
Birmingham
Airport


BETTER
INDOORS
Clean Air for Healthy Buildings


RGF®
ENVIRONMENTAL GROUP, INC.

Case Study

The Challenge:

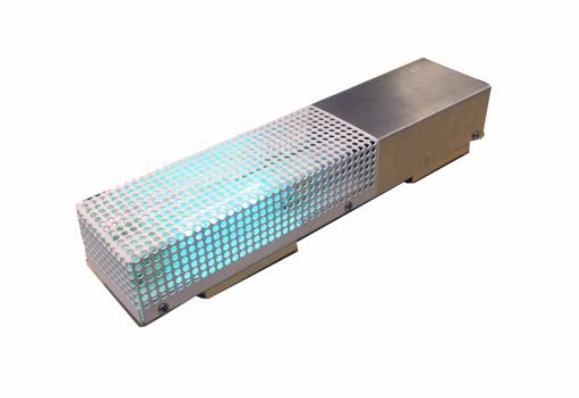
Birmingham Airport is a major international transport hub and growth enabler for Midland Britain handling in excess of 12.5 million passengers as of 2019. Birmingham Airport is the 7th busiest airport in the UK.

The COVID pandemic and the policies of lockdowns and travel bans had a devastating effect on the UK's transport vertical which saw Birmingham Airport's passenger numbers plummet to below 3 million during 2020 – a decline of 75% and virtually 100% from March 23 onwards (the date the first national lockdown was announced.

In anticipation of the economy re-opening during 2021 and ultimately "living with COVID", Birmingham Airport expressed interest in PHI/REME active air purification for continuous sanitising of the air and surfaces throughout terminal buildings to add an extra layer of protection beyond ventilation and filtration/UV measures and to help the travelling public, visitors, staff and contractors stay safer and healthier and help rebuild confidence.

The Solution:

Following our site survey of the terminal buildings including AHUs, ductwork infrastructure and air delivery locations we specified 40 of our in-AHU Package PHI units of differing sizes according to airflow/volume/space requirements across all the AHUs. The units treat the conditioned and filtered supply air (comprising fresh air only or fresh/recirculation mix) on a continuous basis as it leaves each AHU. The treated air reaches throughout the ductwork infrastructure and all the way into the conditioned spaces which include arrival/departure and ticketing halls, passport control, air-side shops, departure gates and baggage halls.



Each Package PHI unit comprises the world leading PHI/REME active air purification technology that is proven to eliminate harmful bacteria and viruses including SARS-CoV-2 and VOCs on a continuous basis throughout the entire indoor environment.

Manufactured by US based RGF Environmental Group Inc, the technology uses no chemicals or harmful substances and works by continuously maintaining similar concentrations of hydrogen peroxide molecules, to those found in the outdoor air.

When coming into contact with microbials and VOCs, the naturally occurring molecules break them down, destroy them and then revert the back to harmless water vapour and oxygen. The air purification technology produces 1 quadrillion of these molecules every second, quickly killing any airborne virus or bacteria, including COVID-19.

The Outcome:

The installation was performed by Birmingham Airport's FM, Carter Synergy following review of the Package PHI product and technology safety and efficacy credentials by independent, accredited labs and universities in line with recommendations in official guidance and various client case studies. Since the installation passenger numbers through the airport have increased significantly.

Context / The Problem

The COVID pandemic brought with it unique challenges:

- Deadly mutating respiratory virus that transmits rapidly via airborne and surface routes
- People are most contagious without showing symptoms (asymptomatic)

Transmission mitigation measures outside the vaccination programs focussed on:

- Wearing of masks, washing of hands, social distancing
- Test & trace processes that trigger self isolation/distancing
- More frequent cleaning/disinfection processes, increased ventilation, use of filtration/UVC
- Lockdowns to force people apart from each other

The fact that subsequent waves of new variants occurred all around the world illustrates the relative futility of these mitigations and shows them to be ineffective and behavior dependent in the context of controlling asymptomatic contagion and the inexplicable exclusion of certain types of safe and proven environmental air treatments. Experience has shown us that as soon as lockdown measures are lifted and people start to mix together again the indoor R rate starts to rise and COVID infections still occur in buildings where the COVID mitigation guidance is followed to the letter including offices, hospitals, care homes, factories, supermarkets, food processing centers and residential homes.

The simple fact is that these ineffective and behavior dependent measures against an asymptomatic virus are simply not enough. The indoor R rate will always be at risk of rising because the measures do not create real time continuous protection against COVID emissions. In other words by following the guidance alone you do not create an indoor environmental process that instantly and continuously destroys the virus at the point of emission either in the air or onto surfaces. Even with the vaccine rollout and now the policy of "living with COVID", the UK still runs the risk of serious ongoing disruption and economic risk as infection rates continue to fluctuate unless a solution to effectively controlling and minimizing the indoor R rate is adopted and critically on that doesn't rely on the actions or behaviours of people. RGF's technology is one such solution.

Further as we have now moved from the paralysis of repeated lockdowns to the reality of "living with COVID" it is now absolutely essential for employers to demonstrate their buildings are safe environments for their staff and customers to return to with confidence. By treating and deactivating viral emissions instantly and continuously at source, RGF's technology creates an unique extra layer of protection throughout entire workspaces allowing responsible and forward thinking employers and duty of care owners to create the safest possible indoor environments.

Overview of Solution & Technology

Limitations of COVID Mitigation Measures

Ventilation is important but:

- It can make rooms uncomfortably cold
- It increases energy consumption and cost
- It increases outdoor pollution ingress
- It does not destroy viruses

Active air purification safely avoids these consequences whilst creating environmental protection throughout the air and surface space.

What is Active Air Purification ?

- Non-chemical process that imitates nature's air cleaning processes indoors.
- Ionised hydroperoxides produced from patented photocatalytic reaction (broad spectrum UV/quad metal catalyst) and ambient water vapour that reach into every cubic cm of air and surface space.
- Effective across all 3 categories of pollutants – microbials, VOCs/gases/odours and particulates/smoke.
- Breaks down microbials through cell lysing and VOCs/odours by changing molecular structure and rendering cell harmless. Agglomerates particulates.
- Treats the air and surfaces. Provides real-time instantaneous and continuous protection against emissions and fomites of common and dangerous viral and bacteria including SARS-CoV-2 anywhere in the indoor space.
- Developed over 15 years ago. 35 year old manufacturer. Tested, proven and widely used. Millions of installs in over 60 countries.
- Creates environmental effect. Adds unique extra layer of protection
- Not behaviour dependent
- Creates safer healthier future proofed environments

Why is our Active Air Purification different ?

An environmental process that works everywhere simultaneously and continuously. This is a completely different process to passive air treatments.

Passives only treat air that passes close or through giving no real time continuous protection elsewhere.

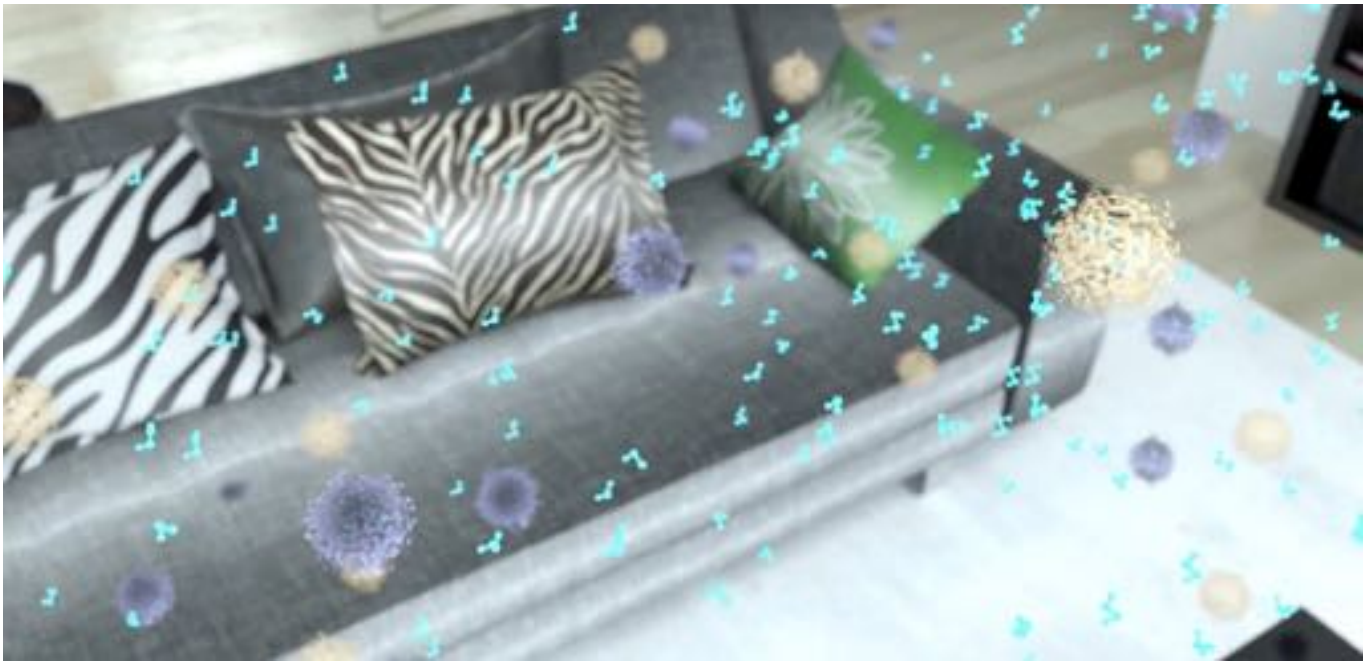
- Viral emissions are alive until removed by ventilation or caught by the system.
- No protection against fomites
- No guarantee of removal when passing by/through

Passive technologies include filtration, UV-C, PCO and bipolar ionization

What are the known benefits of Active Air Purification ?

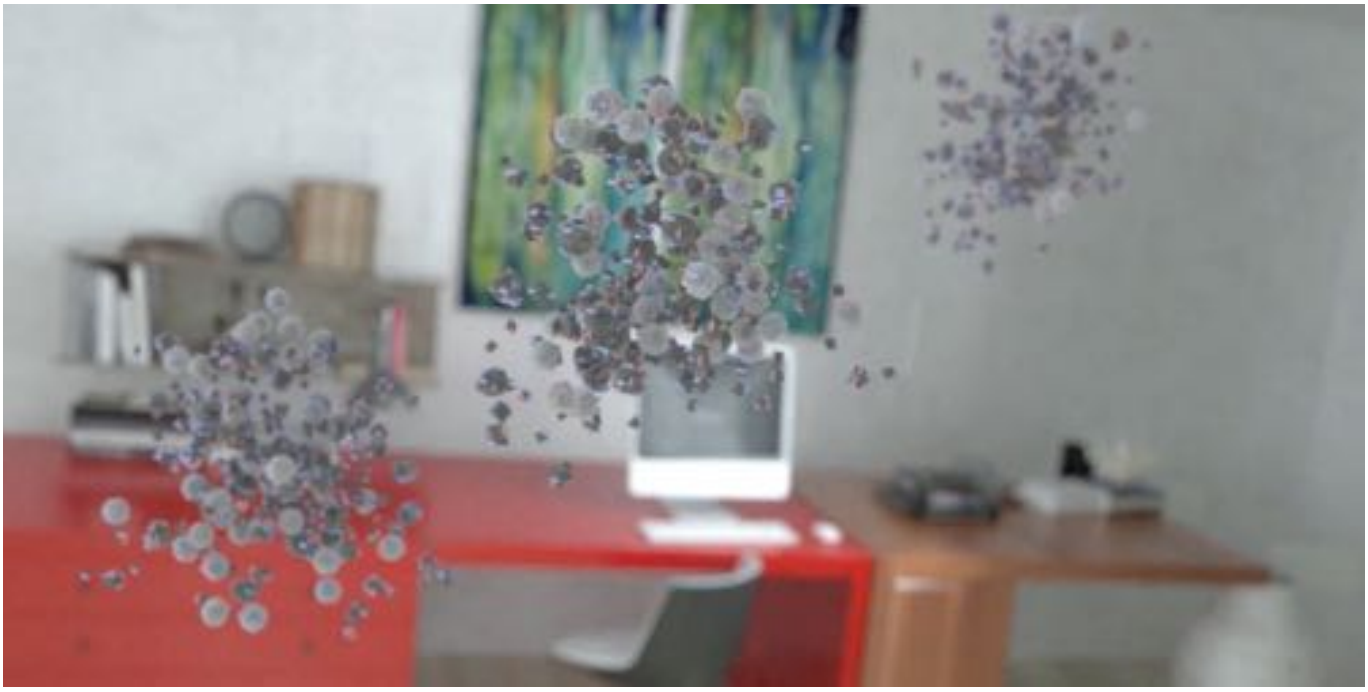
- Improved IAQ. Improved health & wellbeing
- Reduced illness, HAIs and absenteeism. Improved productivity
- Reduced energy costs. Improved energy efficiency
- Eliminates need/cost of recurrent fogging
- Added layer of protection for frontline NHS/emergency workers
- Creates safer, healthier indoor environments
- Improves staff and customer confidence in indoor spaces
- Products for all types of buildings/HVAC, vehicles
- Quick and easy to retrofit (2-4 weeks)
- Affordable. Lease rental / hire purchase options
- Rapid procurement

The Technology Inside



Photohydroionisation (PHI) provides instant protection against viral emissions including SARS-CoV-2 and other dangerous pathogens plus VOCs and gases throughout the air and surface.

Reflective Electro Magnetic Energy (REME) is a more advanced version of PHI with integrated bipolar ionisation for particulate control



PHI units can be accompanied by quadpolar ionisation units for particulate control.

- PHI invented in late 1990s. Came to prominence post 9/11 late 2001
- Sandia Labs / Sneeze Machine developed to prove process
- REME invented 2006
- Both technologies are protected by global patent

Safety

- Units designed to maintain vaporised hydrogen peroxide "equilibrium" – 0.02 ppm or 2% of EH40/2005 Workplace Exposure Limit (1 ppm).
- World's first to comply with UL-867 v5 Verified Zero Ozone by ETL-Intertek. Does not exceed 0.005ppm or 5ppb ozone

- Millions of installations in over 60 countries
- Completely safe. Never a single safety issue

Efficacy (across all 3 pollutant categories)

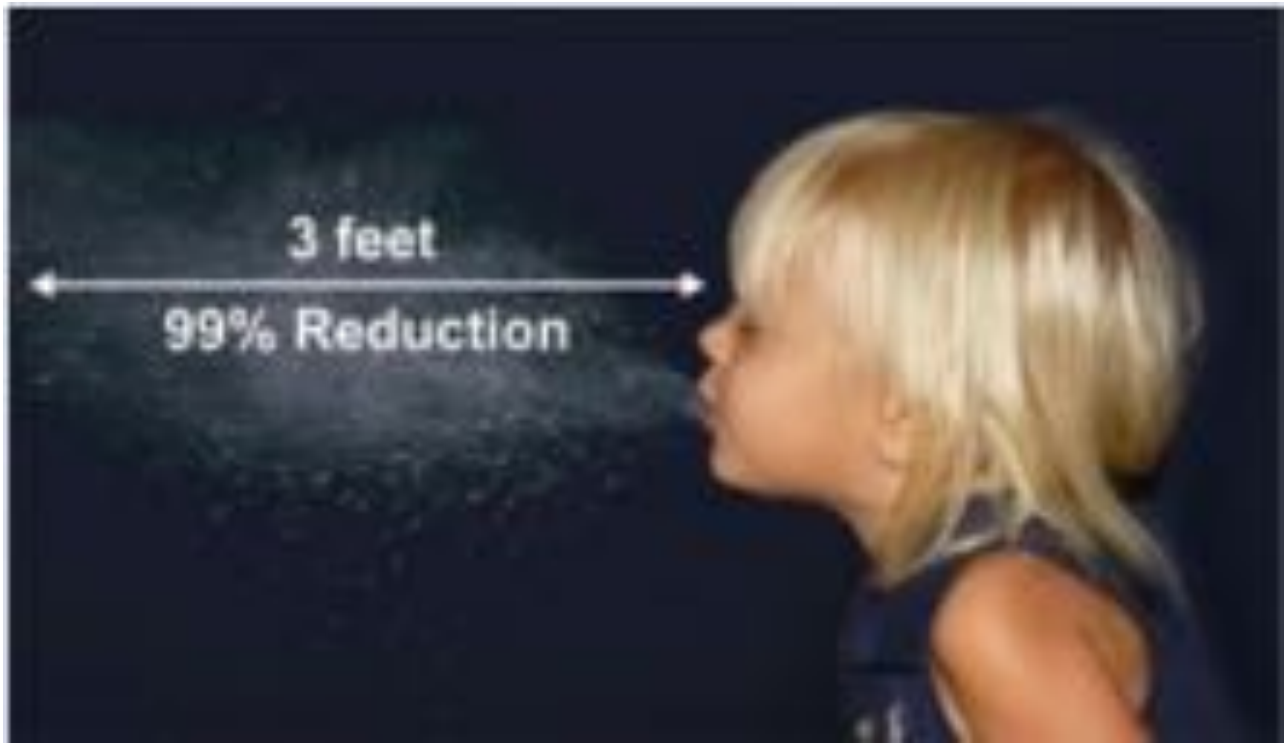
(quoted samples from university and independent lab tests and major corporation studies)

- 99.99% reduction in surface and aerosolized SARS-CoV-2
- 99+% reduction in surface H1N1 swine flu
- 4-log reduction (99.99%) surface bacteria/virus
- 99% of human sneeze microbes killed at 3 feet
- 97% airborne bacteria reduction
- 99% reductions of E-Coli, Listeria, Strep, Tuberculosis, Bird Flu and many others
- 85% odour reduction
- 97% airborne mould spore reduction
- US Military approved for mould protection in field hospitals
- Hospital approvals Infectious Diseases – US and International 99% reduction of Staph (MRSA)
- Major US city school reported 20% reduction in absenteeism
- Tested and approved by the Chinese government in 2003 for protection against SARS-CoV-1
- Fox News 3-part indoor air series featured RGF and concluded substantial mould and bacteria reductions
- RGF's technology has been featured on Fox, ABC, CBS and in Popular Science Magazine

➢ Cells produce 1 quadrillion ionised VHP molecules every second.
➢ No other technology comes close for reach and scalability
➢ Translates into best value for money

Testing & Compliance

- RGF pioneered the development of aerosolized microbial testing protocols which remain unique in the world
  - 2006 Sneeze Machine tested by KSU
  - Kills 99% of sneeze germs within 3 feet



- 99.9% reduction in surface and aerosolized SARS-CoV-2.
  - 2020 Innovative Bioanalysis – 8'x20'x20' chamber. Kill rate same at varying distances proving environmental effect throughout chamber

- Tested and approved by
  - ETL Intertek, TUV SUD, CSA
  - US Military
  - Chinese government
  - Japanese government
  - Canadian government
  - European Union (CE markings)
  - Norovirus/MRSA protection plans of US restaurant chains, theme parks, cruise lines, public schools and hospitals

Who Are We ?

RGF® ENVIRONMENTAL GROUP, INC.

- 35 year old world leader in environmental manufacture and innovation
- 500 products (air & water purification, food sanitisation)
- 32 active patents
- 700+ staff
- $5m+ in new production facilities in 2020
- Global distribution network – 60+ countries
- 500% global sales growth in 2020
- COVID critical manufacturer (US Dept Homeland Security)

The Deployment

The following photographs show various roof mounted AHUs at the terminal buildings at Birmingham Airport. Some AHUs like the one below are large enough for allow a person to stand inside the supply / main duct branch junction.

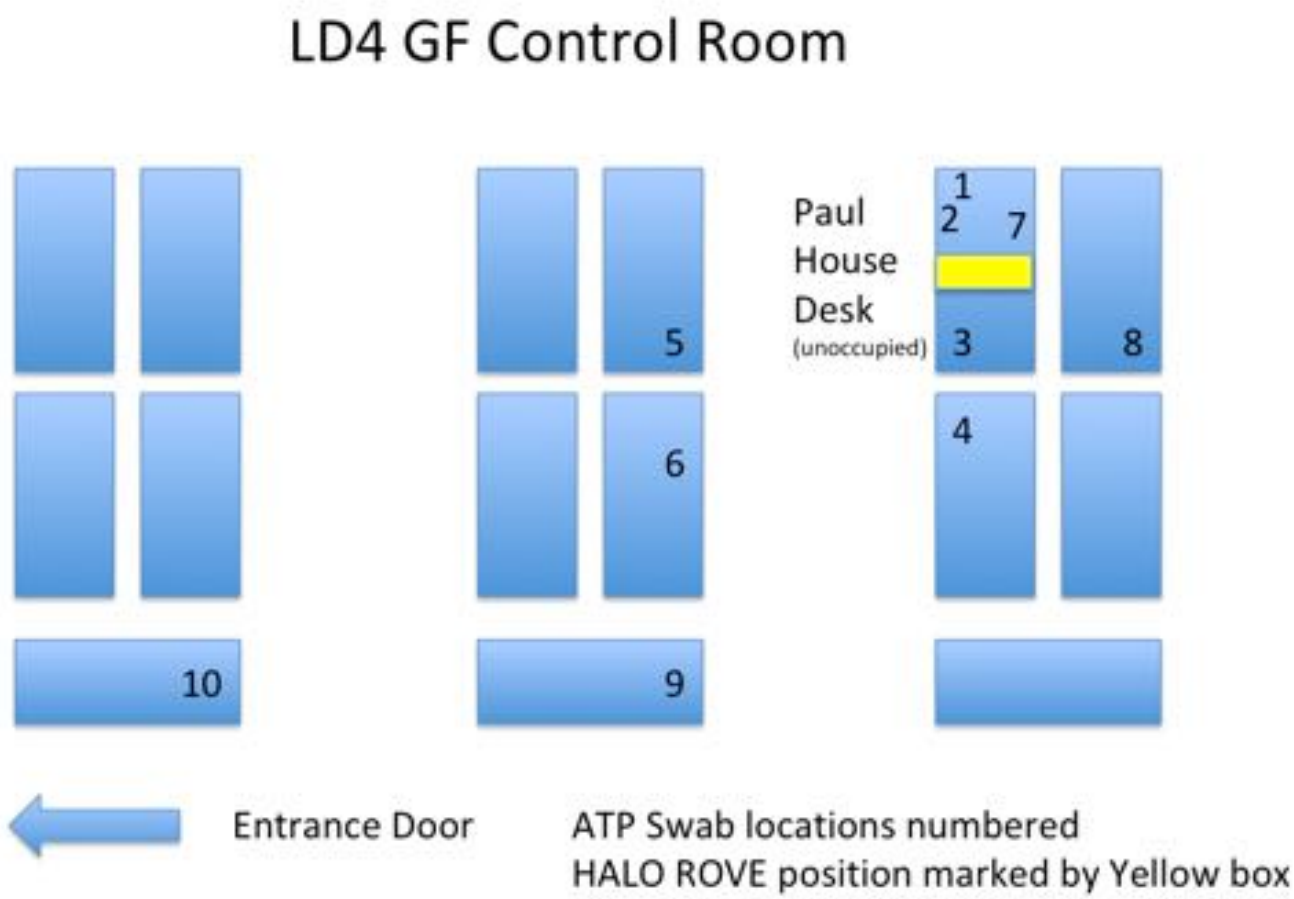
The installation of the 40 Package PHI units is a relatively simple process. Each unit has magnetic feet and can be attached to the inside walls of the AHU at the supply / main duct branch junction. Power supply is via a transformer and an isolated fused spur taken from the lighting circuit inside the AHU.

Proving the Environmental Effect

A proving exercise was not required for Birmingham Airport.

The below detail is taken from another UK study where a proving exercise was necessary.

The below diagram shows the ATP swab locations in relation to the HALO ROVE unit position



The following ATP/RLU readings were recorded:

These show an overall cumulative reduction in actual ATP/RLU across all swab locations of 71.48% over 4 days.

Location Name	16/08/21	18/08/21	Change	20/08/21	Change	Overall Change	%
	CONTROL	+ 48 HOURS 2 DAYS		+ 96 HOURS 4 DAYS			
Paul House Desk (LHS)	100	13	87	3	10	97	97.00
Paul House Keyboard	20	18	2	2	16	18	90.00
Paul House Desk (RHS)	16	5	11	6	-1	10	62.50
Adjacent Desk (LHS)	27	17	10	14	3	13	48.15
Opposite Desk (RHS)	19	11	8	2	9	17	89.47
Opposite Desk (LHS)	68	27	41	16	11	52	76.47
Paul House Screen	24	1	23	2	-1	22	91.67
Other Side Desk	55	13	42	52	-39	3	5.45
Near Front Cabinet	196	84	112	47	37	149	76.02
Far Front Cabinet	36	34	2	16	18	20	55.56
	561	223		160			
	Change	338		401			
	Change %	60.25		71.48			

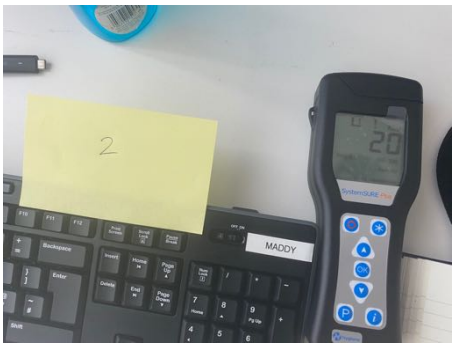
NOTES

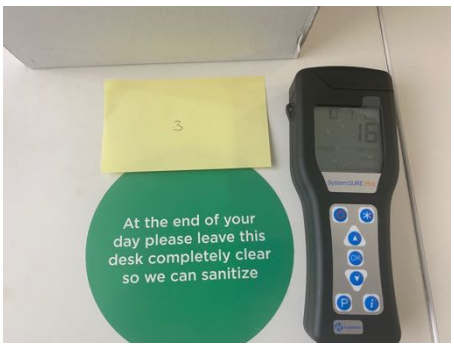
1. The unit location for the test was selected on advice that the desk was not permanently occupied. It was not being used at the time of deployment. The test needed an unoccupied space at desk level.

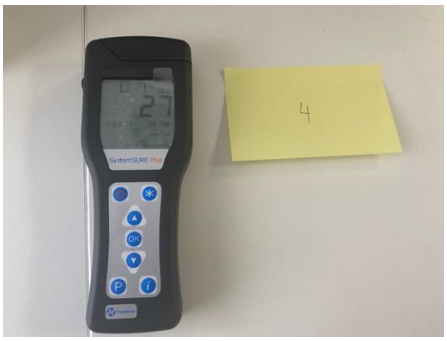
2. On the date of deployment (16/8) clear instructions were left that the HALO ROVE unit should be left running for the duration of the test.

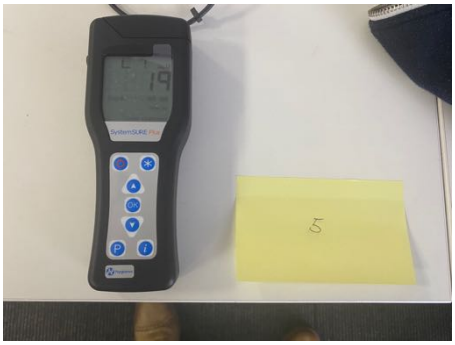
3. There are various ATP scoring systems depending on vertical. Cleaning firms typically consider levels up to 20 as clean, between 20-60 as moderate/watch and 60+ as dirty/in need of cleaning. On this measure the test created 8 clean surfaces and 2 moderate/watch surfaces from 3 dirty and 5 moderate/watch in essentially 78 hours of treatment and 18 hours without treatment where the process remained active. This is highly effective continuous treatment and a clear demonstration of the unique active capability of PHI in occupied spaces.

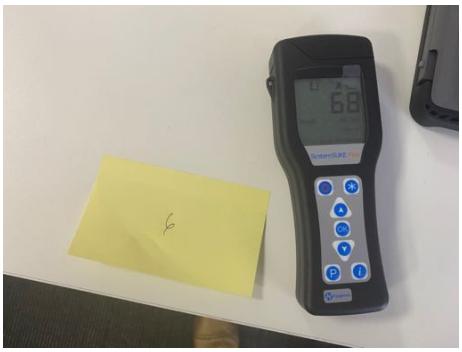
ATP Swab Photos
Control 16/8/21

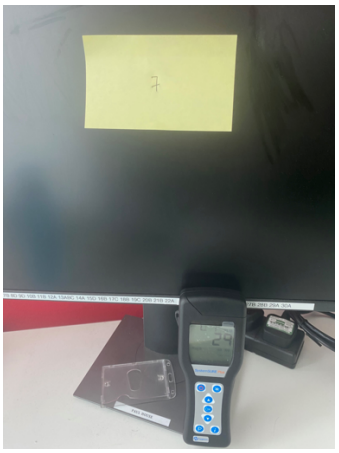


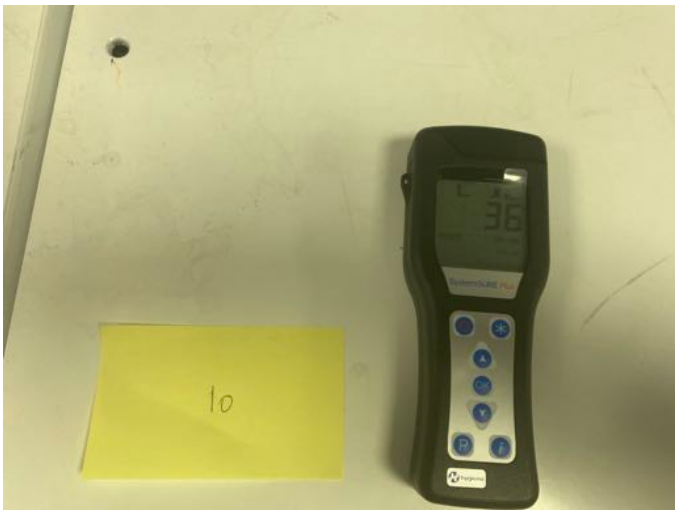




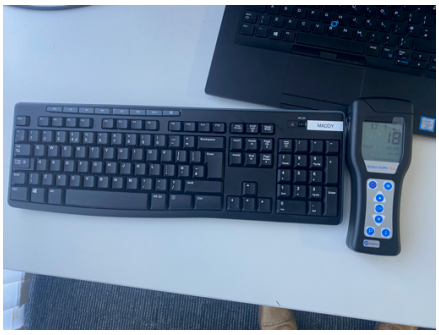




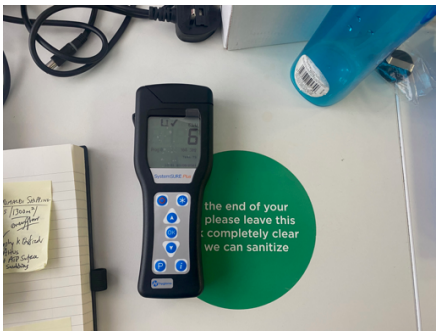




Treated 18/8/21



Treated 20/8/21



What is ATP/RLU ?

Adenosine Triphosphate, or ATP, is the energy molecule found in all living things, making it a perfect indicator when trying to determine if a surface is clean or not. Companies use ATP systems to rapidly verify surfaces have been cleaned thoroughly.

An ATP monitoring system analyses the light emitted from the ATP on a swab sample when mixed with a reagent. The light emitted is in direct proportion to the amount of ATP present in the sample. ATP is measured in RLU's (relative light units). Therefore the greater the ATP or surface contamination, the higher the RLU.

It must be noted that ATP/RLU is simply a measure of how much cellular debris there is on a surface at the time of the swabbing. It will not give a reading on how much of that debris is dead or alive. Also, any high traffic touch point will sometimes show increases in ATP/RLU but that doesn't mean the process is not working and protection is not happening in the air or on surfaces and it would be entirely wrong for such conclusions to be drawn. The following analogy might help illustrate what is going on at the molecular level.

Imagine going to the garden and taking a spade full of dirt and spreading it over a table surface and then placing a grain of rice on top of the dirt. The dirt is all the cellular debris on a surface and the grain of rice is a virus that has fallen onto a surface (molecule sizes do not compare in this analogy). These exposed dirt and virus cells are instantly and continuously deactivated yet they will still show up on a ATP/RLU measure because it takes time for the cells to be broken down sufficiently to reduce the ATP reading. Then each time you touch a surface you effectively add another layer of dirt which increases the ATP reading even though the deactivation starts immediately on the new exposed layer giving immediate protection.

Background & Context – ATP/RLU Surface & Aerosolized Microbial Testing

It must be noted that the ATP/RLU metric is the only practical measure for this process that is in any way meaningful and is not astronomically expensive. ATP/RLU has been used by other adopters of RGF technology including Lloyds of London. Another method is air swabbing for bacteria and mould but this is not the most relevant for an office wishing to protect against viral emissions. In fact there are no currently available standards or protocols for testing the removal of airborne aerosolized virus anywhere in the world so any such attempts at testing this area will incur serious expense.

RGF is responsible for the most meaningful research and testing of aerosolized virus removal techniques over the past 2 decades having first developed the Sneeze Machine and aerosolized test protocol in the aftermath of 9/11 in consultation with Sandia Labs and the US Dept of Homeland Security. Their most recent research collaboration is the 2020 multi phase testing of PHI and REME by Innovative Bioanalysis against the actual aerosolized SARS-CoV-2 virus using a real world sized 8'x20'x20' chamber – the only testing of its kind anywhere in the world. This produced 3-4+ log reductions throughout the chamber proving the environmental effect. This work has spawned interest from academic and governmental authorities to establish the world's first real time aerosolized virus removal air model. In a recent video Dr James Marsden, Executive Director of Science and Technology at RGF said "we will be the first to have a true air model to test what is happening in the air in real time".

Therefore, the only truly meaningful data evidence that exists for the removal of aerosolized SARS-CoV-2 virus is that performed by RGF and Innovative Bioanalysis. All other evidence is anecdotal but no less powerful. Better Indoors' most recent domestic installation is a good case in point. A family in Hounslow recently installed PHI on the same day a family member was diagnosed with COVID who was already suffering severe symptoms (eyes swollen and very painful, severe headache, high temperature, no

taste, lack of appetite). Self isolation and social distancing in the property is a challenge due to lack of space with one person sleeping in very close proximity to his infected brother and they do not open windows due to the cold. After 2 days his symptoms had eased significantly and were gone completely after 3 days and no other family member has become infected after 30 days despite all family members having had 3 further COVID tests. On top of this the indoor air is fresher and the allergy symptoms of one family member have subsided for the first time in years.

Comparison to VHP Fogging

Fogging processes are surface treatments. They offer no protection against aerosolized virus. Most use 5% VHP which is deadly whereas RGF's process is constantly maintained at between 0.0001-0.0004% VHP - same as the outside air. Obviously there is a big difference between these two levels but our prior ATP testing with Lloyds showed our process can break down cellular material just as quickly when averaged over a minimum period of 48 hours. The process kills aerosolized pathogens instantly as the KSU Sneeze Test of 2006 proved but as described above you cannot test in the real world without incurring serious expense. Also we caution against the use of real time viral readers with RGF because these will show incorrect values as they will count dead viral cells as well as live ones.

Fogging processes claim 4-6 log reduction in surface contaminations (99.99-99.9999%) but this is only a snapshot in time. What fogging companies dont tell you is recontamination starts immediately after the fogging (despite their claims) so the 99.9999% is irrelevant because none of us live in a snapshot moment - we all live in continuous time. RGF's process is 3.5-4+ log reduction (99.96-99.99%) but is continuous everywhere and the various surface and aerosolized testing and real world anecdotal evidence proves this is sufficient for any indoor environment. The performance of the RGF process must not be directly compared to fogging or surface disinfection wiping. These are one off more powerful toxic processes that cannot be compared to a safe continuous one that happens in background with people present.

The following example illustrates the "value" of each log reduction step. A colony of 1 million MRSA bacteria would reduce thus:

- A 1-log kill reduces the colony to 100,000 bacteria after a 90% reduction;
- A 2-log kill reduces the colony to 10,000 bacteria after a 99% reduction;
- A 3-log kill reduces the colony to 1,000 bacteria after a 99.9% reduction;
- A 4-log kill reduces the colony to 100 bacteria after a 99.99% reduction;
- A 5-log kill reduces the colony to 10 bacteria after a 99.999% reduction;
- A 6-log kill reduces the colony to 1 MRSA bacterium after a 99.9999% reduction