NOVAERUS

www.novaerus.com

Clean Surfaces. Clean Hands. Clean Air.

Healthy Indoor Environments Keep Students and Staff in School

WellAir is creating an ecosystem for healthy air

wellAir Group

wellAir

WellAirSolutions.com

Ecosystem for healthy indoor air for schools, senior living, and office buildings

NOVAERUS

Novaerus.com

Medical-grade portable air dis-infection for acute healthcare settings

PlasmaAir

Plasma-Air.com

HVAC air purification system for commercial, industrial, and residential projects

Company

- Founded in Ireland in 2008; established in US in 2012; Plasma Air acquired in 2016
- Offices in Dublin and Stamford, CT
- 48 employees

Customers

- 400+ schools
- 500+ hospitals
- 700+ ambulances / rescue vehicles
- 300+ senior living facilities
- 30+ other healthcare settings (e.g., hospice)
- 15 casinos
- 10 water treatment plants

Distribution

- 40 countries
- US Hillyard partnership

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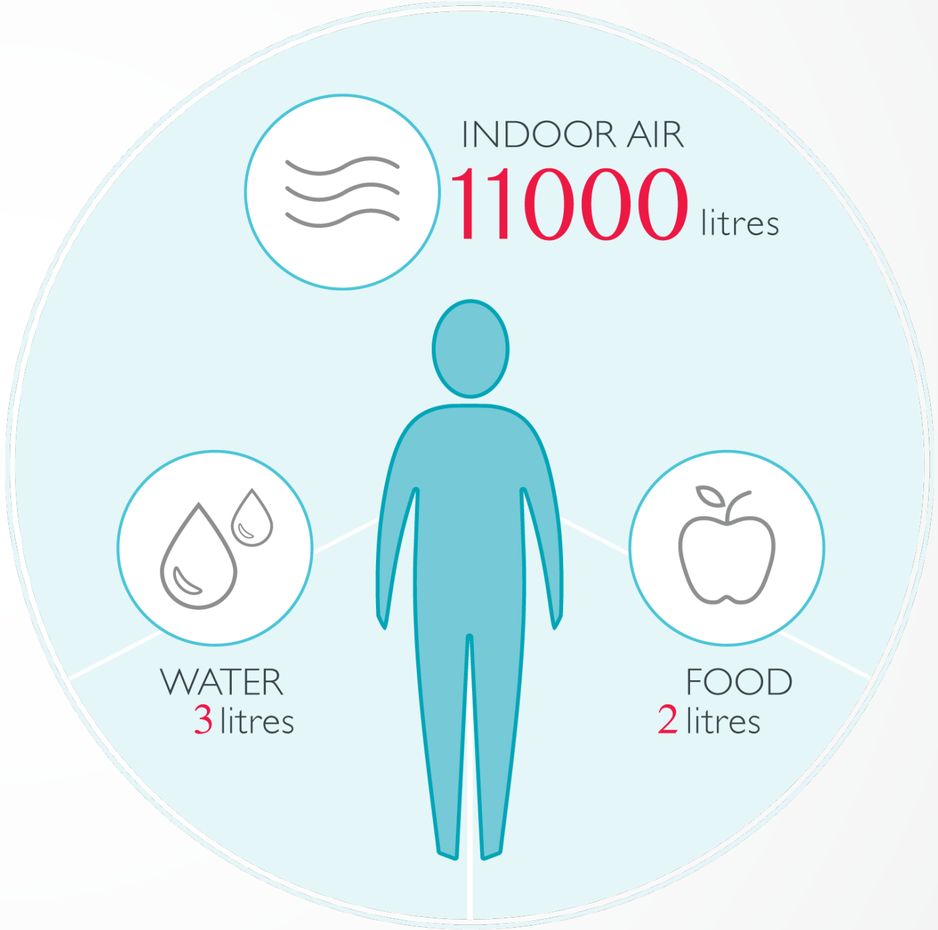
The Importance of Indoor Air

The Importance of Indoor Air

People spend 90% of time indoors inhaling up to 2700 gallons of air.

Indoor air is 10 times more contaminated than outdoor air.

EPA



Common Indoor Air Contaminants

Viruses*

NOROVIRUS, INFLUENZA, SARS, RABIES, MEASLES, MUMPS, SMALLPOX, CHICKENPOX

Bacteria*

MRSA, TUBERCULOSIS, LEGIONELLA, CLOSTRIDIUM DIFFICILE, BACILLUS ANTHRACIS

Fungi*

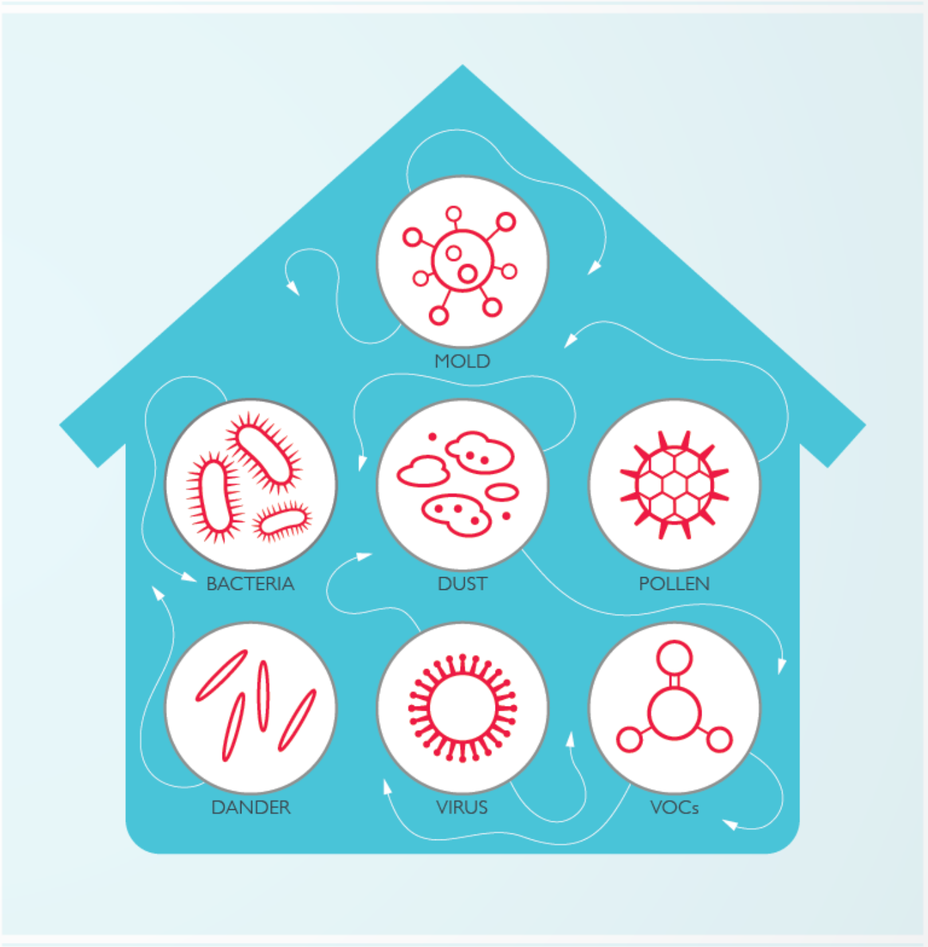
ASPERGILLUS, PENICILLIUM, CLAGOSPORIUM

Volatile Organic Compounds

FORMALDEHYDE, BENZENE, NITROGEN DIOXIDE

Particulate Matter

DUST, POLLEN, DANDER, PM2.5, PM1.0

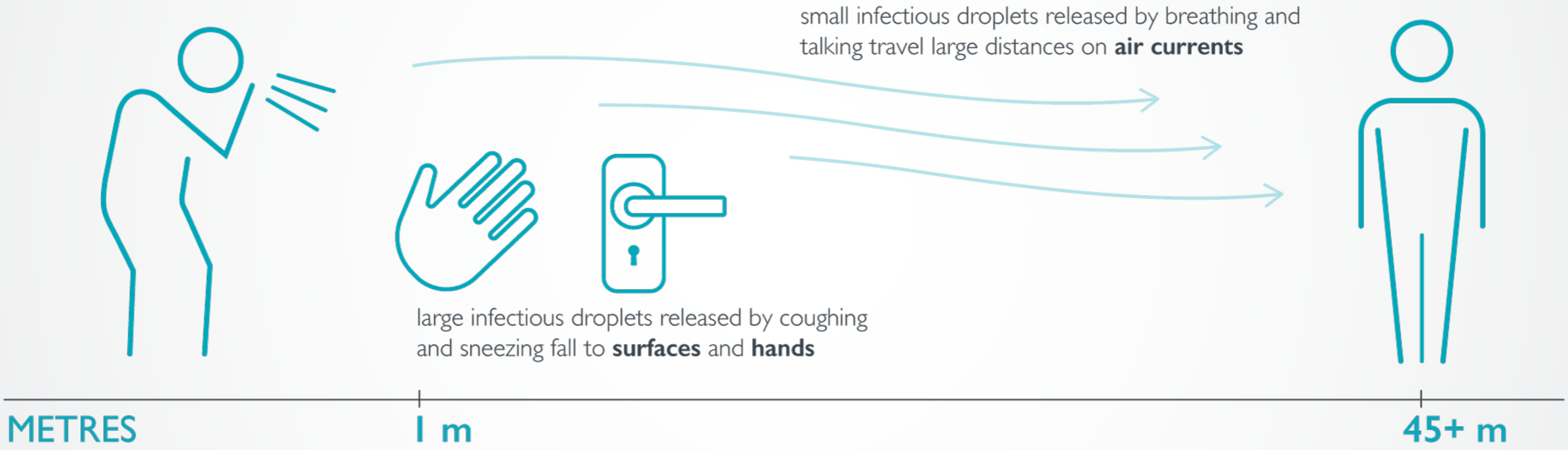


*M.K. Ijaz et al. ,Generic aspects of the airborne spread of human pathogens indoors and emerging air decontamination technologies. American Journal of Infection Control 44 (2016) S109-S120

Sources of Indoor Air Contaminants

- Building materials
- Population density
- Human actions / illness
- Lack of ventilation
- Cleaning chemicals
- Personal care products
- Paint, carpet, furniture
- Pollen, fungal spores, mould
- Pet dander (brought from home)
- Humidity

The Importance of Air Dis-infection



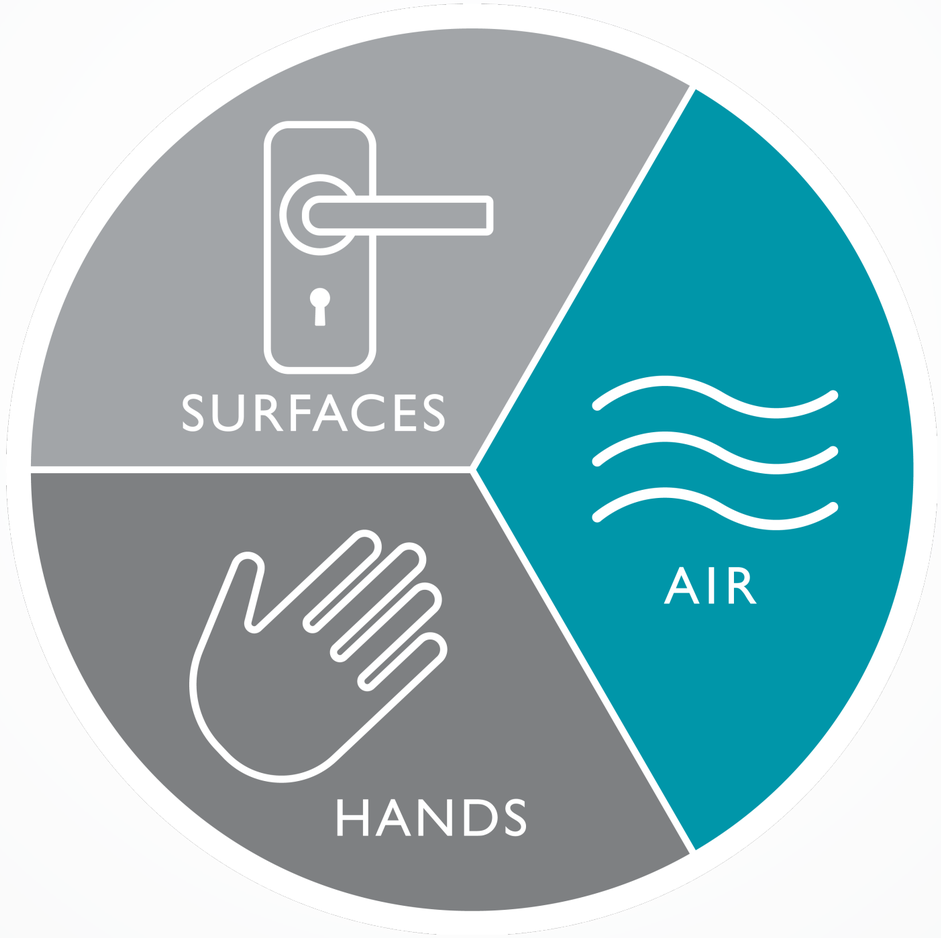
"Air is a universal environmental equalizer that has profound health implications in all indoor environments".
Sattar et al stated in the September 2016 supplement of the American Journal of Infection Control

It is estimated that airborne transmission is responsible for up to 20% of all endemic hospital-acquired infections.
P. S. Brachman and T. C. Eickhoff, Eds., pp. 189–192, American Hospital Association, Chicago, Ill, USA, 1971

Closing the Infection Control Loop

Cleaner air means cleaner hands and surfaces.

Large infectious droplets fall on to surfaces infecting students and staff directly.



Infectious droplet nuclei can remain airborne indefinitely, infecting students and staff directly over large distances.

Infectious droplets are transferred from surfaces to hands, infecting stuents & staff indirectly.

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The Health Impact of Poor Indoor Air in Educational Settings

Good Indoor Air Quality Improves Educational Outcomes

Taking steps to improve the IAQ of schools is critical to bettering student health and academic performance . (EPA)

Allergies, common colds, and other infectious illnesses can prevent students and staff from feeling well throughout the academic year.

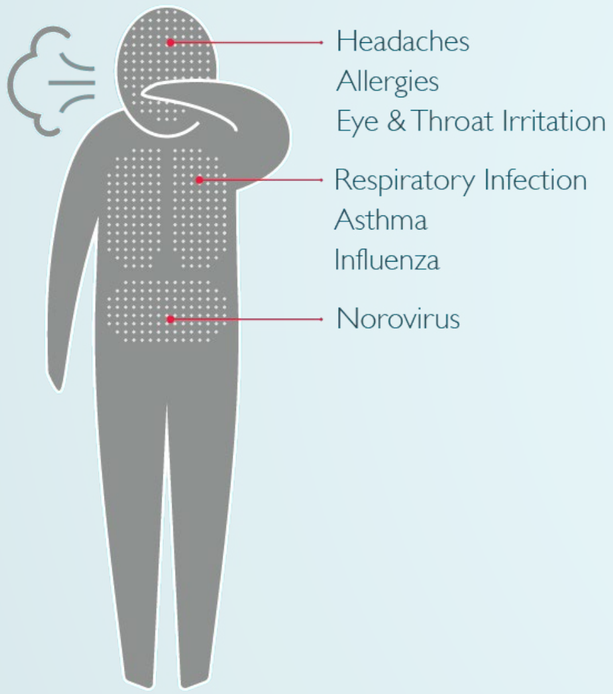
Poor indoor air quality impacts cognitive function including attention, engagement, comprehension, annoyance, and irritability.

Poor health leads to absenteeism and diminished thinking which negatively impacts the long term academic performance of students.

Harvard T.H. Chan School of Public Health

The Health Impact of Poor Indoor Air in Education

Common indoor air pollutants in schools have been observed at levels 2-5 times higher that outdoor concentrations and are associated with acute and chronic health effects. (EPA)



ASTHMA:

- Education employees have a higher prevalence of asthma compared with other non-industrial occupational groups.[1]
- Childhood asthma is a leading cause of student absenteeism and accounts for more than 10.5 million missed school days each year.[2]

INFLUENZA

- School-aged children are considered a high-risk group for influenza .
- Influenza is highly contagious and 89% of virus-carrying particles stay airborne indefinitely.[4]

HEADACHES& IRRITATION

- Exposure to VOCs, such as formaldehyde, can cause eye irritation, respiratory symptoms, nausea, dizziness and headaches.[3]

NOROVIRUS

- Highly contagious virus that can be spread by airborne transmission. Causes nausea, vomiting, fever, cramps, and diarrhea .

School bus drivers and passengers are exposed to high concentrations of pollutants from heavy traffic, other vehicles being followed, and your bus's own emissions. *Buses also present high risk for the flu or other infections spreading between passengers.*[5]

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[1] Angelon-Ga etz et al., 2016 | [2] EPA, | [3] EPA | [4] Nikitin et al., 2014 | [5] California Air Resources Board

The Health Impact on Students with Special Needs

Accommodating and modifying your classroom environment can help children be successful learners and be an active participant in classroom activities. (Kaplan)

"Students with special education needs or disabilities that are related to high levels of health needs are often the most vulnerable to poor IAQ. Poor ventilation often leads to health issues resulting in absenteeism or inattention in class."

Ministry of Education

- Poor IAQ and ventilation can have short and long-term affects that negatively impact children's learning and productivity.
- This is true even more so for children with learning disabilities such as Autism Spectrum Disorder (ASD) due to sensory sensitivity and the need for a comfortable learning environment.

(Krawcke, 2018)

Our children overall and, even more specifically, our children with special needs, are affected by the quality of the air they breath in their school settings. We, as design professionals, need to become aware that the materials we select and the systems we use have a direct impact on the inside air quality of our school buildings and the learning opportunities of our children.

School Planning and Management

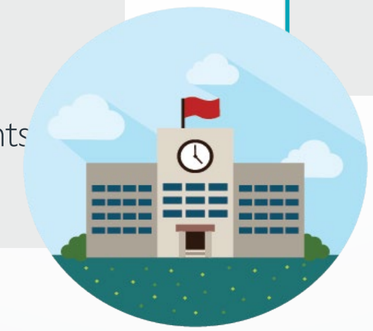
The Financial Impact of Poor Indoor Air in Education

- Student Attendance
  - 6.5M students are chronically absent[1]
  - More than 10.5M school days are missed each year due to asthma[2]
- Staff Attendance
  - 16% of teachers miss on average 18+ days per year[3]
  - Teacher absenteeism costs $1,800 *per teacher employed* in substitute teacher wages and administrative costs[3]

The value of decreasing absenteeism by 1% is

$245,000

The value of Avg. New York School District (3,500 students



"A school's indoor environment can have a significant impact on a student and district staff health and attendance at school. A healthier environment, complete with good indoor air quality, can help reduce the number of school days missed by both students and staff"

U.S. Department of Education

"Good IAQ contributes to a favorable environment for students, performance of teachers and staff, and a sense of comfort, health and well-being."

EPA

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[1] USDOE, 2016 | [2] EPA, | [3] National Council on Teacher Quality, 2013

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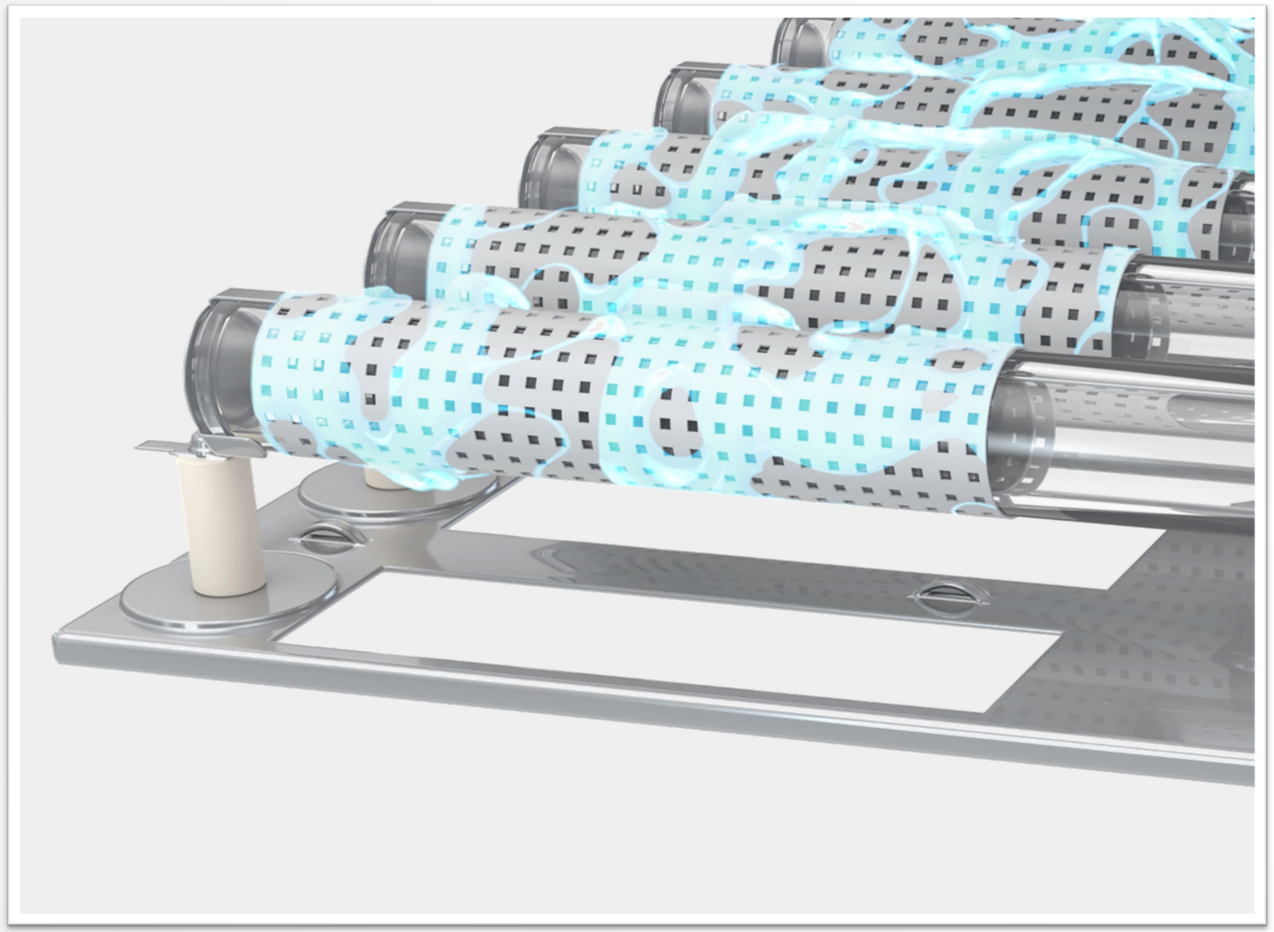
Novaerus Air Dis-Infection Technology

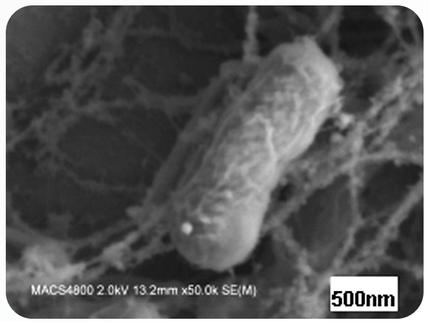
Plasma: The Fourth State of Matter

Novaerus Ultra-Low Energy Plasma

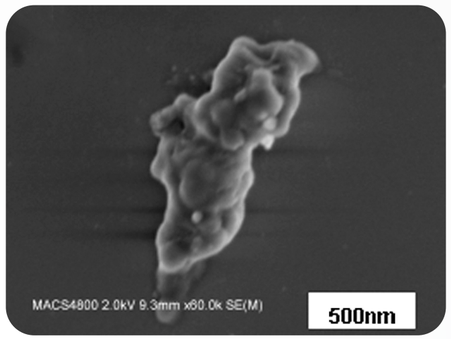


- Patented dielectric barrier discharge (DBD) plasma
- Ultra-low energy plasma field is powerful yet gentle and safe for use around vulnerable patients
- Tested and proven safe and effective in more than 30 independent laboratory studies

The Effect of Novaerus Plasma on *E. coli* Bacteria



Healthy E.coli Bacteria
prior to exposure



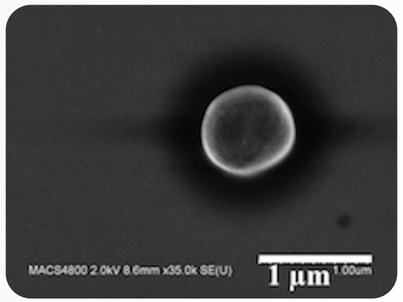
Novaerus Plasma after
0.002 Seconds

*Scale is 1 Micrometer or 1 millionth of a meter; images taken under scanning electron microscope at NASA Ames Research Laboratory

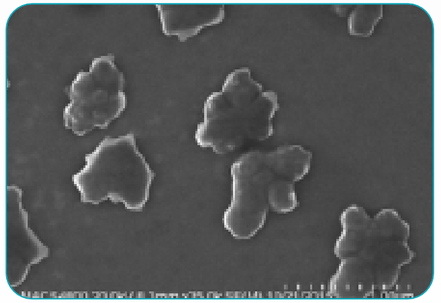
"The bacteria underwent physical distortion to varying degrees, resulting in deformation of the bacterial structure. The bacterial reculture experiments confirm inactivation of airborne E. coli upon treating with DBD"

NASA Ames Research Center

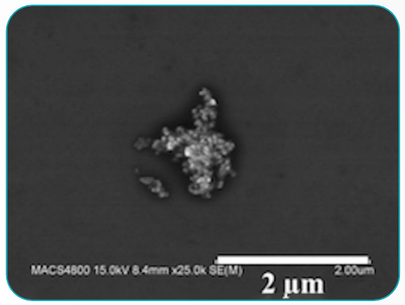
The Effect of Novaerus Plasma on *Staphylococcus* Bacteria



Healthy Staphylococcus Bacteria prior to exposure



Bacteria become stressed and deformed



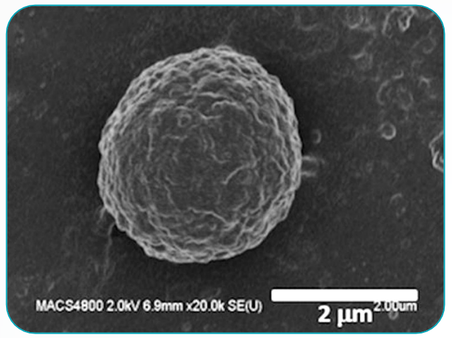
Novaerus Plasma after **0.002 Seconds**

*Scale is 1 Micrometer or 1 millionth of a meter; images taken under scanning electron microscope at NASA Ames Research Laboratory

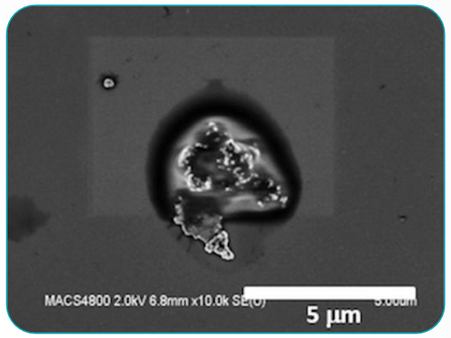
"It is concluded that the DBD caused severe size and shape change of the cell structure, possibly resulting in destruction of cellular components and eventually to cell death."

Jaione Romero-Mangado et al. Efficacy of atmospheric pressure dielectric barrier discharge for inactivating airborne pathogens, Journal of Vacuum Science & Technology A: Vacuum, Surfaces, and Films 35, 041101 (2017)

The Effect of Novaerus Plasma on Fungi Spores



Healthy Aspergillus niger spores



Aspergillus niger spore after exposure to Novaerus plasma

*Scale is 1 Micrometer or 1 millionth of a meter; images taken under scanning electron microscope at NASA Ames Research Laboratory

"A similar effect was also found on the fungal spores, indicating the versatility of the equipment toward a range of microorganisms."

Jaione Romero-Mangado et al. Efficacy of atmospheric pressure dielectric barrier discharge for inactivating airborne pathogens, Journal of Vacuum Science & Technology A: Vacuum, Surfaces, and Films 35, 041101 (2017)

How it Works: Novaerus Protect 800

1 Contaminated indoor air is pulled into the unit by an internal dual-speed fan.

2 Contaminants are rapidly and safely destroyed at the DNA level by an ultra-low energy patented plasma field emitted by 2 internal plasma coils.

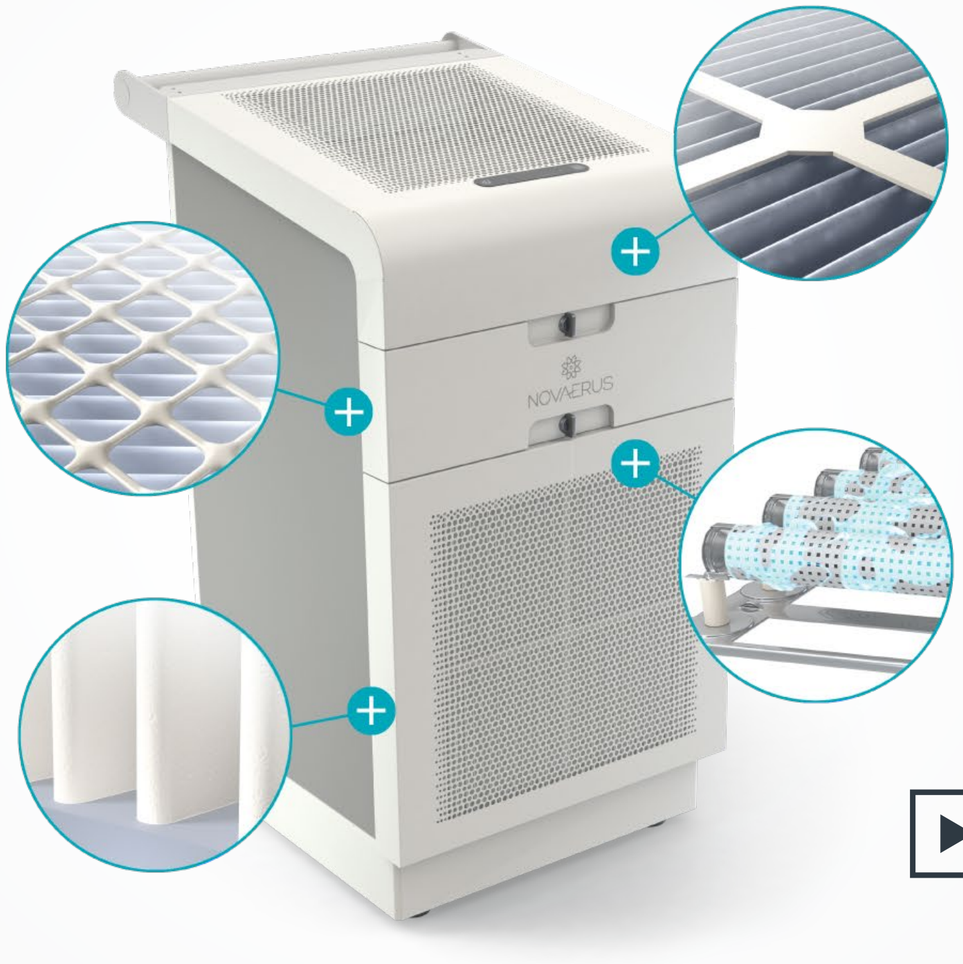
3 Healthy, contaminant-free air is returned to the room.

PLAY 3D ANIMATION

How it Works: Novaerus Defend 1050

A Camfil® HEPA H13 filter traps bacterial debris and particles as fine as 0.12µm.

Powerful multi-speed fan pulls indoor air throzugh a Camfil® pre-filter, capturing large particles protecting the internal plasma coils and extending the life of the HEPA filter.



A Camfil® carbon/molecular filter neutralizes VOCs, odours, and impurities.

Six ultra-low energy plasma coils rapidly deactivate microorganisms and viruses at the DNA level.

PLAY 3D ANIMATION

Air Cleaning Technologies Comparison

1 = Not Effective 5 = Very Effective

	NOVAERUS	Photocatalytic Oxidation	UVGI Cleaner	Sanitization Misting	HEPA Filtration	Ozone	Laminar Air Flow	Carbon Filtration
Harmful byproducts	NO	YES[1]	YES[2]	YES	NO	YES[3]	NO	NO
Prevents filter colonization	5	3	4	1	1	1	1	1
24/7 bacteria load reduction	5	3	3	1	5	1	1	5
24/7 viral load reduction	5	3	4	1	1	1	1	1
24/7 fungal and bacterial spores reduction	5	3	4	1	5	1	1	5
24/7 odour & VOC neutralization[4]	5	3	1	1	1	1	1	5
Operating costs for maintenance	LOW	HIGH	HIGH	HIGH	MEDIUM	HIGH	LOW	MEDIUM
Removal of ultra/fine particulates[4]	5	1	1	1	5	1	1	3

1. PCO can produce formaldehyde. 2. At high levels, UV can create noxious gases and is mutagenic.
3. High levels of ozone is unsafe to humans. 4. Defend 1050 only.

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Novaerus Products

Portable Air Dis-infection Products

DEFEND 1050

Six ultra low-energy plasma coils combined with a three-stage filter system and five-speed fan. Free-standing unit ideal for rapid remediation in large, high-risk spaces.

PROTECT 800

Two ultra low-energy plasma coils combined with a two-speed fan. Mounted on the wall or a stand, unit is ideal for continuous infection control, odour mitigation, and IAQ maintenance in medium spaces.

PROTECT 200

One ultra low-energy plasma coil combined with single-speed fan. Wall mounted or table top unit ideal for continuous infection control, odour mitigation, and IAQ maintenance in small spaces.

Defend 1050 Technical Specifications

VOLUME TREATMENT*
45 - 226m^3 (4 air changes per hour)
90 - 452m^3 (2 air changes per hour)

AREA COVERAGE**
18.6 - 92.9 m^2 (4 air changes per hour)*
37.2 - 185.8 m^2 (2 air changes per hour)*

AIR FLOW
Speed 1 - 181 m^3/hr
Speed 2 - 317 m^3/hr
Speed 3 - 453 m^3/hr
Speed 4 - 679 m^3/hr
Speed 5 - 906 m^3/hr

NOISE LEVEL*
48 - 75 dBA (at unit)
38- 63 dBA (at 1m)

* Depending on speed setting 1-5
* * Assuming ceiling is 2.44 m tall

CONSTRUCTION + COLOR
Precision-cut fabricated metal casing in a white anti-bacterial powder coat finish

DIMENSIONS + WEIGHT
93.0 (h) x 48.5 (w) x 57.5 (d) cm
53.8 kg

ENERGY CONSUMPTION
137 – 331W
Medical grade isolation transformer

PORTABILITY
2-wheeled base
1 top handle

QUALITY + SAFETY
Manufactured under ISO 9001, ISO 14001 and OHSAS 18001

PURIFICATION PLASMA

TRIPLE STAGE FILTER

LARGE ROOMS

FAN SPEED CONTROL

NOVAERUS

Protect 800 Technical Specifications

ELECTRICAL RATING
230 VAC, 50 Hz, 20 W Fuse Rated at 250 VAC, 3 Amps, Listed
Power consumption maximum 20 watts

DIMENSIONS + WEIGHT
33.6 (h) x 33.6 (w) x 10.4 (d) cm
4.8 kg

ELECTRICAL CONNECTION
Switched and fused with a grounded, molded 3 pin 8.2ft power cord

FAN AIR FLOW VOLUME
SPEED I: 220 m^3/hr
SPEED II: 260m^3/hr

NOISE LEVEL
SPEED I: 40 dB
SPEED II: 45 dB

CONSTRUCTION + COLOR
Precision-cut fabricated metal casing in a white anti-bacterial powder coat finish

OPERATING CONDITIONS
10-35°C, 10-75% Relative Humidity, 2000m

SHIPPING / STORAGE CONDITIONS
5°C-50°C, Maximum 95% Relative Humidity

QUALITY + SAFETY
Manufactured under ISO 9001, ISO 14001 and OHSAS 18001
Conforms to the Medical Device Directive

PURIFICATION PLASMA

MEDIUM ROOMS

FAN SPEED CONTROL

NOVAERUS

Protect 200 Technical Specifications

ELECTRICAL RATING
120VAC, 60Hz, 0.08A
Fuse rated at 125VAC, 3 amps, Listed

ELECTRICAL CONNECTION
Switched and fused with a grounded, molded 3 pin 8.2ft power cord

POWER CONSUMPTION
20W

FAN AIR FLOW VOLUME
80 m^3/hr

NOISE LEVEL
35 dB

PURIFICATION PLASMA

SMALL ROOMS

CONSTRUCTION + COLOR
Precision-cut fabricated casing with a off-white powder coat finish.

OPERATING CONDITIONS
10-35°C, 10-75% Relative Humidity, 2000m

DIMENSIONS + WEIGHT
28.3 (h) x 13.1 (w) x 11.6 (d) cm
3.4kg

SHIPPING / STORAGE CONDITIONS
5°C-50°C, Maximum 95% Relative Humidity

QUALITY + SAFETY
Manufactured under ISO 9001, ISO 14001 and OHSAS 18001

Safety and Efficacy

Test Results

TYPE	NAME	REDUCTION	TIME	SPACE	MODEL
VIRUSES	SARS-CoV-2[1]	99.99%	15 min	16 m^3	NV1050
	Measles[2]	99.87%	20-30 min	28.5 m^3	NV1050
	Influenza A	99.9%	10-20 min	28.5 m^3	NV1050
	Phi X 174	98.8%	30 min	60 m^3	NV1050
	SARS-CoV-2[3]	99.99%	5 hours	16 m^3	NV800
	Norovirus[4]	99.99%	5 hours	16 m^3	NV800
	Influenza A[5]	99.99%	5 hours	16 m^3	NV800
BACTERIA	Tuberculosis[6]	97%	30 min	30 m^3	NV1050
	MRSA[7]	99.94%	15 min	30 m^3	NV1050
	Clostridium difficile spores	99.9%	40 min	28.5 m^3	NV1050
	Staphylococcus epidermidis	99.9%	60 min	60 m^3	NV1050
	MRSA	99.99%	4 hours	1 m^3	NV800
	Bacillus subtilis	86.63%	6 hours	16 m^3	NV800
	Escherichia coli	71.80%	5 min	2.3 m^3	NV200
MOULD SPORES	*Aspergillus niger*	99.99%	30 min	16 m^3	NV1050
	Aspergillus niger	99.10%	4 hours	16 m^3	NV800
VOCs	Nitrogen Dioxide	99.49%	7.2 min	16 m^3	NV1050
	Formaldehyde	99.68%	1.1 min	16 m^3	NV1050
	Toluene	99%	9.1 min	19.72 m^3	NV1050
PARTICULATE	PM 1	99%	6.33 min	19.72 m^3	NV1050
	PM 2.5	99%	6.26 min	19.72 m^3	NV1050

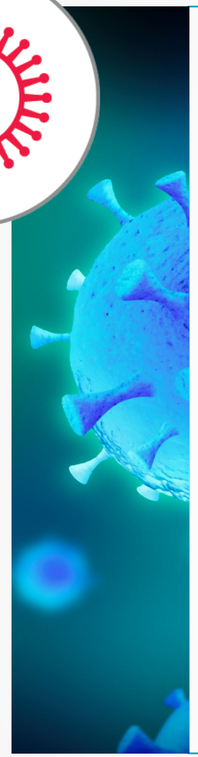
TESTING PARTNERS

- Aerosol Research & Engineering Laboratories, USA
- Microsearch Laboratories, UK
- Microbac Laboratories, USA
- NASA Ames Research Center, USA
- Airmid Healthgroup, Ireland
- Camfil Laboratories, Sweden
- Indoor Biotechnologies, UK
- Avomeen Analytical Services, USA
- Univeristy of Huddersfield, UK
- Qualiflife Diagnostics, India

Test Results

1. Tested on MS2 Bacteriophage, a surrogate for SARS-CoV-2 (2020 - Efficacy of the Novaerus NV1050 device against Aerosolized MS2 Virus, Aerosol Research and Engineering Laboratories)
2. Tested on Human parainfluenza type 3 (HPIV3), a commonly used surrogate for Measles. (2019 – To assess the impact of an air purifier on Human parainfluenza virus Type 3, Airmid Healthgroup)
3. Tested on MS2 Bacteriophage, a surrogate for SARS-CoV-2 (2020 - Efficacy of the Novaerus NV1050 device against Aerosolized MS2 Virus, Aerosol Research and Engineering Laboratories)
4. Tested on MS2 Bacteriophage, a surrogate for Norovirus (Tested on MS2 Bacteriophage, a commonly used surrogate for Norovirus (2005 - Survival of viruses on fresh produce, using MS2 as a surrogate for Norovirus, Dawson DJ et al.)
5. Tested on MS2 Bacteriophage, a surrogate for Influenza (2010 – Evaluation of filters for the sampling and quantification of RNA Phage Aerosols, Louis Gendron et al.)
6. Tested on *Mycobacterium smegmatis,* a commonly used surrogate for *Mycobacterium tuberculosis* (2007 - Evaluation of *Mycobacterium smegmatis* as a possible surrogate screen for selecting molecules active against multi-drug resistant *Mycobacterium tuberculosis*, Chaturvedi V et al.).
7. Tested on *Staphylococcus epidermidis*, a commonly used surrogate for MRSA. (2011 – Aerosol survival of *Staphylococcus epidermidis*, Thompson KA et al.)

Novaerus Impact on Coronavirus – Independent Testing



Novaerus technology has been tested against MS2 Bacteriophage, a surrogate for SARS-CoV-2 (COVID-19), reducing the airborne virus by 99.99%.

The Defend 1050 was shown to reduce the virus by 99.99% in 15 minutes.

The Protect 800 was shown to reduce the virus by 99.99% in 5 hours.

Due to the small size of viruses, many clean air solutions, including standalone filtration, are unable to trap viral particles.

Novaerus portable air dis-infection units use a non-selective, rapid killing, patented plasma technology, offering a unique and safe solution to kill airborne viruses 24/7.

Reducing Viral Outbreaks In Educational Facilities

Mamos Delne, a medium-sized educational facility in Vilnius, Lithuania, decided to trial Novaerus technology, mounting a NV800 unit in each of their three classrooms.

After the trial period had ended, the Novaerus units were removed from the facility.

Shortly after, Mamos Delne was hit with an outbreak of rotavirus infecting 100% of the children in the facility. Following the outbreak, the parents of the children in Mamos Delne's care demanded the Novaerus units be reinstalled.

"Compared to other years, we saw an increase in child attendance and a decrease in children being sick."

- Kindergarten Mamos Delne, Lithuania

NOVAERUS

Safety & Compliance

- Listed / Certified by Underwriters Laboratories (UL)
- CE Medical Device Certification for NV800 model
- Manufacturing facilities are audited quarterly by UL/Intertek to ensure to ensure product safety and integrity.
- Manufactured to ISO 9001, ISO 14001, OSHA 18001 standards
- Tested and certified to UL 867 for Electrical and Ozone Safety and to UL 1995 for Electrical Safety
- A safety Certification evaluation by UL or Intertek demonstrates a high level of product safety and integrity to protect persons and property against risk of fire, electric shock, and mechanical hazards. Products are tested under both normal and abnormal conditions to ensure the highest level of safety.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