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CONTINUOUSLY ACTIVE ANTIMICROBIAL COATINGS

THE CYNICAL SPECIFIER'S GUIDE

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The Purpose of this guide

In the beginning we were naïve as might be expected from a small R&D team of biochemists and microbiologists.

We felt that as:

- The threat from an array of dangerous bacterial and fungal pathogens was growing.
- Many of these same pathogens were displaying dangerous antibiotic and antifungal resistance.

- that coatings manufacturers were diligent in the manufacture and testing of their coatings.

During a survey of the competitive landscape, we discovered we were standing on the edge of an enormous swamp.

1. Companies were making claims about antimicrobial efficacy and promoting 'hygienic' coatings with no test evidence to support their claims.
2. Virtually all manufacturers of antimicrobial coatings conducted only the very limited antibacterial testing described in ISO 22196.
3. Almost no companies conducted rigorous antifungal testing.

Some companies were:

A. Using EU BPR approved herbicides in their coatings which were widely used in care homes. Following detailed evaluation of the EU BPR herbicide approval we discovered that the particular herbicide was only approved for external use in the agricultural industry and was not approved for use as an internal coating.

B. Selling antimicrobial coatings that had neither indication of the biocide employed nor any evidence of third-party independent laboratory testing. These products were sold into markets in which there is little or no pesticidal control legislation. Interestingly, despite the companies involved being international, the products were not offered in the USA and European markets.

These ***"tales from the swamp"*** resulted in the 'Cynical Specifier's Guide to continuously active antimicrobial coatings'

In the beginning, it was written for internal use and only later did we realise how important it could be for specifiers involved in construction projects and facilities management roles.

THE ROLE OF THE CYNICAL SPECIFIER

A specifier is a trusted technical adviser and part of project and facilities management teams. It is an often-undervalued role and demands expertise across a range of disciplines.

The aim of the Guide is to equip the Cynical Specifier with the tools necessary to:

- Understand the bacterial and fungal landscape.
- Recognize which bacteria and fungi represent the most dangers to humanity.
- Understand the mechanisms by which dangerous pathogens are transmitted.
- Understand regulations regarding biocides.
- Have an overview of the various biocides that are being used in antimicrobial coatings.
- Decide which (if any) biocidal coatings are appropriate for a given project.

- and most importantly, make informed decisions and ask difficult questions from antimicrobial coating manufacturers.

What does Antimicrobial Mean?

The term ‘antimicrobial’ and ‘hygienic’ are two much-abused words particularly in the coatings industry. ‘Antimicrobial’ has no clear meaning as it spans a wide range of microbial species whereas it should be definitive and specific. ‘Hygienic’ means nothing.

The term “antimicrobial” refers to substances or agents that have the ability to kill or inhibit the growth of microorganisms, including bacteria, viruses, fungi, and parasites. Antimicrobial agents can be found in various forms, such as medications, chemicals, or natural compounds, and they are designed to target and disrupt specific processes or structures within microorganisms.

Antimicrobial substances work by interfering with vital functions or structures necessary for the survival and replication of microorganisms. For example, antibiotics are a common type of antimicrobial agent that specifically target bacteria by disrupting their cell walls, proteins, or DNA synthesis. Antiviral drugs, on the other hand, are antimicrobial agents designed to inhibit the replication of viruses within host cells.

Antimicrobial agents can be classified into several categories based on their target microorganisms.

Some antimicrobials are broad-spectrum, meaning they are effective against a wide range of microorganisms, while others are narrow-spectrum and specifically target certain types of microorganisms.
Additionally, there are different classes of antimicrobial agents, each with its own mechanisms of action and specific targets.

In terms of coatings the targeted pathogens are generally bacteria, fungi and viruses; though the impact of coatings upon the spread of viruses is questionable as is discussed later in this Guide.

Predominantly this Guide is aimed at pinpointing coatings that present proven efficacy against the most dangerous bacterial and fungal pathogens.

The use of antimicrobial agents in coatings can be a major step in the fight against increasingly drug-resistant microbial pathogens which are dangerous to human health.

At the same time, the Cynical Specifier must use caution to ensure that the antimicrobial agents employed are not harmful to human health and the wider environment.

The Cynical Specifier must also recognise that it is important to use antimicrobial agents judiciously and responsibly to minimize the risk of antimicrobial resistance, where microorganisms become resistant to the effects of these agents, making infections harder to treat.

E. Coli bacteria

Candida auris fungi

Understanding the 'Tricks of the Trade'

Rather like stage magicians, some manufacturers of alleged antimicrobial coatings use 'sleight of hand' in support of their claims that their coatings provide continuously active antimicrobial efficacy.

A number of differing tricks are used including ***'Just Trust Us', 'Test Adopters' and 'Not Stating Clearly'.***

'Just Trust Us'

The 'Just Trust Us' group comprises those companies who simply stick a label on their coatings saying 'Antimicrobial' or 'Hygienic' without any supporting evidence.

'Test Adopters'

'Test Adoption' is the process whereby a manufacturer of an active antimicrobial additive intended for use in an antimicrobial coating conducts a series of tests and successfully proves that their antimicrobial agent works against specific bacteria, fungi or viruses.

A coatings manufacturer subsequently employs this antimicrobial agent and then claims efficacy against the tested pathogens based solely upon the tests conducted by the antimicrobial additive manufacturer.

These claims are misleading as:

- The quantity (and quality) of antimicrobial additive included in the coating manufacturer's mix may differ radically from the material which passed the test.
- The blend of materials from which the coating is produced may inhibit or eliminate the efficacy of the antimicrobial additive.

It is essential for a coatings manufacturer to prove that their antimicrobial coatings have been tested in the finished coating separately from the antimicrobial additive they employ.

'Not Stating Clearly'

Any biocide employed in a coating must be:

- Approved for use by either the USA EPA or the EU BPR (Biocidal Products Regulation) and preferably both.
- Such approval must include clear confirmation that such biocidal additive is suitable for use in the proposed application.

“Pestilence” in the 21st Century

In 1347 what became known as the Black Death was simply known as the “Pestilence”.

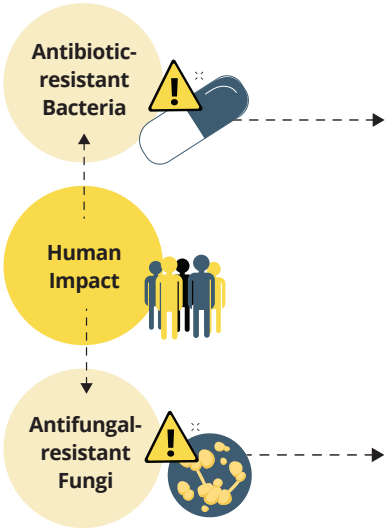
The Black Death (also known as Bubonic Plague) was caused by a bacteria, Yersini pestis, which was transmitted by fleas from rats to people.

From 1346 to 1353 the most fatal pandemic recorded in human history, caused the deaths of 75–200 million people.

“Pestilence” in the 21st Century is marked by dangerous bacteria (particularly the growing number showing antibiotic resistance), fungal pathogens and viruses.

“We must act now to build our defences against future catastrophe. Another war is coming.”

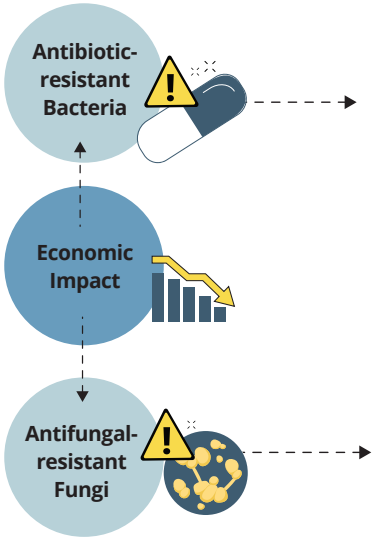
Kate Bingham – Head of the UK’s Vaccine Taskforce in her Romanes Lecture at Oxford University wasn’t speaking solely about SARS-CoV-2. She was speaking about the cumulative threat of antibiotic and antifungal resistant pathogens as well mutating viruses in an uncertain future.



In 2019 1.27 million people died as a direct result of antibiotic-resistant bacteria and antibiotic resistance played a role in a further 4 million deaths.

By 2050 it is forecast that 10 million people per annum will die directly from antibiotic resistant bacteria with a further 37 million cases where antibiotic-resistant bacteria are noted as a major contributory factor in mortality rates.

Annually, over 150 million cases of severe fungal infection occur worldwide, resulting in debilitating illness and approximately 1.7 million deaths per annum.



In 2013 the CDC estimated that the economic cost of antibiotic resistant bacteria is $55 billion per annum in the United States alone.

In 2017 the World Bank released research indicating that, on a global basis, the economic impact of antibacterial resistance would grow to $150-210 trillion by 2050.

2022 report estimated the US economic burden of fungal diseases as $11.5 billion in 2019.

Equivalent worldwide data is not available as fungi have been widely neglected as a threat to public health.

We know what's coming

We are running out of antibiotics. We have reached a point where increasingly fewer treatment alternatives are available for many bacterial infections.

The last antibiotic class that was successfully introduced as treatment was discovered in 1987.

A study released in 2020, **'Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis',** looked at the data for 494 million patient records from 2019. The results of this study and projections are shown graphically.

On 22 October 2022, the World Health Organization published a paper entitled ***'WHO fungal priority pathogens list to guide research, development and public health action'.*** This paper is the first global effort to systematically prioritize fungal pathogens, considering their unmet yet perceived public health importance.

The WHO listed the priority fungal groups and noted 'against the backdrop of this major global health threat, invasive fungal diseases are evidenced by the emergence of antifungal resistance in many settings.

Antibiotic-resistant Bacteria

The growing death toll from antibiotic-resistant bacteria is forecast to exceed the peak of Sars-Cov-2 deaths per annum by 2033.

There is a growing death toll where antibiotic-resistant bacteria was noted as a major factor in the cause of death.

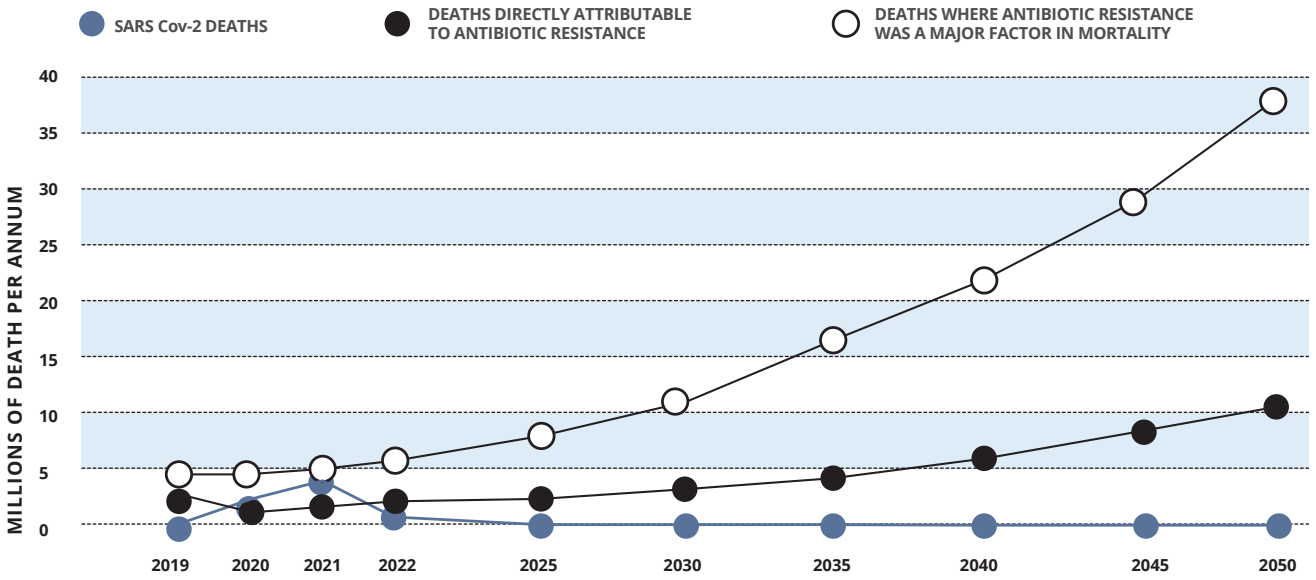
By 2050 it is forecast that 10 million people per annum will die directly from antibiotic resistant bacteria with a further 37 million deaths recorded where antibiotic-resistant bacteria are a major factor.

Most Dangerous Fungal Pathogens

Annually, over 150 million severe cases of fungal infections occur worldwide, resulting in debilitating illness and approximately 1.7 million deaths per annum.

In addition, there are dangerous fungal moulds found in damp conditions within our homes which, whist rarely life threatening, can be extremely debilitating. These have been added to our target list as they are widespread and their impact upon health is significantly underestimated.

GLOBAL BURDEN: PROJECTION FOR ANNUAL DEATHS DUE TO ANTIBIOTIC RESISTANCE COMPARED TO SARS-CoV-2 DEATH RATE



What about Viruses?

The decision whether or not to use continuously active antiviral coatings on surfaces has to be governed by understanding the mechanism by which differing viruses are transmitted. If they are not transferred via surfaces, then there is little point in using antiviral coatings.

The transmission of viral pathogens from one person to another can arise through:

- Airborne transmission where coughing, sneezing, or even talking can create droplets and aerosols which through formites can transfer infectious viruses from person to person without a surface as intermediary. A fomite is a 'passive vector' (a non-living element) capable of transmitting a viral pathogens from one individual to another, as long as it has been previously contaminated with said pathogen.

- Through direct person to person interaction and indirect via surfaces.

Viral Transmission Mechanisms

Research into SARS-CoV 2 (and MERS-CoV) indicates that the vast majority of infection arises through inhalation of airborne droplets and aerosols but leaves open the possibility that some SARS-CoV 2 viral pathogens could have been transferred through formites and droplets on surfaces.

This view was confirmed by the World Health Organization (WHO) and the US Centers for Disease Control and Prevention (CDC) have officially acknowledged the inhalation of virus-laden aerosols as a main transmission mode in spreading SARS-CoV 2 at both short and long ranges in 2021.

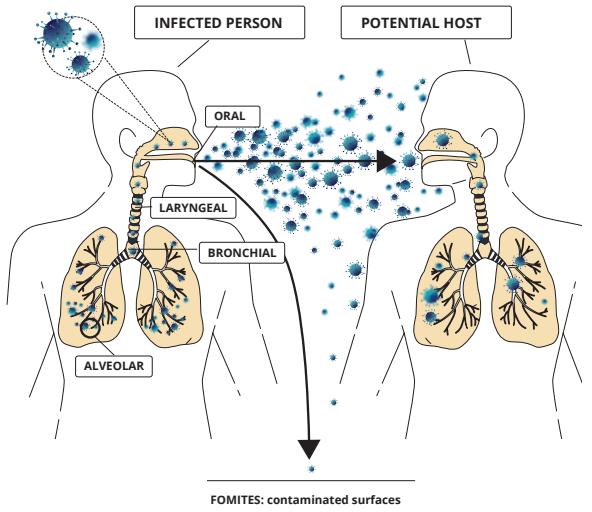
The illustration may serve to further explain the current view of the transmission mechanisms involved in the spread of SARS-CoV 2 and MERS-CoV.

The decision to use continuously active antiviral coatings on surfaces has to be governed by rational consideration of how differing viruses are transmitted. If they are not transferred via surfaces, then there is little point in using antiviral coatings.

During the Covid pandemic several major coatings companies released products with claimed antiviral efficacy. These were developed and released whilst the jury was still out on the mechanism by which viral pathogens were being transmitted.

Since the release of the CDC and WHO publications the case for antiviral coatings has been significantly undermined. Nevertheless, the companies that produce these coatings persist in promoting them into healthcare.

It is important to be clear that for many airborne viral pathogens a client's money may be better spent on improved ventilation technology.



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Targets & Tests

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Targeting the most dangerous bacterial & fungal pathogens

Lack of investment and timescales in developing new antibiotics and antifungal drugs mean that alternate strategies must be adopted.

A key part in this strategy must be to target the most dangerous bacterial and fungal pathogens allied with a clear understanding of how these diseases are transmitted.

Combining data from the CDC report in the United States 2019 ***(Table 1)*** with the WHO's **'Fungal Priority Pathogens List'** published in October 2022 allows the creation of the consolidated target list shown in ***Table 2.***

Understanding how these pathogens are transmitted (often from person-to-surface-person and person-person) forms the second plank in formulating a response.

Proven Efficacy is Key

Table 2 presents an amalgamation of the most dangerous bacteria and fungi detailed in the CDC and WHO reports.

The Importance of Testing

Extensive independent, third-party laboratory testing to recognized international standards is essential to prove the efficacy of coatings designed to stop the spread of the listed most dangerous and fungal pathogens.

Table 1: CDC 'Antibiotic Resistance Threats in the United States' 2019 ' Extract

RANK	BACTERIAL PATHOGEN
1	Drug-resistant Streptococcus pneumoniae
2	Clostridioides difficile
3	Vancomycin-resistant Enterococcus (VRE)
	Methicillin-resistant Staphylococcus aureus (MRSA):
	Escherichia coli (E. coli)
	Multidrug-resistant Pseudomonas aeruginosa
	Drug-resistant Campylobacter
	Klebsiella pneumoniae
	Carbapenem- resistant Acinetobacter (CRAB)
	ESBL-producing Enterobacterales
	Drug-resistant nontyphoidal Salmonella
	Carbapenem-resistant Enterobacteriales (CRE)

1 - Kills more people
2 - Highest death rate as a % of those infected
3 - Infects more people

Table 2: The Consolidated Target List: the most dangerous bacterial & fungal pathogens

PATHOGEN TYPE	SUB-TYPE	PATHOGEN
BACTERIA		Drug-resistant Streptococcus pneumoniae
		Clostridioides difficile
		Vancomycin-resistant Enterococcus (VRE)
		Methicillin-resistant Staphylococcus aureus MRSA
		Escherichia coli (E. coli)
		Multidrug-resistant Pseudomonas aeruginosa
		Drug-resistant Campylobacter
		Klebsiella pneumoniae
		Carbapenem-resistant Acinetobacter (CRAB)
		ESBL-producing Enterobacterales
		Drug-resistant nontyphoidal Salmonella
		Carbapenem-resistant Enterobacteriales (CRE)
FUNGI	NON-SPORE FORMING	Candida albicans
		Candida auris
		Cryptococcus neoformans
		Candida glabrata
		Candida tropicalis
		Candida parapsilosis
	SPORE FORMING	Aspergillus brasiliensis
		Penicillium chrysogenum

Added to the ***Table 2*** list are dangerous fungal moulds found in damp conditions within our homes which, whist rarely life threatening, are a worldwide problem and can be extremely debilitating. Their impact upon health is significantly underestimated.

Independent Laboratory Testing & Certification

The efficacy of any antibacterial or antifungal coating can only be assessed by independent laboratory testing. Unsupported claims should be viewed with caution and **The Cynical Specifier's Guide** has been produced to equip a specifier engaged in selecting coatings and finishes with a firm grasp of not only the most threatening pathogens, but also have the knowledge to view manufacturers' claims with that cynical eye.

Table 3 provides a listing of the most dangerous bacterial and fungal pathogens and lists the appropriate test standards.

ISO 22196:2021 'Measurement of antibacterial activity on plastics and other non-porous surfaces' is the current international benchmark for testing the efficacy of continuously active antibacterial coatings.

One of its limitations is that only two bacterial pathogens are required to be tested: gram-positive S. aureus and gram-negative E. coli. The problem with this approach is that some antibacterial coating manufacturers then assume that a coating that shows efficacy against S. aureus and E. coli will be equally effective against the whole range of dangerous bacterial pathogens. More a leap of faith than rational science.

Table 3: Appropriate Test Standards

TEST STANDARD	PATHOGEN TYPE	REP. TYPE	PATHOGEN
ISO 22196	BACTERIA		Drug-resistant Streptococcus pneumoniae
			Clostridioides difficile
			Vancomycin-resistant Enterococcus faecium (VRE)
			Methicillin-resistant Staphylococcus aureus MRSA
			Escherichia coli (E. coli)
			Multidrug-resistant Pseudomonas aeruginosa
			Drug-resistant Campylobacter jejuni
			Klebsiella pneumoniae
			Carbapenem-resistant Acinetobacter (CRAB)
			ESBL-producing Enterobacterales
			Drug-resistant nontyphoidal Salmonella
			Carbapenem-resistant Enterobacteriales (CRE)
	FUNGI	NON - SPORE FORMING	Candida albicans
			Candida auris
			Cryptococcus neoformans
			Candida glabrata
			Candida tropicalis
			Candida parapsilosis
ASTM G21	FUNGI	SPORE FORMING	Aspergillus brasiliensis
			Penicillium chrysogenum

TESTING SPORE FORMING FUNGI

ASTM G21:2021 'Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi is used to determine the resistance of continuously active antifungal coatings. This test is most appropriate for use when the fungi in question are spore-forming.

TESTING NON-SPORE FORMING FUNGI

To be tested using ASTM G21, fungi need to be spore forming so that they grow/creep over the sample surface. Candida, a yeast, will not do this, but does form countable colonies which make it more suited to ISO 22196 testing.

Similarly, Cryptococcus neoformans forms distinct mucoidal colonies on agar. As the colonies are separate, they can be counted, and quantitative methods are generally better for reproducibility and accuracy therefore ISO 22196 is more appropriate.

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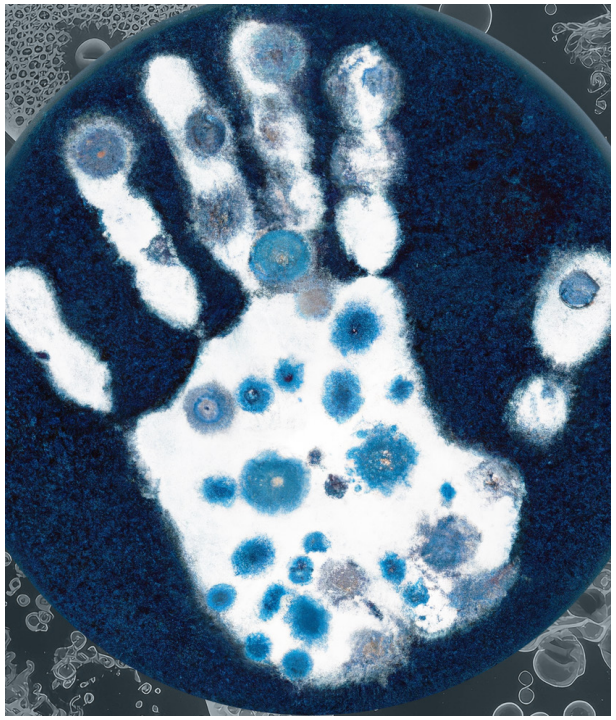
Stopping the Spread

Stopping The Spread

In contrast to how viruses spread, the US Centers for Disease Control and Prevention (CDC) estimates that over **80% of infectious diseases are transferred either directly through touch or use touch as a secondary method of spread.**

The Topography of a Fingerprint



Each person's fingerprint is unique. However, the channels and ridges that are a part of the topography of our fingers and hands serve as excellent carriers of bacteria and fungi.

The Network Multiplier Effect

80% of pathogens are spread through touch and the term 'spill-over effect' is sometimes used in biomedical sciences to describe one person's exposure affecting the outcome of another. Spill-over is the transfer of an infectious pathogen either:

- Directly from one person to another or
- Through an intermediary such as a surface where an infected person touches a locus which is then touched by a susceptible third party. This transfer can be affected through medical equipment as well ordinary surfaces such as walls, door handles and handrails.

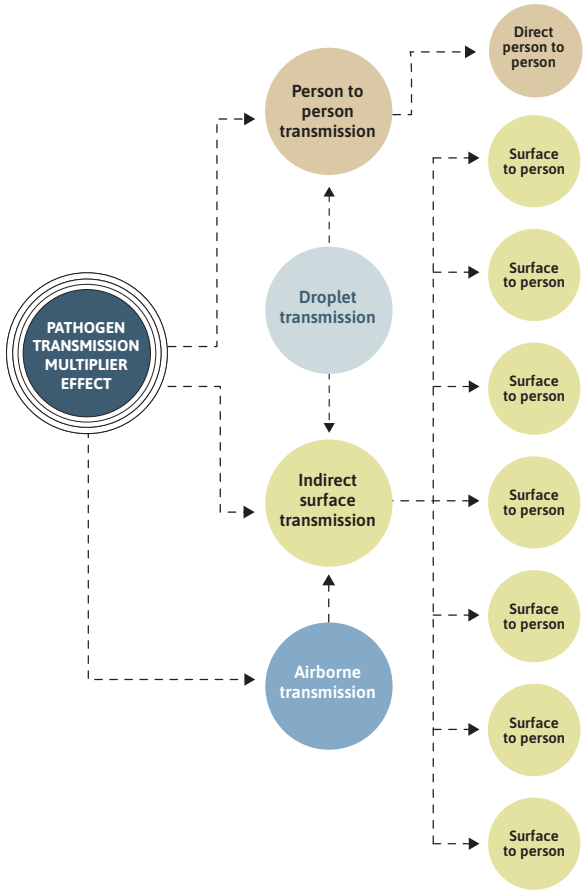
The paper 'Network multipliers and public health' (VanderWeele et al: Int J Epidemiol. 2019 Aug; 48(4): 1032–1037) clearly states that:

> ***'Spill-over effects and contagion should be taken into account when assessing the public health impact of an intervention and also its cost-effectiveness.'***
>
> **With direct transmission, the limiting factor in spread is the number of people with whom an infected individual comes into direct contact.**

There is no such limitation when it comes to pathogenic transfer through surface transmission.

A person living in a remote outpost is likely to infect only their immediate neighbours but that same person travelling through a city can infect thousands of people whom they will never know personally nor interact.

The impact of surface-to-person transmission of pathogens cannot be overemphasised.



A pathogen's formula for success

The spread of an infection through contact with a contaminated surfaces can be exponential when compared to person-to-person contact. A coherent combat strategy taking account of the specific usage and functions of different building types is essential and this can be (somewhat) simplified to seven critical 'project-type surface-pathways'.

High risk locations:

People in hospitals, care and nursing homes as well as those working in medical centres, pharmacies, laboratories and veterinary clinics are at particular risk of pathogenic transmission both through person to person contact and via surface contamination. Water treatment facilities also fall into the high-risk category.

Locations with high transit densities:

As people travel, they come into contact with a vast array of bacteria and fungi largely through touching contaminated surfaces. Rail and mass transit stations, airports and bus stations offer enormous potential for surface-resident infectious pathogens not only to spread within the group using the transport system but for that infection to be carried throughout the network into wider communities.

Locations with high residential density:

People living and working in apartment blocks, offices, hotels, prisons and military facilities as well as those attending schools, colleges and universities are similarly at risk of pathogenic transmission both through person to person contact and via surface contamination. Contamination of surfaces in common shared areas present major opportunities for bacteria and fungi to pass from person to person. With surface contamination the parties never need to meet, share a conversation or even nod to each other in passing. Like an insidious person, a dangerous pathogen that dwells upon a surface seeks to gradually and destructively perpetuate itself by stealth.

Locations with periodic high residential densities:

Buildings where people temporarily congregate such as places of worship, stadiums, shopping centres, cinemas, theatres and other public entertainment venues offer similar opportunities for infectious, surface-dwelling bacteria and fungi to spread exponentially.

Food Processing and Handling Facilities:

Facilities involved in food processing, storage, and handling, such as restaurants, cafeterias, and food production plants, face high risk of bacterial and fungal contamination.

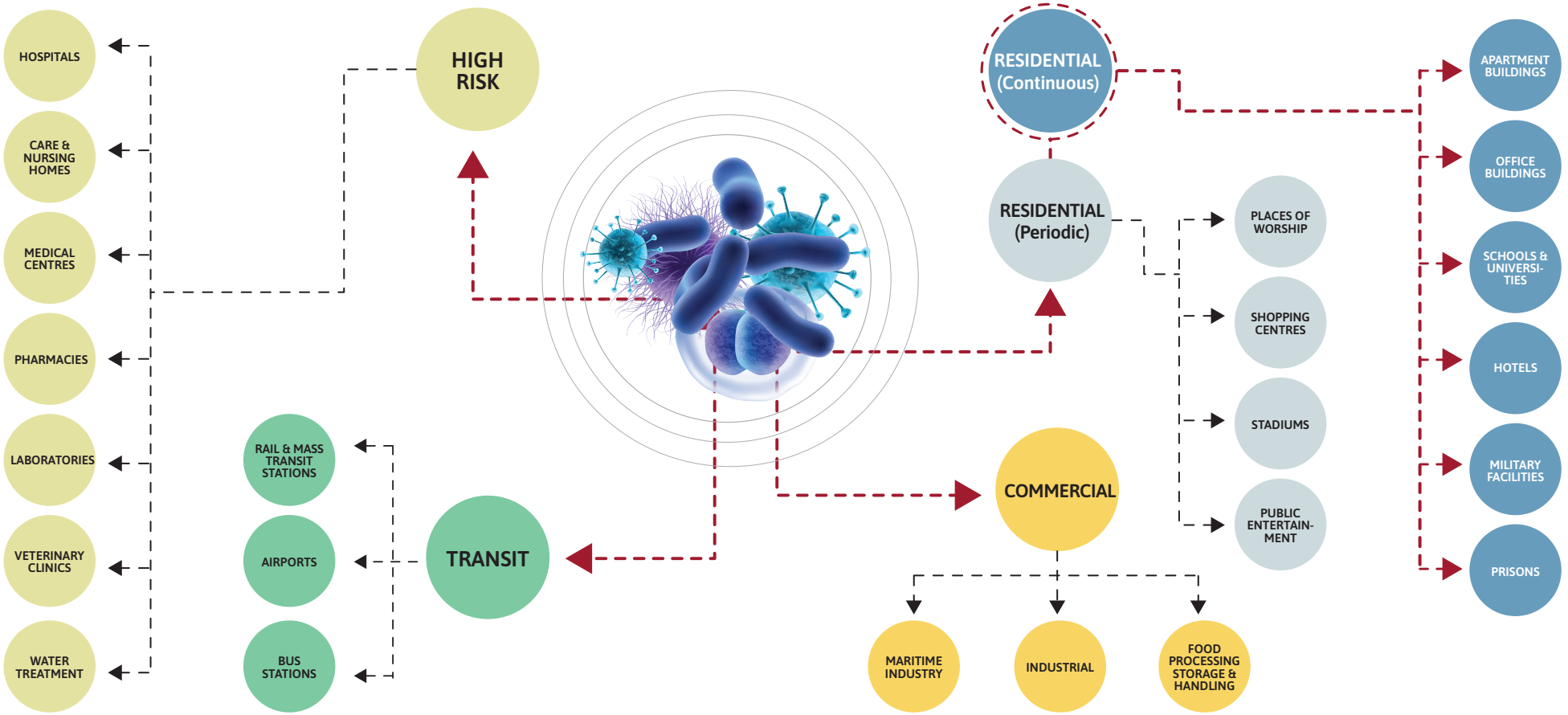
Industrial Manufacturing:

Industrial facilities and manufacturing plants where moisture, organic materials, and machinery are present can create an environment conducive to the growth of bacteria and fungi.

Maritime Industry:

As with industrial manufacture, conditions in the maritime industry where moisture, heat and enclosed spaces create a near perfect environment for bacterial and particularly fungal growth.

Dangerous bacteria and fungal infections live with us,
travel with us and come to work with us.



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Biocides & Regulations

Testing is Essential but Safety is Paramount

The approach of antimicrobial coating manufacturers should be completely transparent and ethical where safety is paramount by ensuring the technologies employed in no way impact:

- The lives of people producing the coatings
- The lives of people applying the coatings
- The lives of people using the facilities where antimicrobial coatings have been applied
- The wider environment

There are two regulatory bodies who set the benchmark for approval of any biocidal compound incorporated into antimicrobial coatings

The US Environmental Protection Agency and the EU Biocidal Products Regulatory body.

Any biocide used in an antimicrobial coating should be approved for a stated use by at least one (and preferably both) of these agencies.

EPA Pesticide Registration

The US Environmental Protection Agency (EPA) assess pesticides/biocides across a wide variety of potential human health and environmental effects associated with use of the product.
The EPA regulates pesticides under broad authority granted by several statutes:

- The Federal Insecticide, Fungicide, and Rodenticide Act (FIRFA)
- The Federal Food, Drug, and Cosmetic Act (FFDCA)
- The Food Quality Protection Act (FQPA)
- The Pesticide Registration Improvement Act (PRIA)
- The Endangered Species Act (ESA)

EPA approval of individual biocides for the intended purpose should be an essential part of any audit conducted by a Cynical Specifier.

https://www.epa.gov/pesticide-registration/about-pesticide-registration

EU Biocidal Products Regulation (BPR)

The Biocidal Products Regulation (BPR, Regulation (EU) 528/2012) concerns the placing on the market and use of biocidal products, which are used to protect humans, animals, materials or articles against harmful organisms like pests, bacteria and fungi, by the action of the active substances contained in the biocidal product. This regulation aims to ensure a high level of protection for humans and the wider biosphere.

https://echa.europa.eu/regulations/biocidal-products-regulation/understanding-bpr

Understanding Biocides

Active antimicrobial (biocidal) agents used in coatings broadly split into two groups:

1. Active pesticides and herbicides
2. 'Passive' nanoparticle biocides

Active pesticides and herbicides

This category includes organic compounds such as IPBC (Iodopropynyl Butylcarbamate), OIT (octylisothiazolinone), terbutryn, diuron, isoproturon, and many others. Some are persistent in the environment, are hazardous to organisms (particularly those at the base of the ecosystem) or may cause dangerous targeted pathogens to develop biocidal resistance. It is incredibly important to know that if an active pesticide is being used that it is US EPR and/or EU BPR approved. If this is not the case it can have significant implications for people, animals and the wider environment. As these coatings break down, active biocides can thereby pass into the environment.

'Passive' Nanoparticle biocides

Incorporating silver, copper and zinc nanoparticles into paints or coatings can be an effective way to provide additional protection against microbial growth. However, the use of nanoparticles presents significant risks.

NANO or NONO: A potential Scandal lurking just Off Stage

As with any biocide it is important to weigh potential benefits against potential risks and to take appropriate precautions to ensure the safe use, handling and disposal of these materials.

The increasing trend of using nanoparticles in antimicrobial coatings should be of great concern.

The fact that nanoparticles of silver and copper are gaining increasing use in antimicrobial coatings relates directly to their efficacy in killing dangerous microbial pathogens.

Nanomaterials however present a significant cost in the form of:

- Toxicity to living organisms including humans.
- Nanoparticles can accumulate in various organs and tissues, including the liver, kidneys, and brain. Prolonged exposure or accumulation of nanoparticles may lead to adverse health effects.
- Environmental exposure.
- Development of antibiotic and antifungal resistance.

The increased toxicity of nanoparticles compared to their microparticle counterparts is primarily attributed to their increased surface area.

When materials are reduced to the nanoscale, they exhibit a larger surface area-to-volume ratio. This high surface area allows for greater interaction with the surrounding environment, including biological systems.

The increased surface area of nanoparticles results in more atoms or molecules being exposed, which can enhance their reactivity and toxicity. In the case of silver and copper nanoparticles, this increased reactivity can lead to the generation of reactive oxygen species (ROS) and other mechanisms of cellular damage.

ROS can induce oxidative stress, inflammation, and damage to cellular components, potentially causing adverse effects in biological systems.

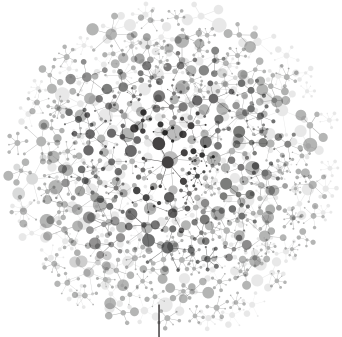
Moreover, the small size of nanoparticles enables them to penetrate biological barriers more readily, including the respiratory system. Nanoparticles in the respirable size range can reach the deep regions of the lungs, such as the alveoli, where gas exchange occurs. This direct contact with sensitive lung tissues can lead to localized toxicity and inflammation.

Nanoparticle characterisation, pathways and toxicological impact:

Nanoparticles in the body and possible entry routes:

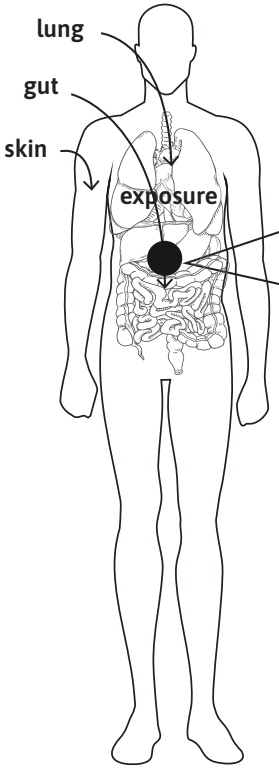
Nanoparticles:

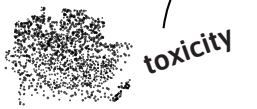
- **industry**
- **research**
- **medicine**

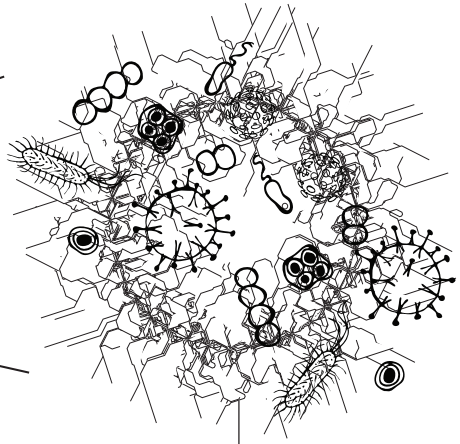


Nanoparticles in the environment:

- **alteration of surface**
- **protein corona**
- **agglomeration**







Nanoparticles in cells:

- **production of reactive oxygen species**
- **protein misfolding**
- **membrane damage**
- **mitochondrial damage**
- **DNA damage**

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Coating Resistance & Durability

What will Happen to the Coating over Time?

The Cynical Specifier must also consider the application and the environment within which a coating has to exist and provide continuously active antimicrobial properties. There are a series of essential characteristics that a continuously active antimicrobial coating must meet in order to be deemed 'fit for purpose'.

The two most important criteria are:

- Resistance to disinfectants and particularly harsh chemicals
- Abrasion and Impact Resistance

Resistance to Disinfectants & Chemicals

In many applications, and particularly in healthcare the routine use of disinfectants is an integral part of the facilities hygiene programme. As such, it is complementary to the use of continuously active antimicrobial coatings. The use of disinfectants is periodic and between disinfectant applications the continuously active coating is designed to carry responsibility for limiting harmful microbial activity.

Continuously active antimicrobial coatings should be resistant to a wide range of chemicals and solvents used in decontamination processes as well as the removal of graffiti. This resistance should include hydrochloric acid (10%), sulphuric acid (10%), nitric acid (10%), formic acid (10%), caustic soda (10%), and benzyl alcohol as well as water and steam.
Whilst these coatings must exhibit long term resistance to the above chemicals and disinfectants, this resistance must extend two types of aggressive disinfectant that are used in areas susceptible to cross contamination. These aggressive disinfectants are hydrogen peroxide vapour (HPV) and formaldehyde.

Hydrogen Peroxide Vapour (HPV)

HPV is the vapour form of hydrogen peroxide (H_2O_2) with applications as a low-temperature antimicrobial. HPV is used to decontaminate isolation and pass-through rooms and other enclosed and sealed areas

such as laboratory areas and clean rooms.
The use of HPV extends to areas where there is an increased risk due to open wounds and body fluids, patient rooms, hospital bio-decontaminate procedural rooms and operating theatres. As the most aggressive forms of disinfectant, any continuously active antimicrobial coating claiming to be suitable for use (where formaldehyde or HPV is used) must, through independent testing, show ongoing resistance to chemical attack by these disinfectants.

The continuously active antimicrobial coating must also list the resistance of the coating to a broad range of other chemicals including acids, alkalis/bases, alcohols, hydrocarbons, keytones, vegetable oils and other chemical groups such as ethyl acetate, ethylene glycol and phenols.

Formaldehyde

Formaldehyde is a potent, colourless gas carried in a methanol and water solution. It is commonly used in hospitals, medical laboratories, dental offices, and paediatric practices as a preservative, sterilizer, and disinfectant.

Abrasion Resistance

Durability is the watchword of any coating, and this is particularly important for continuously active antimicrobial coatings as they are used as more than mere decorative surfaces. They are mission-critical in the fight against harmful pathogens and their resistance to impact and abrasion contributes to their longevity.

The fact that the active antimicrobial agent is evenly dispersed throughout the depth of the coating is vitally important as all surfaces wear over time. However proven durability under abrasion testing is essential.

ASTM D2486-17 'Standard Test Methods for Scrub Resistance of Wall Paints' is the most widely used test method for coatings and measures the resistance of paints to erosion caused by scrubbing. This test is used when assessing the potential durability of wall paint that is frequently cleaned or scrubbed due to soiling in high-traffic spaces such as work areas, play areas, windows, and areas around doorways. The scope of testing involves scrubbing the surface of a test specimen with a bristle brush and an abrasive compound repeatedly in a circular motion. The specimen is then checked and rated based on the number of scrub cycles it reached before failure.

Impact Resistance

In some areas within buildings coatings may be subjected to impact. The standard test to estimate the effects of such impact is ASTM D2794 'Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)'

Coating manufacturers must be able to confirm that proposed coatings have successfully passed this test.

Service Life Projections

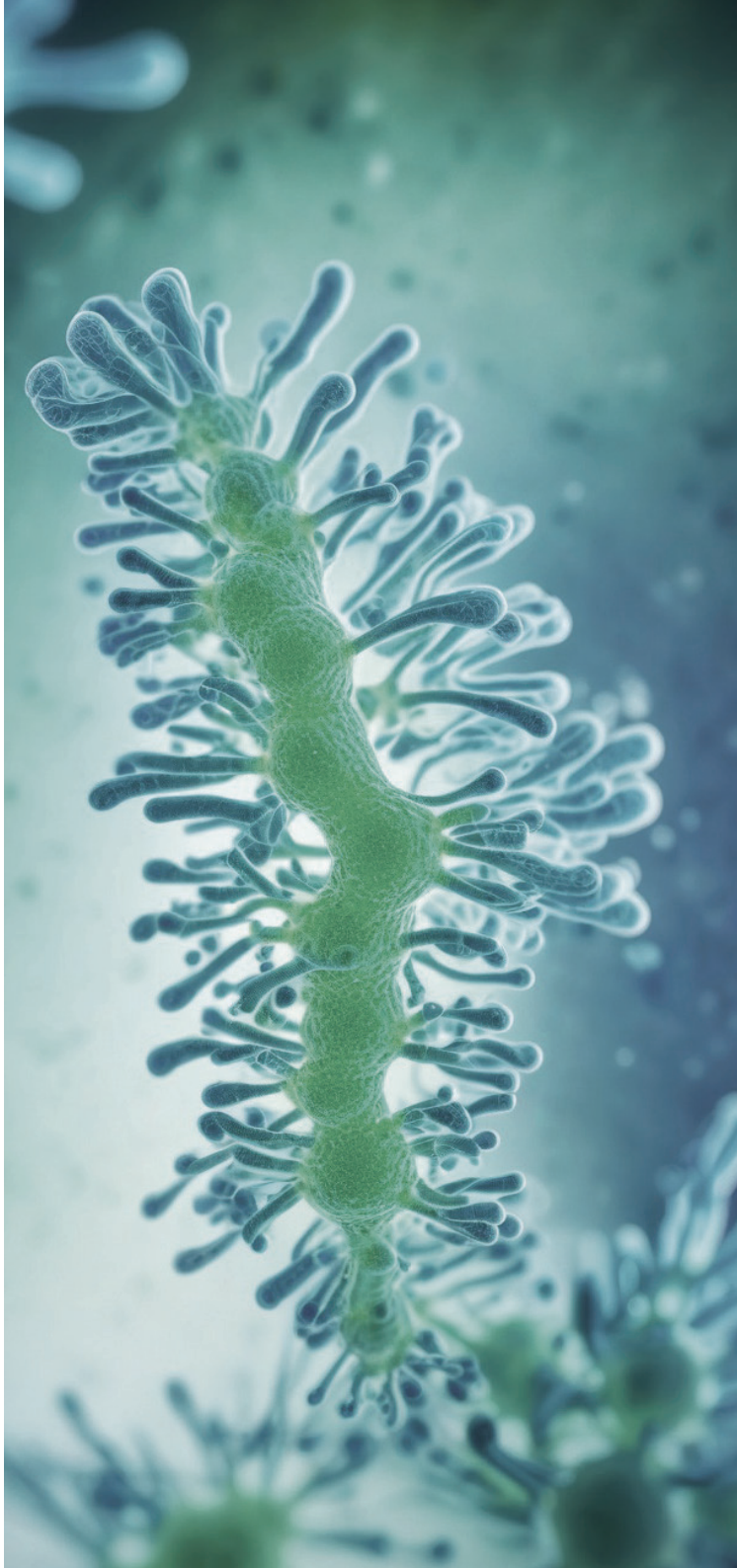
Service life projections are a problem for all materials as is noted in the US Department of Commerce publication 'Methodologies for Predicting the Service Lives of Coating Systems'.

The multiplicity of variables renders absolutist predictions virtually impossible and therefore a somewhat arbitrary approach has been taken where coatings which have successfully undergone ≥ 8,000 abrasion cycle oscillations are assessed as having a service life of ≥ 6 years. Coatings which have successfully undergone greater numbers of abrasion cycle oscillations are deemed to have a proportionally longer service life.

Safety Data Sheets (SDS)

SDS must be issued by continuously active antimicrobial coatings manufacturers.

These Safety Data Sheets (SDS) list information relating to occupational safety and health for the use of various substances and products.



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Making Informed Decisions

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The Cynical Specifier's Evaluation DECISION TREES

It can be difficult to evaluate the claims made by differing antimicrobial coating manufacturers. We discovered this fact ourselves when our R&D team of microbiologists and biochemists reviewed the competitive landscape at the beginning of this process.

As noted earlier this Guide was originally written for internal use and only later did we realise how important it could be for specifiers involved in construction projects and facilities management roles.

Despite the information contained in this Guide it can be difficult for a specifier to filter the various factors involved in selecting the most appropriate antimicrobial coatings for their project application.

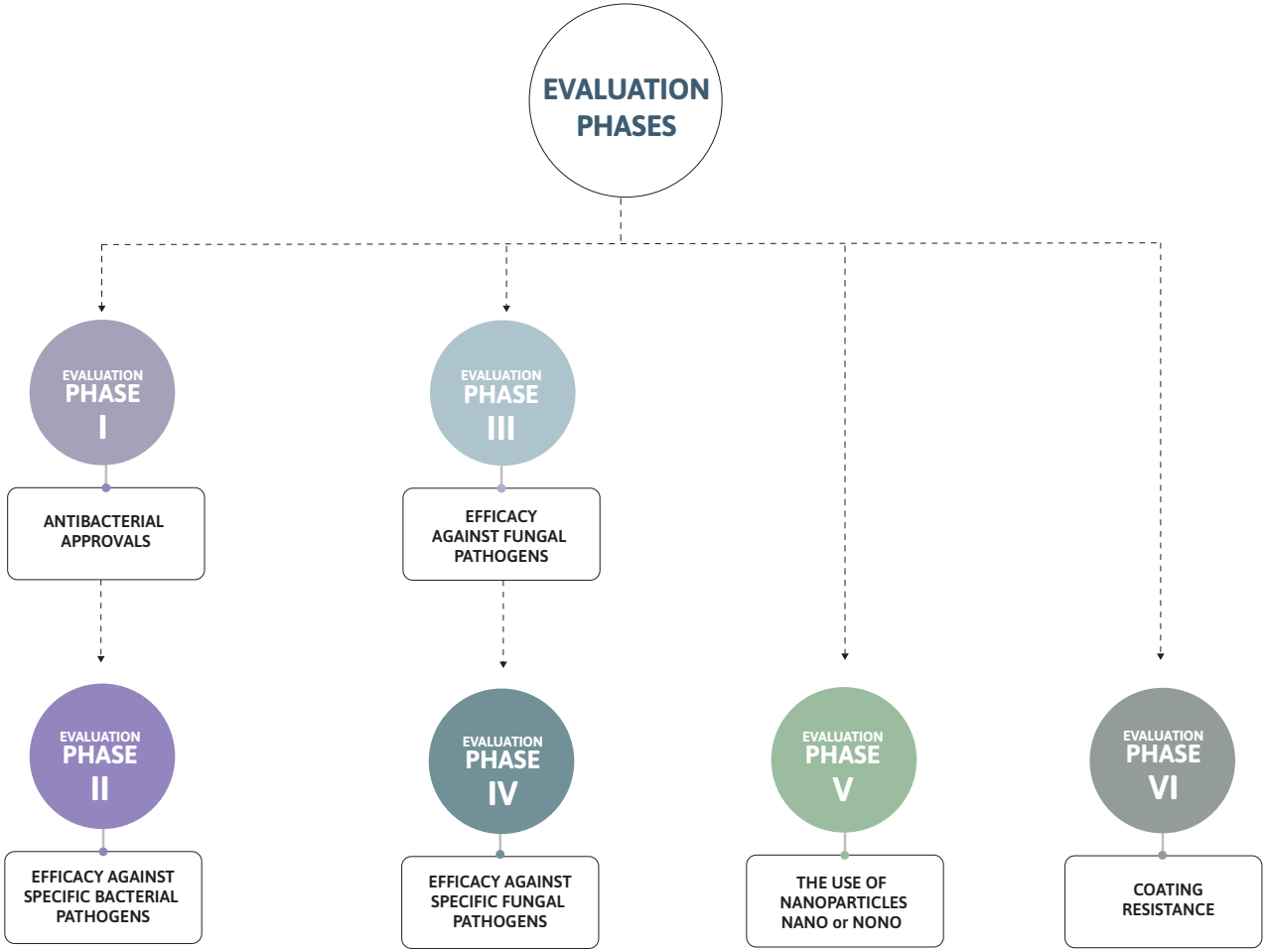
This is further complicated by the differing claims that antimicrobial coating suppliers often make and whether such claims withstand serious scrutiny or not.

Claims must be supported by rigorous, independent, third-party testing.

In addition, the threat, testing and technological landscape is continually changing, and it is against this background that a specifier must make evidence-based decisions as to the suitability of specific continuously active antimicrobial products for the intended application.

The following set of **DECISION TREES** have been designed to (hopefully) make the task somewhat simpler.

.... or perhaps not; but at least we tried .....



IMPORTANT NOTICE

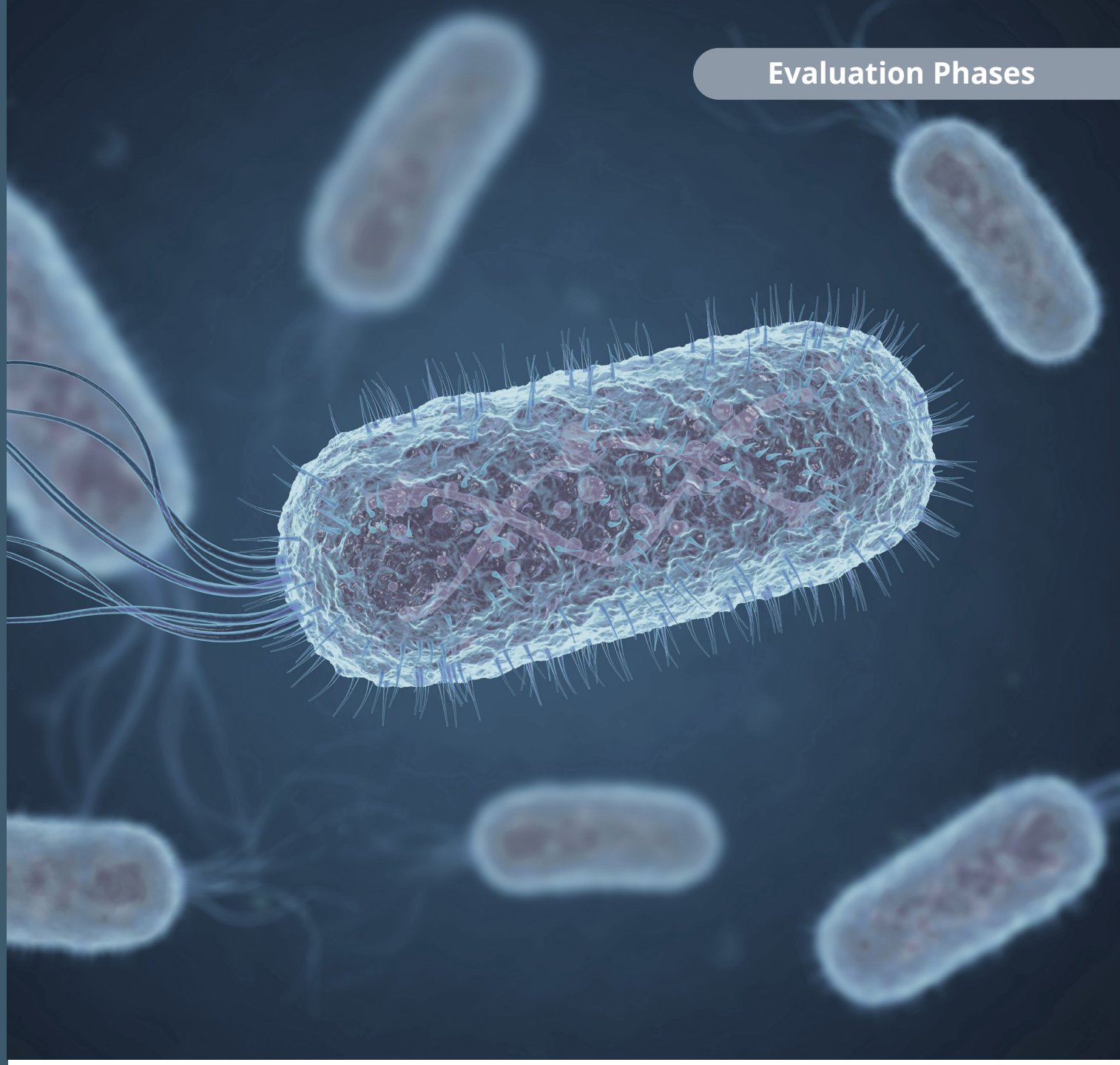
The evaluation process has been broken down into six distinct phases reviewing all of the pertinent aspects of a proposed antimicrobial coating and, in effect, asking coating manufacturers to prove the validity of their claims.

Before a coating can pass onto a follow-on phase it must fully satisfy that it has passed the current phase.

We recognise that this is a stop-start process, but it provides a logical, analytical process breaking down somewhat complex issues into manageable components. Thereby allowing stage-by stage conclusions to be reached.

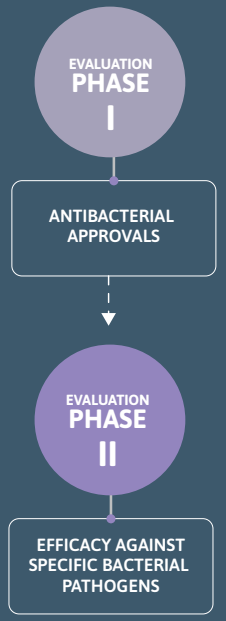
We found it incredibly useful, and we hope the Cynical Specifier finds it helpful.

Photo: Escherichia Coli (E. Coli)



Notes & Questions

Antibacterial Evaluation Phase I & Phase II



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Phase I Evaluation

Antibacterial Approvals

Decision Tree

A. DOES THE COATING INCORPORATE A BIOCIDE?

B. IS APPROVAL OF THE BIOCIDE BY US EPA OR EU BPR A REQUIREMENT TO APPROVE THE COATING?

C. IS US EPA BIOCIDAL APPROVAL A REQUIREMENT?

D. DOES THE MANUFACTURER'S DOCUMENTATION CONFIRM THAT THE BIOCIDE IS US EPA APPROVED FOR USE IN THE PROPOPSED APPLICATION?

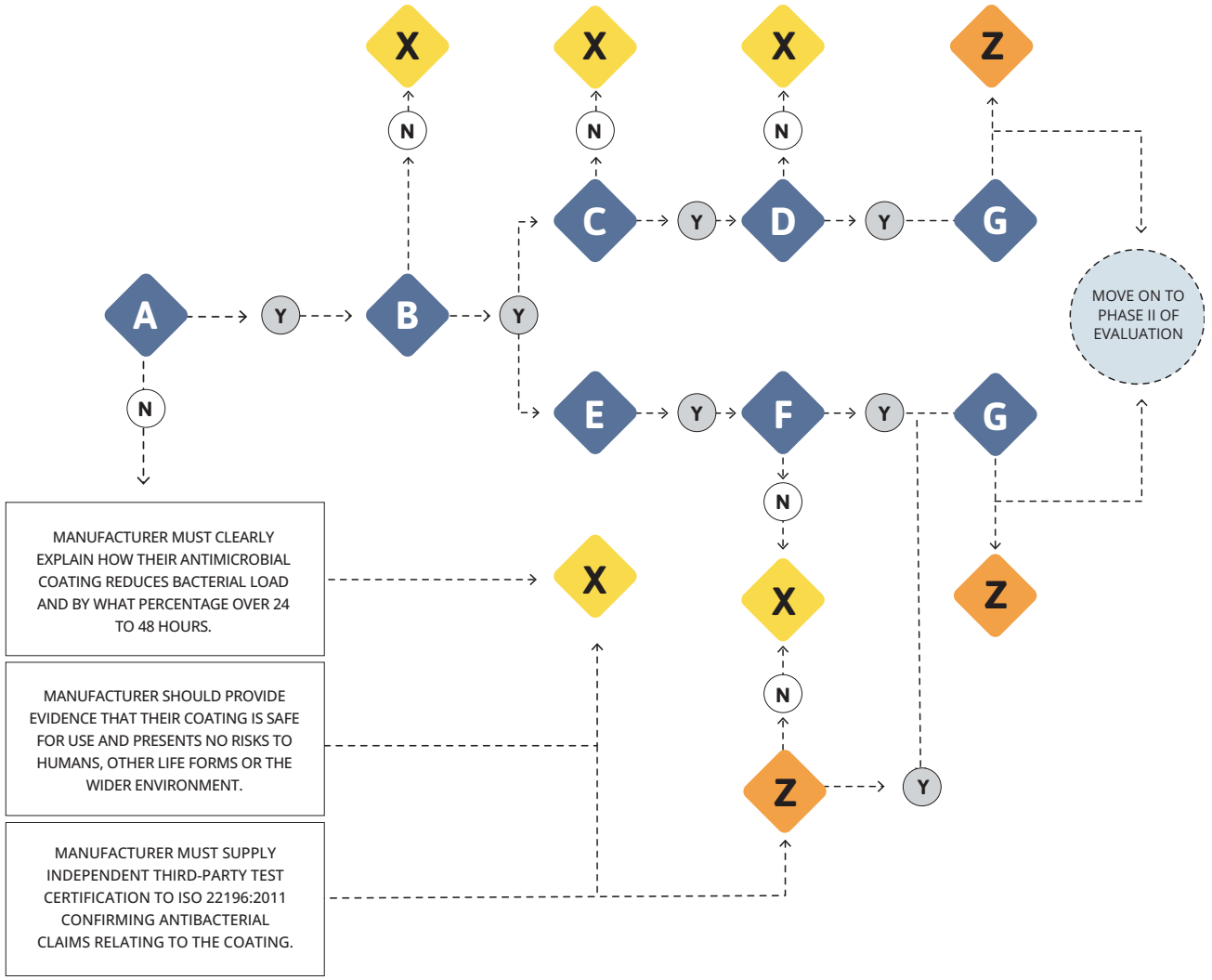
E. IS EU BPR BIOCIDAL APPROVAL A REQUIREMENT?

F. DOES THE MANUFACTURER'S DOCUMENTATION CONFIRM THAT THE BIOCIDE IS EU BPR APPROVED FOR USE IN THE PROPOPSED APPLICATION?

G. HAS THE COATING BEEN TESTED TO ISO 22196: 2011?

X. THE CYNICAL SPECIFIER SHOULD CONSIDER REJECTING THE COATING OR SEEK WRITTEN INSTRUCTIONS FROM THE CLIENT CONFIRMING APPROVAL

Z. REVIEW ISO 22196 TEST RESULTS



ISO 22196 Test Limitations

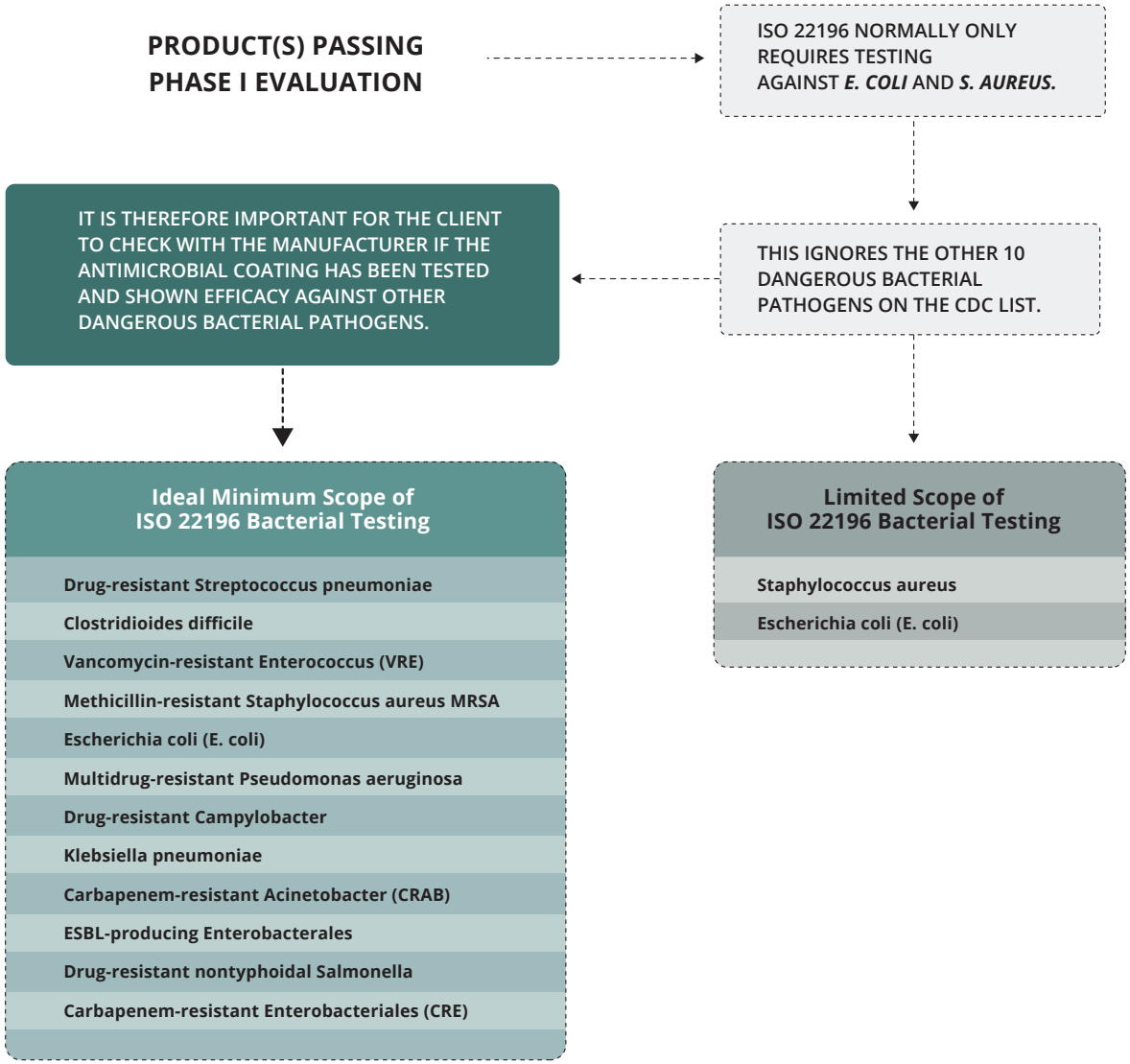
ISO 22196:2021
'Measurement of antibacterial activity on plastics and other non-porous surfaces' is the current international benchmark for testing the efficacy of continuously active antibacterial coatings.

One of ISO 22196's limitations is that only two bacterial pathogens are tested: gram-positive S. aureus and gram-negative *E. coli.* The problem with this approach is that some antibacterial coating manufacturers then make the assumption that a coating that shows efficacy against *S. aureus* and *E. coli* will be equally effective against the whole range of dangerous bacterial pathogens. More a leap of faith than rational science.

Showing efficacy against *E. coli* and *S. aureus* does not necessarily mean that an antimicrobial coating will be equally effective against other bacterial pathogens.

Other bacterial pathogens may have different susceptibilities to antimicrobial agents. Therefore, it is important to evaluate the efficacy of antimicrobial coatings against the range of most dangerous bacterial pathogens

Efficacy Against Specific Bacterial Pathogens – Limited ISO 22196 Scope vs Ideal Test Scope



Efficacy Against Specific Bacterial Pathogens:

The TICK-BOX Summary

- Coatings claiming antibacterial efficacy should be tested by an independent third-party laboratory.
- Testing should be conducted against an array of the most dangerous bacterial pathogens listed in Table 1.
- ISO 22196:2021 'Measurement of antibacterial activity on plastics and other non-porous surfaces' is the current international benchmark for testing the efficacy of continuously active antibacterial coatings.
- **norigin has conducted independent ISO 22196 laboratory testing to confirm the efficacy of its coatings against all the bacterial pathogens shown in *table 1.***

○ These circles are provided so a specifier can tick off whether to approve coatings incorporating nanoparticles or not

table 1

Ideal Scope of ISO 22196 Bacterial Testing	
Drug-resistant Streptococcus pneumoniae	○
Clostridioides difficile	○
Vancomycin-resistant Enterococcus (VRE)	○
Methicillin-resistant Staphylococcus aureus MRSA	○
Escherichia coli (E. coli)	○
Multidrug-resistant Pseudomonas aeruginosa	○
Drug-resistant Campylobacter	○
Klebsiella pneumoniae	○
Carbapenem-resistant Acinetobacter (CRAB)	○
ESBL-producing Enterobacterales	○
Drug-resistant nontyphoidal Salmonella	○
Carbapenem-resistant Enterobacteriales (CRE)	○

Phase II Evaluation

Norigin uses the absolute minimum amount of biocompatible biocides in their coatings to achieve maximum effect with the least possible impact. Excessive use of biocides will have a detrimental effect upon people producing our coatings, those applying our coatings, those living and working in projects where our coatings have been applied and throughout the wider environment.

Two summary tables are shown for our antibacterial coating products namely the AVERT-ALL, AVERT-AB, DETER-ALL and DETER-AB. These tables have been extracted directly from third-party independent laboratory test reporting.

By increasing biocidal content, we can increase the efficacy of out coatings but have deliberately chosen not to do so.

AVERT-ALL TEST RESULTS

TEST STANDARD	PATHOGEN TYPE	REP. TYPE	PATHOGEN	REDUCTION	TOTAL ELIMINATION*	
				24 HOURS	HOURS	MINUTES
ISO 22196	BACTERIA		Drug-resistant Streptococcus pneumoniae	≥99.81%	24	3
			Clostridioides difficile	≥99.44%	24	8
			Vancomycin-resistant Enterococcus faecium (VRE)	≥99.90%	24	1
			Methicillin-resistant Staphylococcus aureus MRSA	≥99.87%	24	2
			Escherichia coli (E. coli)	≥99.89%	24	2
			Multidrug-resistant Pseudomonas aeruginosa	≥99.89%	24	1
			Drug-resistant Campylobacter jejuni	99.82%	24	17
			Klebsiella pneumoniae	≥99.06%	24	14
			Carbapenem-resistant Acinetobacter (CRAB)	≥99.88%	24	2
			ESBL-producing Enterobacterales	≥99.17%	24	12
			Drug-resistant nontyphoidal Salmonella	≥99.89%	24	1
			Carbapenem-resistant Enterobacteriales (CRE)	≥99.44%	24	8

By Extrapolation

DETER-ALL TEST RESULTS

TEST STANDARD	PATHOGEN TYPE	REP. TYPE	PATHOGEN	REDUCTION	TOTAL ELIMINATION*	
				24 HOURS	HOURS	MINUTES
ISO 22196	BACTERIA		Drug-resistant Streptococcus pneumoniae	≥99.44%	24	8
			Clostridioides difficile	≥99.26%	24	11
			Vancomycin-resistant Enterococcus faecium (VRE)	≥99.90%	24	1
			Methicillin-resistant Staphylococcus aureus MRSA	99.36%	24	9
			Escherichia coli (E. coli)	≥99.89%	24	1
			Multidrug-resistant Pseudomonas aeruginosa	≥99.89%	24	1
			Drug-resistant Campylobacter jejuni	99.00%	24	14
			Klebsiella pneumoniae	≥99.40%	24	9
			Carbapenem-resistant Acinetobacter (CRAB)	≥99.88%	24	2
			ESBL-producing Enterobacterales	≥99.28%	24	10
			Drug-resistant nontyphoidal Salmonella	≥99.89%	24	1
			Carbapenem-resistant Enterobacteriales (CRE)	≥99.89%	24	1

By Extrapolation

Notes & Questions

Antifungal Evaluation Phase III & Phase IV

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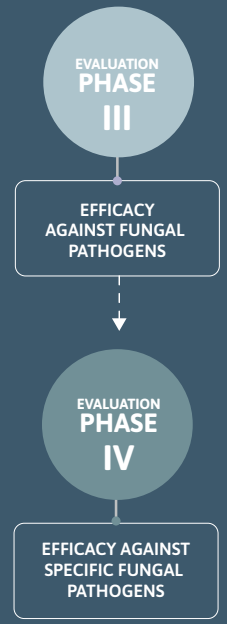

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Antifungal Testing & Approvals

IMPORTANT NOTICE

Moulds, fungi, and yeasts are all types of micro-organisms that belong to the kingdom Fungi. While they share many similarities, there are some key differences between these three groups of fungi.

Moulds are a type of fungi that typically grow in the form of multicellular filaments called hyphae and produce spores. Moulds reproduce by producing spores that are typically dispersed through the air.

Yeasts (unlike moulds) are single-celled fungi that reproduce asexually by budding.

Spore-forming Fungal Testing

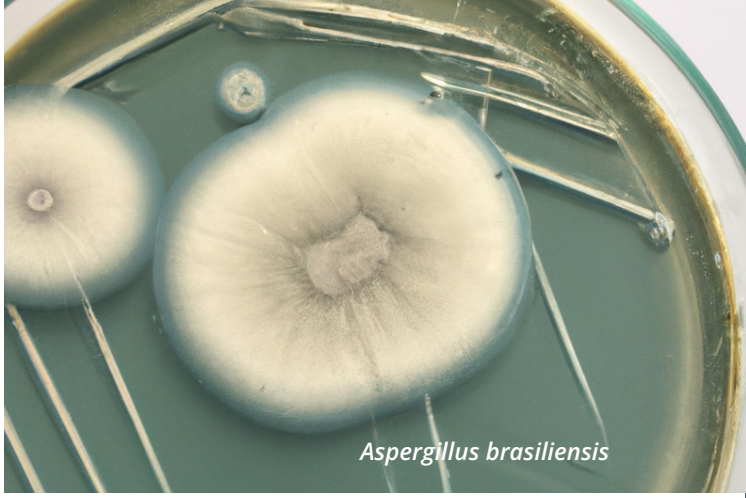
ASTM G21:2021 'Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi is used to determine the resistance of continuously active antifungal coatings. This test is most appropriate for use when the fungi in question are spore-forming.

Fungi such as ***Aspergillus brasiliensis*** spread out over the plate (as shown) which gives it the opportunity to 'crawl' over a sample surface. This makes ASTM G21 testing applicable as it would not be possible to count individual colonies using a test such as ISO 22196.

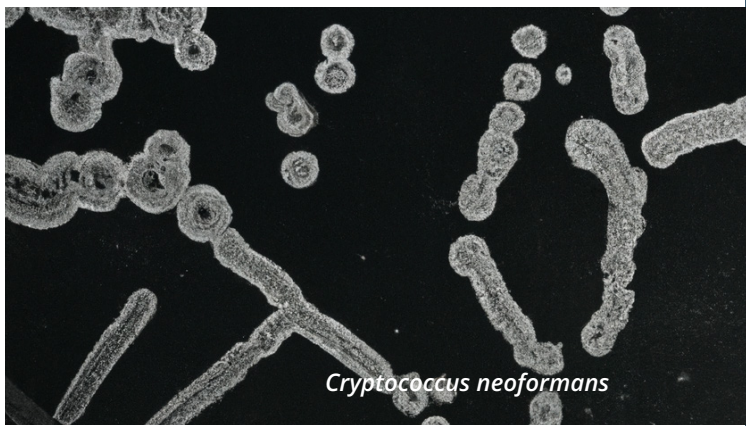
Non-spore Forming Fungal Testing

To be tested using ASTM G21, fungi needs to be spore forming so that they grow/creep over the sample surface. ***Candida***, a yeast, will not do this, but does form countable colonies which make it more suited to ISO 22196 testing.

Similarly, ***Cryptococcus neoformans*** forms distinct *mucoidal colonies* on agar,. As the colonies are separate, they can be counted, and as quantitative methods are generally better for reproducibility and accuracy ISO 22196 is more appropriate.


Aspergillus brasiliensis


Candida auris


Cryptococcus neoformans

Antifungal Approvals

Decision Tree

A. DOES THE COATING INCORPORATE A BIOCIDE?

B. IS APPROVAL OF THE BIOCIDE BY US EPA OR EU BPR A REQUIREMENT TO APPROVE THE COATING?

C. IS US EPA BIOCIDAL APPROVAL A REQUIREMENT?

D. DOES THE MANUFACTURER'S DOCUMENTATION CONFIRM THAT THE BIOCIDE IS US EPA APPROVED FOR USE IN THE PROPOSED APPLICATION?

E. IS EU BPR BIOCIDAL APPROVAL A REQUIREMENT?

F. DOES THE MANUFACTURER'S DOCUMENTATION CONFIRM THAT THE BIOCIDE IS EU BPR APPROVED FOR USE IN THE PROPOSED APPLICATION

G. AS THE COATING BEEN TESTED TO ASTM G21 AND/OR ISO22019 2011?

X. THE CYNICAL SPECIFIER SHOULD CONSIDER REJECTING THE COATING OR SEEK WRITTEN INSTRUCTIONS FROM THE CLIENT CONFIRMING APPROVAL

Z. REVIEW ASTM G21 & ISO 22196 TEST RESULTS

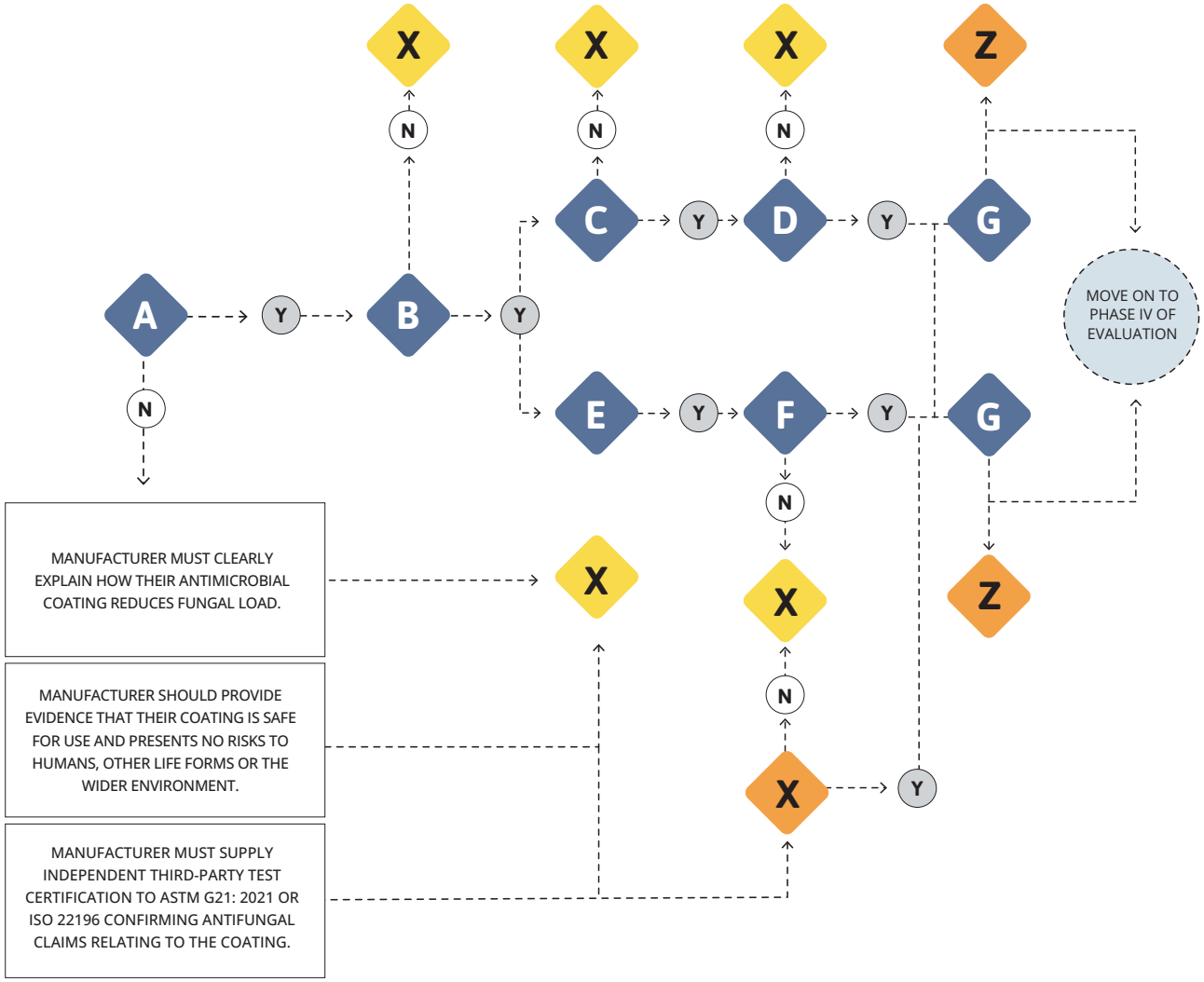


table 2

TEST STANDARD	FUNGAL TYPE	FUNGAL PATHOGEN	
ISO 22196	NON-SPORE FORMING FUNGI	Candida albicans	○
		Candida auris	○
		Cryptococcus neoformans	○
		Candida glabrata	○
		Candida tropicalis	○
		Candida parapsilosis	○
ASTM G21	SPORE FORMING FUNGI	Aspergillus brasiliensis	○
		Penicillium chrysogenum	○

Efficacy Against Specific Fungal Pathogens:

The TICK-BOX Summary

- Coatings claiming antifungal efficacy should be tested by an independent third-party laboratory.
- Testing should be conducted against an array of the most dangerous fungal pathogens listed in Table 2.
- ASTM G21:2021 'Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi' should be used to test the efficacy of the coating against spore-forming fungal pathogens.
- ISO 22196:2021 'Measurement of antibacterial activity on plastics and other non-porous surfaces' should be used to test the efficacy of the coating against non-spore forming fungal pathogens.

○ These circles have been provided so that a specifier can record whether a particular antifungal coating has been tested against these most dangerous fungal pathogens.'

- **norigin has conducted independent ASTM G21 laboratory testing to confirm the efficacy of its coatings against all the spore-forming fungal pathogens listed in *table 2.***
- **norigin has conducted independent ISO 22196 laboratory testing to confirm the efficacy of its coatings against all the non-spore forming fungal pathogens listed in *table 2.***

Norigin uses the absolute minimum amount of biocompatible biocides in their coatings to achieve maximum effect with the least possible impact. Excessive use of biocides will have a detrimental effect upon people producing our coatings, those applying our coatings, those living and working in projects where our coatings have been applied and throughout the wider environment.

Two summary tables are shown for our antifungal coating products namely the AVERT-AF and DETER-AF. These tables have been extracted directly from third-party independent laboratory test reporting.

By increasing biocidal content, we can increase the efficacy of out coatings but have deliberately chosen not to do so.

AVERT-AF TEST RESULTS

TEST STANDARD	PATHOGEN TYPE	REP. TYPE	PATHOGEN	REDUCTION 24 HOURS	TOTAL ELIMINATION* HOURS	MINUTES
ISO 22196	FUNGI	NON - SPORE FORMING	Candida albicans	≥99.87%	24	2
			Candida auris	99.78%	24	3
			Cryptococcus neoformans	99.03%	24	14
			Candida glabrata	99.20%	24	11
			Candida tropicalis	99.74%	24	4
			Candida parapsilosis	≥99.72%	24	4
ASTM G21	FUNGI	SPORE FORMING	Aspergillus brasiliensis	0	Growth Rating After 28 Days	
			Penicillium chrysogenum	1		

*by extrapolation

ASTM G21 GROWTH RATING
0 = NO GROWTH
1 = TRACE GROWTH (≤ 10% COVERAGE)
2 = LIGHT GROWTH (> 10% ≤ 30% COVERAGE)
3 = MODERATE GROWTH (> 30% ≤ 60% COVERAGE)
4 = HEAVY GROWTH (>60% COVERAGE)

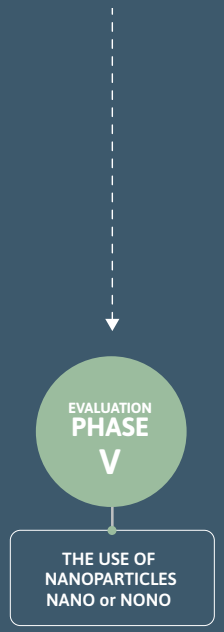
DETER-AF TEST RESULTS

TEST STANDARD	PATHOGEN TYPE	REP. TYPE	PATHOGEN	REDUCTION 24 HOURS	TOTAL ELIMINATION* HOURS	MINUTES
ISO 22196	FUNGI	NON - SPORE FORMING	Candida albicans	≥99.87%	24	2
			Candida auris	99.78%	24	3
			Cryptococcus neoformans	99.84%	24	2
			Candida glabrata	99.85%	24	2
			Candida tropicalis	≥99.84%	24	2
			Candida parapsilosis	≥99.72%	24	4
ASTM G21	FUNGI	SPORE FORMING	Aspergillus brasiliensis	0	Growth Rating After 28 Days	
			Penicillium chrysogenum	0		

*by extrapolation

ASTM G21 GROWTH RATING
0 = NO GROWTH
1 = TRACE GROWTH (≤ 10% COVERAGE)
2 = LIGHT GROWTH (> 10% ≤ 30% COVERAGE)
3 = MODERATE GROWTH (> 30% ≤ 60% COVERAGE)
4 = HEAVY GROWTH (>60% COVERAGE)

The use of Nanoparticles Evaluation NANO or NONO **Phase V**



Nanoparticles: NANO or NONO

IMPORTANT NOTICE

Incorporating silver, copper and zinc nanoparticles into coatings can be an effective way to provide additional protection against microbial growth.

However, it's important to weigh the benefits against the potential risks and to take appropriate precautions to ensure the safe use, handling and disposal of these materials.

The increasing trend of using nanoparticles in antimicrobial coatings should be of great concern. The fact that nanoparticles of silver and copper are gaining increasing use in antimicrobial coatings relates directly to their efficacy in killing dangerous microbial pathogens.

However, everything has a cost.

○ NANO ○ NONO

○ These circles are provided so a specifier can tick off whether to approve coatings incorporating nanoparticles or not.

The Toxic Cost

Nanomaterials present that cost in the form of:

- Toxicity to living organisms including humans.
- Nanoparticles can accumulate in various organs and tissues, including the liver, kidneys, and brain. Prolonged exposure or accumulation of nanoparticles may lead to adverse health effects.
- Environmental exposure.
- Development of antibiotic and antifungal resistance.

The increased toxicity of nanoparticles

The increased toxicity of nanoparticles compared to their microparticle counterparts is primarily attributed to their increased surface area. When materials are reduced to the nanoscale, they exhibit a larger surface area-to-volume ratio.

The increased surface area of nanoparticles results in more atoms or molecules being exposed, which can enhance their reactivity and toxicity.

In the case of silver and copper nanoparticles, increased reactivity can lead to the generation of reactive oxygen species (ROS) and other mechanisms of cellular damage. ROS can induce oxidative stress, inflammation, and damage to cellular components, potentially causing adverse effects in biological systems.

Moreover, the small size of nanoparticles also enables them to penetrate biological barriers more readily, including the respiratory system.

Nanoparticles in the respirable size range can reach the deep regions of the lungs, such as the alveoli, where gas exchange occurs. This direct contact with sensitive lung tissues can lead to localized toxicity and inflammation.

Nanoparticle Size

Nanoparticles are usually defined as particles of matter that are between 1 and 100 nanometres in diameter.

The limit on nanoparticle size when considering potential dangers to respiration is generally associated with particles in the respirable range. Respirable particles are typically defined as those with a diameter of 10μm or smaller.

Small particles in the nanoscale range, can exhibit enhanced mobility and may penetrate deeper into the respiratory system, potentially reaching sensitive regions and causing adverse effects.

Silver (AgNP) & Copper (CuNP) Nanoparticles

Both silver and copper nanoparticles have been widely used in various applications due to their antibacterial and antifungal properties.

However, there are potential dangers associated with the use of nano silver and copper in antibacterial or antifungal coatings.

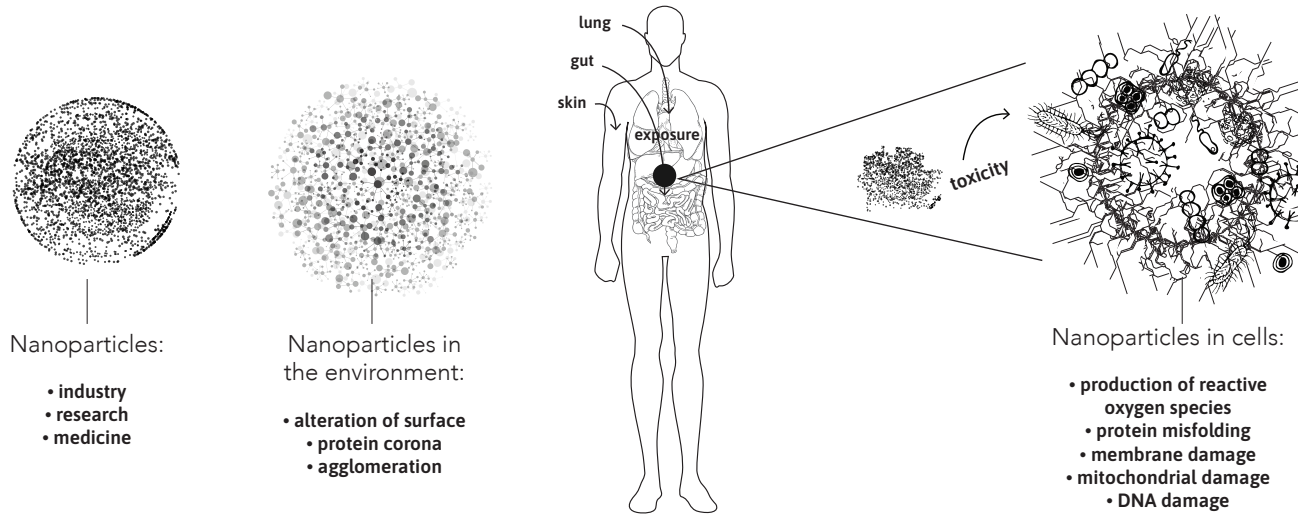
Both silver and copper nanoparticles can release ions, which can be toxic to living organisms, including humans. These ions can interact with biological systems and disrupt cellular processes. The small size of nanoparticles allows them to penetrate cells and tissues, potentially causing damage.

The high surface area and reactivity of silver and copper nanoparticles can result in the generation of reactive oxygen species (ROS). ROS can induce oxidative stress and cause damage to cells, DNA, proteins, and lipids, leading to cellular dysfunction and potential health problems. Reactive oxygen species (ROS) are chemically reactive molecules that contain oxygen and have high reactivity due to the presence of unpaired electrons.

ROS can cause oxidation of lipids in cell membranes, leading to membrane disruption. They can also oxidize amino acids in proteins, affecting their structure and function. Additionally, ROS can cause DNA damage, including DNA strand breaks and modifications to bases, potentially leading to mutations and genetic instability.

Nanoparticle characterisation, pathways and toxicological impact:

Nanoparticles in the body and possible entry routes:



NANOPARTICLES

Decision Tree

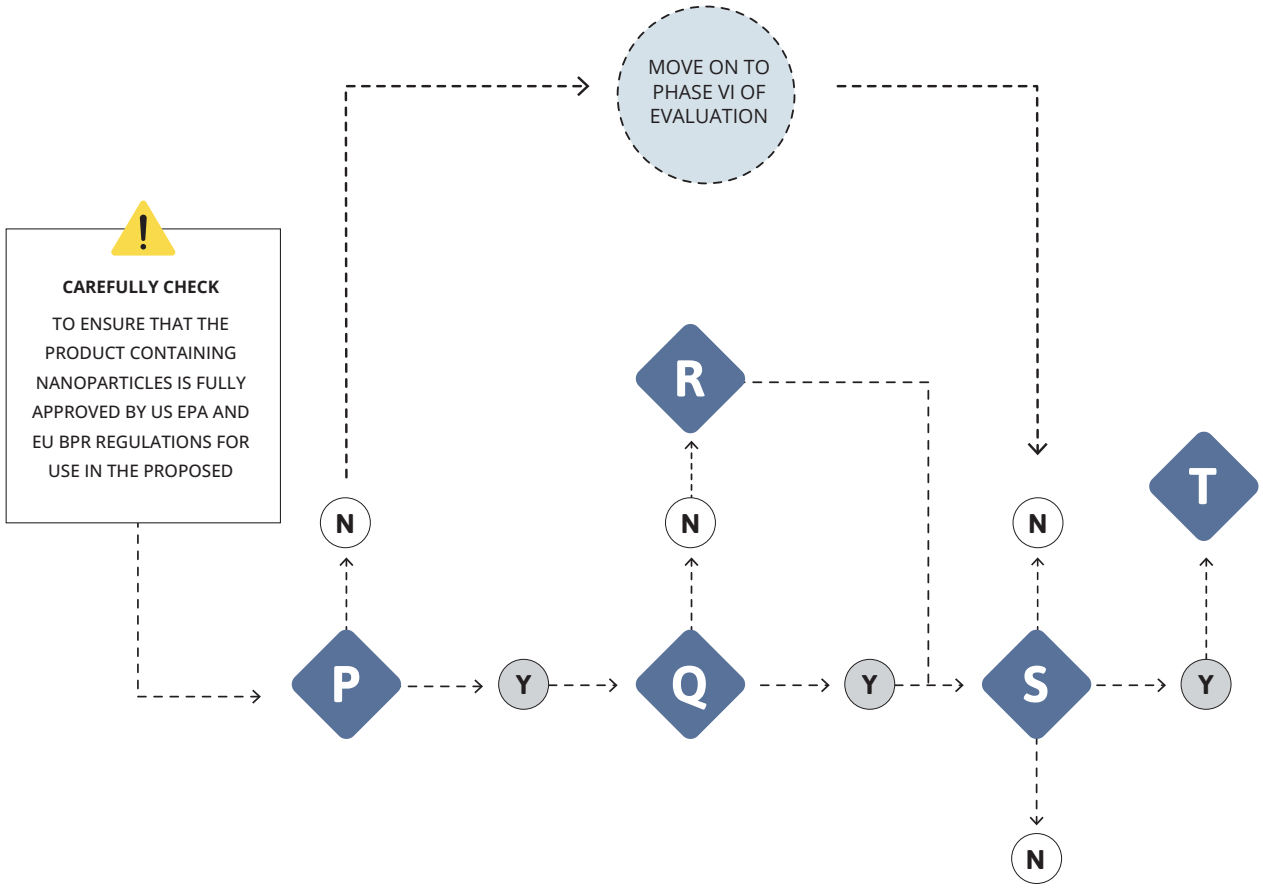
P. DOES THE COATING INCORPORATE NANOPARTICLES SUCH AS COPPER, SILVER OR ZINC AS AN ANTIMICROBIAL AGENT?

Q. DOES THE COATING MANUFACTURER DECLARE THE TYPE AND SIZE OF NANOPARTICLES USED IN THEIR COATINGS?

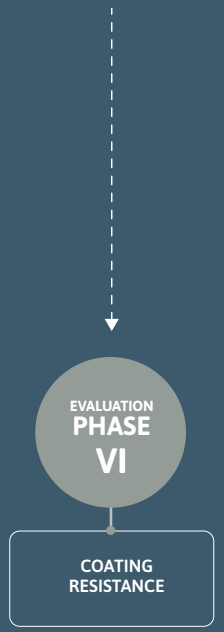
R. CONFIRMATION OF NANOPARTICLE SIZE SHOULD BE SOUGHT FROM THE MANUFACTURER.

S. DO THE NANOPARTICLES HAVE AT LEAST ONE DIMENSION <100nm?

T. THE CYNICAL SPECIFIER SHOULD CONSIDER REJECTING THE COATING OR SEEK WRITTEN INSTRUCTIONS FROM THE CLIENT CONFIRMING APPROVAL



Coating Resistance Evaluation **Phase VI**



Coating Resistance

IMPORTANT NOTICE

Abrasion Resistance & Service Life Expectations

Service life projections are a problem for all coating materials as is noted in the US Department of Commerce publication 'Methodologies for Predicting the Service Lives of Coating Systems'.

A multiplicity of variables renders absolutist predictions virtually impossible and therefore a somewhat arbitrary approach has been taken where coatings which have successfully undergone ≥ 8,000 abrasion cycle oscillations are assessed as having a service life of ≥ 6 years.

Coatings which have successfully undergone greater numbers of abrasion cycle oscillations are deemed to have a proportionally longer service life.

IMPORTANT NOTICE

Chemical Resistance: General

Chemical resistance is of paramount importance in coatings as it ensures long-lasting durability and protection against various corrosive substances.

In commercial, residential and industrial settings, coatings are constantly exposed to a multitude of chemicals, (disinfecting and cleaning agents, solvents, acids, and alkalis).

Without adequate chemical resistance, these substances can cause coatings to deteriorate, leading to staining, discoloration, or even structural damage.

Chemical-resistant coatings form a robust barrier that shields the underlying surface from chemical attack.

All coatings manufacturers should provide information relating to the resistance of their products to such chemical attack.

IMPORTANT NOTICE

Chemical Resistance: HPV

Hydrogen peroxide vapour is a powerful oxidizing agent which is frequently employed as a sterilizing agent in medical facilities, laboratories, and cleanrooms to eliminate harmful pathogens and contaminants.

The chemical resistance of any coating used in such environs is essential in ensuring the long-term durability and integrity of surfaces.

Unlike ordinary coatings that may degrade or discolour when exposed to hydrogen peroxide vapor, HPV-resistant coatings maintain their physical and aesthetic properties. This resilience not only ensures a lasting and visually pleasing appearance but also guarantees a consistent barrier against potential leaks or spills of the sterilizing agent.

Antimicrobial coatings manufacturers should be able to provide third-party test evidence to show that their coatings can resist attack from HPV.

Phase VI Evaluation

COATING RESISTANCE

Decision Tree

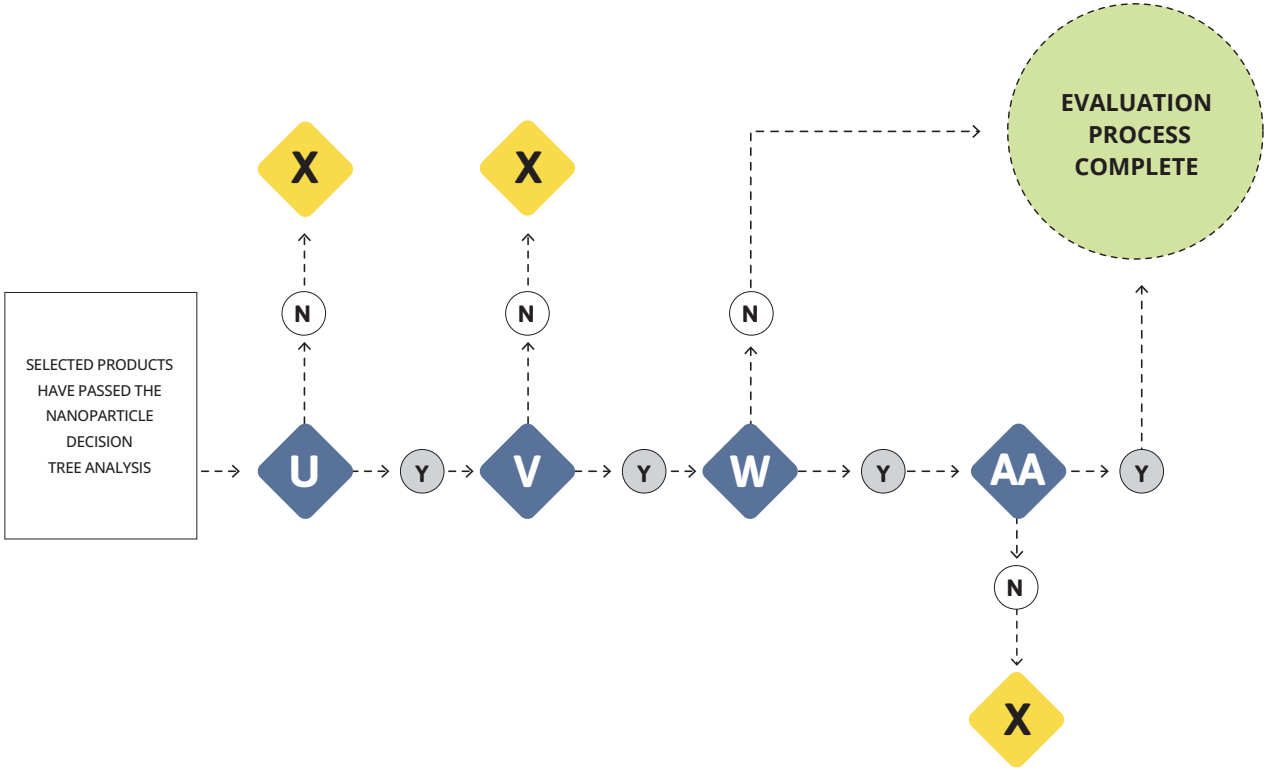
U. HAS THE MANUFACTURER INDICATED THEIR COATINGS RESISTANCE TO IMPACT & ABRASION?

V. HAS THE MANUFACTURER INDICATED THAT THEIR COATING IS RESISTANT TO DISINFECTANTS AND CLEANING AGENTS, SOLVENTS, ACIDS & ALKALIS?

W. ARE HYDROGEN PEROXIDE VAPOUR (HPV) DISINFECTING ROUTINES LIKELY TO BE USED WITHIN THE AREA OF COATING APPLICATION?

AA. HAS THE COATING MANUFACTURER PROVIDED THIRD-PARTY, INDEPENDENT TEST CERTIFICATION THAT THE PROPOSED COATING IS RESISTANT TO HPV?

X. THE CYNICAL SPECIFIER SHOULD CONSIDER REJECTING THE COATING OR SEEK WRITTEN INSTRUCTIONS FROM THE CLIENT CONFIRMING APPROVAL



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