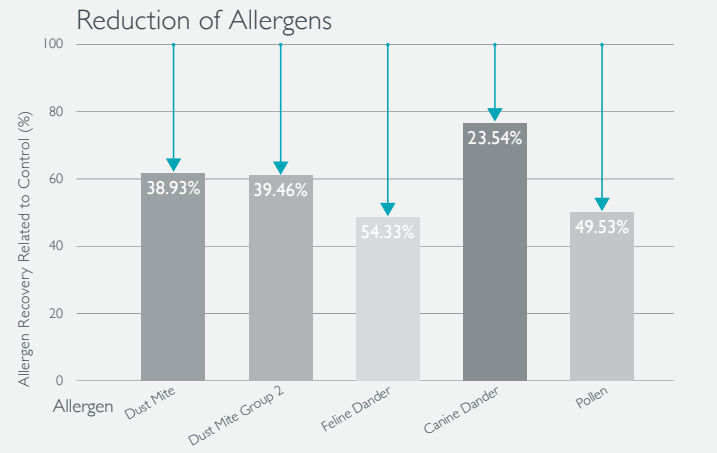
To evaluate the efficacy of the NV800 on reducing airborne allergens.

Methodology

Testing was performed with the NV800 placed in a closed, thoroughly cleaned experimental chamber measuring approximately 1m³.

Summary of Results

The NV800 produced an overall allergen reduction of 41.16%, with a 38.93% reduction of house dust mites, a 39.46% reduction of house dust mites (group 2), a 54.33% reduction of feline dander, a 23.54% reduction of canine dander, and a 49.53% reduction of pollen.



Evaluation of the Novaerus Technology in a Dialysis Centre

Fresenius Dialysis Centres: Vedras and Alverca

Portugal

Testing reflected an 87% reduction in airborne bacteria, a 93% reduction in VOCs, and up to a 67% reduction in moulds.

Evaluation of the Novaerus Technology in an Emergency Hospital

Bucharest Emergency University Hospital

Bucharest, Romania

The testing of air samples reflected an 89% reduction in airborne bacteria CFU/m^3, an 87% reduction in airborne fungi CFU/m^3, and up to a 100% reduction in airborne *Staphylococcus* CFU/m^3.

Evaluation of the Novaerus Technology in Hospital Wards

Leopardstown Park Hospital

Dublin, Ireland

Testing reflected no outbreaks of MRSA, *C. diff*, influenza, or norovirus in wards with Novaerus units installed in three years, a continued decline in staff sickness, a reduction in odours throughout the wards, and a reduction in infections and antibiotic use.

Evaluation of the Novaerus Technology in a Hospital

Royal Free Hospital

Hampstead, London

Testing reflected a 97% reduction in environmental surface MRSA, a 49% reduction in environmental surface TVC, and a 75% reduction in environmental air MRSA.

Evaluation of the Novaerus Technology in an Infectious Disease Hospital

The "Dr V. Babes" Hospital of Infectious and Tropical Diseases

Bucharest, Romania

The testing of air samples reflected a 96% reduction in airborne bacteria CFU/m^3 and airborne fungi CFU/m^3. The hospital staff found the Novaerus air purification system to be tolerable, easy to use, and safe for patients and staff. The Novaerus air purification system complements existing measures to combat infections and does not require additional interventions to ensure that it functions without interruption.

Evaluation of the Novaerus Technology in Intensive Care

Brothers Hospitallers of Saint John of God Hospital

Łódź, Poland

Results of the microbiological test indicated significant reduction in the number of microorganisms in the air in the DAIC. Since the Novaerus devices were installed, the amount of microorganisms in subsequent tests were low.

Evaluation of the Novaerus Technology in a Nephrology Clinic

Rigshospitalet

Copenhagen, Denmark

There was a significant reduction in bacterial loads on high surfaces and window sills. In the control section with no units, the number of overall infections increased by 35% from 2013 to 2014. In the section with Novaerus units, the number of overall infections fell 23% during the same time period.

Evaluation of the Novaerus Technology in a Paediatric Department and a Pulmonology Clinic

Międzyrzecz Hospital

Międzyrzecz, Poland

Novaerus devices effectively reduced the number of airborne pathogens in the admission room of the Paediatric Department by 61% and by 19% in the Pulmonology Clinic.

Evaluation of the Novaerus Technology in a Pulmonology Department and a Traumatology, Septic Department

Uzsoki Hospital

Budapest, Hungary

Testing reflected an 82% drop in CFU rates and a 93% reduction in fungi count. The air quality now meets the Swiss Class III standard (500 CFU/m^3 for general wards).

Powered by NanoStrike® technology

NOVAERUS

Defend 1050
(NV1050)

Protect 800
(NV800)

Protect 200
(NV200)

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