Response of rubber floor coverings to disinfectants registered on the EPA List-N

Stephan FREIBERG Ph.D., R&D Project Leader

Victor CALDAS Ph.D., Vice-President of R&D / Technical Services

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Preface

Jane M. Rohde, AIA, FIIDA, ASID, ACHA, CHID, LEED AP BD+C, GGA-EB
Principal of JSR Associates, Inc.

Evidence-based decision making is key in supporting the health, safety and welfare of building occupants. Everyday decisions made by architects and interior designers include the opportunity to use science to make informed decisions about specifications, material use and appropriate product selection based on the required performance characteristics for a specific application. Prior to the pandemic, it has been the healthcare design segment that predominantly focused on high-touch surface cleaning and disinfection, the importance of hand washing to reduce the spread of infection and completion of product specifications that comply with minimum performance testing.

However, with the spread of coronavirus (SARS-CoV-2), the virus responsible for the COVID-19 disease, the focus on durability and cleaning has broadened to encompass not only healthcare environments, but all types of settings. SARS-CoV-2 is considered a healthcare-acquired infection (HAI), which is an infection patients get while receiving care for another condition, that may occur in any healthcare facility (hospital, ambulatory surgical centers and long-term care facilities). It is also a community-acquired infection (CAI), which arises within the general population and an individual contracts the infection while being out in the community at-large. Because SARS-CoV-2 is both a HAI and CAI, guidance has been provided by the Centers for Disease Control and Prevention (CDC) on cleaning and disinfecting environmental surfaces in all community spaces, such as schools, universities, retail settings, hospitality accommodations and workplaces.

In evaluating products, there are two parts of the equation: one is the efficacy of the disinfecting agent on a surface and the other is the impact of the chemical on a surface or material to verify it will not prematurely fail or degrade because of the application of a cleaning or disinfecting chemical. Efficacy is regulated through the United States Environmental Protection Agency (EPA) and disinfectants effective against coronavirus are provided on EPA's List-N. The other component requires manufacturers to evaluate the impact of these chemistries on their product through minimum performance testing. American Biltrite has completed testing by comparing their products with others in the marketplace to evaluate the potential impact of using disinfectant chemicals on their resilient flooring products. The transparent provision of their testing results provides the

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design community with the evidence to make an informed specification decision based upon science. The two components a designer needs to know are the cleaning and disinfecting chemicals used by their client and the chemical impacts on the product, material or surface to reduce the potential risk of a premature product failure. In taking this leadership initiative within the resilient flooring industry, American Biltrite is providing the framework needed for effective decision-making by a healthcare architect and interior designer. It is my hope to see this same approach used by other interior product categories as we move forward through and beyond the COVID-19 pandemic.

[1] Definition of health care associated infections: U.S. Department of Health and Human Services (HHS): Office of Disease Prevention and Health Promotion (ODPHP): available on line at: https://health.gov/our-work/health-care-quality/health-care-associated-infections

[2] Definition of community acquired infection (CAI): Merriam-Webster: available online at: https://www.merriam-webster.com/dictionary/community-acquired

[3] Surface contamination is an indirect transmission method of acquiring the virus, as it is on a surface, touched by the hand, and then if the face, mouth, nose, or eyes are subsequently touched can spread the infection.

Preface Author's Background

Jane Rohde is the founder and principal of JSR Associates, located in Catonsville, Maryland. JSR Associates celebrated 24 years of consulting services in 2020. Ms. Rhode champions a global cultural shift toward de-institutionalizing senior living and healthcare facilities through person-centered principles, research and advocacy, and design of the built environment. In 2015, she received the first Changemaker Award for Environments for Aging from The Center for Health Design and in 2018, she received the ASID Design for Humanity Award. Ms. Rohde has also been recognized as an Honorary Alumni of Clemson University's Architecture + Health program, and has been honored as one of the top ten Women in Design for leadership in healthcare and senior living design. For more information on COVID-19 resources, please go to www.jsrassociates.net.

Executive Summary

In the midst of the COVID-19 outbreak, the Centers for Disease Control and Prevention (CDC) has provided up-to-date guidelines for cleaning and disinfection,[1] while also recommending the use of disinfectants registered on the United States Environmental Protection Agency (EPA) List-N.[1, 2] Such guidelines and disinfectants have been used regularly in healthcare environments. In the context of the pandemic, however, the CDC has expanded its guidance and now recommends the application of cleaning and disinfection protocols in a broad range of other environments to reduce virus spread through community transmission. Rubber and resilient floorings are the floorings of choice in healthcare environments since they are easy to both clean and disinfect.

The goals of this white paper, presented by the American Biltrite research and development department, are to:

- Validate that ABPURE® Nfuse® was not negatively impacted by the disinfection chemicals recommended by the EPA List-N.

- Evaluate the resiliency of ABPURE Nfuse with increasing exposure to disinfectants

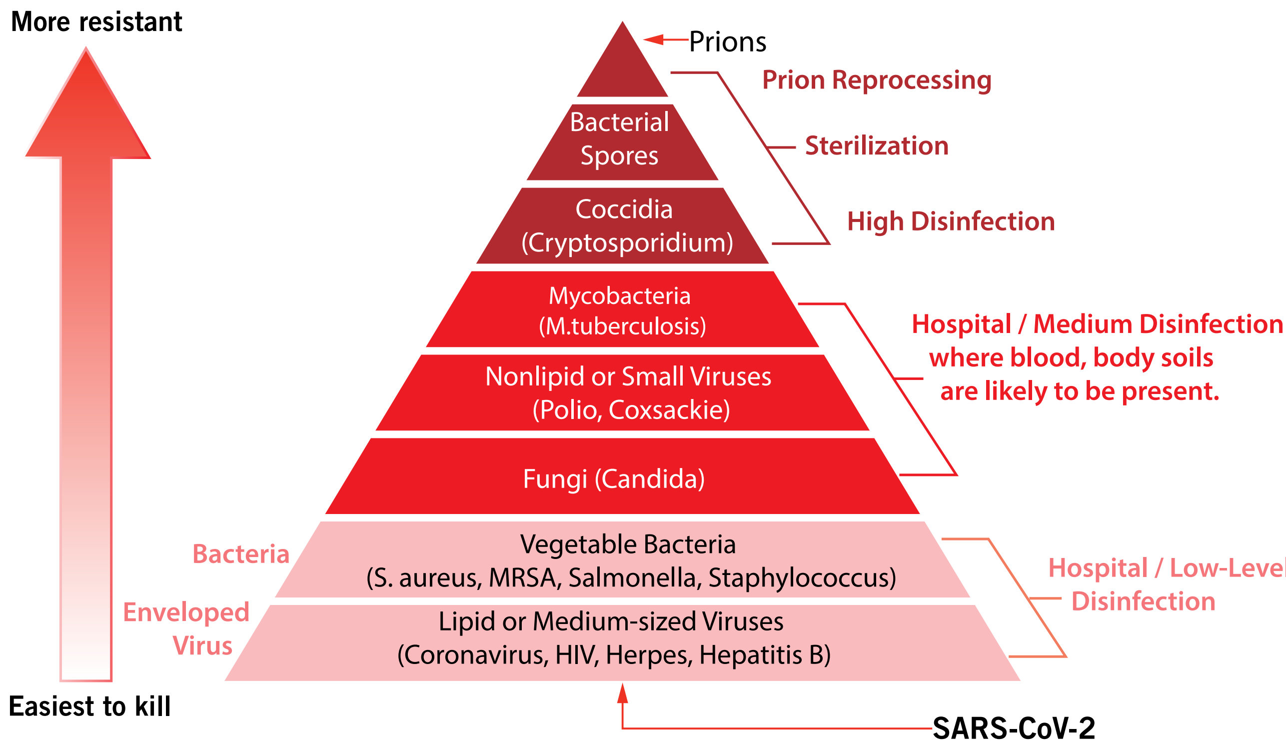
Across the products studied, ABPURE Nfuse was the surface least affected by the chemicals tested, implying that it is the easiest flooring to clean and disinfect. This white paper shares our internal results showing that not all rubber floors provide the same resistance to disinfecting agents, while also discussing the significance of the steps employed when disinfection is the goal.

Cleaning and Disinfection to Inhibit Pathogen Transmission

SARS-CoV-2, the virus that causes the COVID-19 illness, is an enveloped virus. According to Figure 1, such pathogens are those most easily killed when outside a human host through exposure to disinfectants. This relative ease of deactivation, enabled first by surface cleaning and then followed up with proper disinfection, presents an opportunity to kill the virus before surface-to-human transmission and, therefore, further subsequent human-to-human transmission as well.

Cleaning is an important initial step because foreign matter on surfaces can limit or inhibit the germicidal effectiveness of the disinfectants used. On the other hand, well-cleaned hard surfaces mean that disinfectant can reach the maximum number of the intended pathogen targets without being reacted, absorbed or blocked by the presence of untargeted foreign materials.

Figure 1 - Hierarchy of pathogen susceptibility to disinfectants



Source: Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008, Modified May 2019.[1]

With a high susceptibility for deactivation, hospital environmental service (EVS) management teams help to prevent COVID-19 transmission without the need for sophisticated protocols. Instead, the implementation of simple and rational protocols is applied consistently to achieve successful disinfection. The CDC now recommends that EVS teams outside of healthcare environments follow similar guidelines to limit the spread of community acquired infections (CAI).

Resilient floors—including rubber floors—are the most specified floors in the healthcare industry because they:

- Offer exceptional durability with surfaces that are easy to clean and disinfect
- Provide seamless installations after heat welding for aseptic environments

Rubber, in particular, has been described positively in terms of comfort, low noise and durability.[3]

Evaluating the Response to Disinfection Protocols

American Biltrite floors have been used in healthcare applications for over half a century. In light of the current critical situation, we employed existing test concepts to begin evaluating the response of resilient floors to increased disinfection protocols.

This begins by considering the general nature of the active ingredients used in making disinfectants. The molecules applied generally function through non-selective modifications and degradations of critical pathogen components including cell walls, DNA, amino acids and others.[4-6] When used correctly, disinfectants are intended to cause enough transformation on the pathogen scale without undesirable collateral damage to surfaces.

Flooring in healthcare settings requires cleaning and low-level disinfection; however, in the current situation, all settings are evaluating the implementation of CDC guidelines. With that in mind, we performed tests where resilient floorings were exposed to disinfectants so that any responses could be observed. This is nothing new for the resilient floor-covering industry, which employs ASTM F925 as a guide to evaluate how any substances (foods, chemicals, etc.) could interact with flooring surfaces.

Active Ingredients Used for Making Disinfectants

List-N, as generated by the EPA, identified more than 431* disinfectant products as of June 28, 2020, for combatting the Sars-CoV-2 virus.[2] Considering the number of disinfectants and also their limited availability at this time, it remains impractical to consider testing all of them. Therefore, using data available on the EPA's website, we were able to generate Table 1, which lists the 10 most common active ingredients used for making the List-N disinfectants (as of June 28, 2020).

Being present in about half of the List-N disinfectants, quaternary ammonium compounds (QACs or 'quats') are the most common active ingredient employed. The next top ingredients are each used in about 15% of disinfectant formulas and the frequency of usage drops from there. This provides a pathway for focusing our energy when considering the number of ingredient possibilities available as well as the difficulty in obtaining samples at this time.

Table 1 – Ten (of 34) most common active ingredients listed for use in the disinfectants on EPA List-N

Individual Ingredient	# times counted per 431 List N disinfectants	Notes
Quaternary ammonium	217	Refers to more than one molecule type in the "**quaternary ammonium**" family being good at killing pathogens.
Hydrogen peroxide	66	Hydrogen **peroxide** (H_2O_2) usually found as a 3% solution when sold in pharmacies.
Sodium hypochlorite	65	This is **bleach** when diluted to about 5.25% in water. This one molecule transforms into other disinfectant molecules as a function of pH and concentration.
Ethanol (Ethyl alcohol)	25	This is what we normally refer to as "**alcohol.**"
Peroxyacetic acid	23	A **peroxide** chemically similar to acetic acid (vinegar).
Isopropanol (Isopropyl alcohol)	16	Rubbing **alcohol** when diluted to 70% solution in water.
Citric acid	14	A naturally occurring, weak organic acid that is synthesized for industrial applications.
Phenolic	11	Phenols are a type of **alcohol** different from those already mentioned above.
Hypochlorous acid	9	One of the disinfectant molecules coming from **bleach.**
Sodium chlorite	7	A molecule that is chemically similar to hypochlorite.

*EPA List-N from June 28, 2020 was used for this study.
By early September 2020, EPA List-N contained 489 disinfecants.

Methodology

ASTM F925 was used as our reference test method where stain agents dwell on a material for specific times. We used dwell times of one hour and 24 hours, which are typical for investigations of this nature in our industry. However, most disinfectants have much shorter minimum kill times. The longest minimum contact time found on EPA List-N (as of June 28, 2020) was 20 minutes, and the average minimum time for the 431 disinfectants was seven minutes.

The agent dwell results were rated according to three criteria:

- Attack (surface cracking, surface deformation or significant surface degradation)
- Color change
- Tarnish (gloss change)

A rating of zero indicates no change for any one result type and three is the maximum damage value.

In regular tests, we cut out a 1 x 1-inch sample of floor covering along with a 0.5-inch diameter circle of filter paper. Then the dwell agent was added to the flooring sample followed by application of the filter paper to hold the liquid. The whole setup was covered with a watch glass for either one hour or 24 hours. At the end of the allotted time, we wiped down the sample using a wet paper towel and evaluated the samples for surface attack, color changes and tarnish, followed by the assignment of ratings from 0 to 3.

Materials

Table 2 provides a list of the agents tested. The first five are pure ingredients as found in Table 1, which would usually be diluted for use in a disinfectant formula. The balance are formulated commercial disinfectants, most of which are included in EPA List-N. Table 3 contains a list of the floorings investigated where we employed the lightest possible colors available. The study included ABPURE Nfuse (a non-SBR* rubber flooring) and Mirra, an American Biltrite Luxury Vinyl Tile (LVT) flooring. We also included two other rubber floorings and one linoleum flooring as competitor samples whose brand names will not be mentioned.

*SBR: styrene butadiene rubber

Table 2- Agents that were tested for staining

	DISINFECTANT / BRAND	(EPA Number) List	Main Active Ingredient	Other Ingredients According to SDS / TDS / Internet	Contact Time (min)	Dilution*
NON-FORMULATED INGREDIENTS	Rubbing alcohol	N / A	N / A	70% Isopropanol (IPA), an alcohol	N / A	N / A
	Ethanol	N / A	N / A	100% Ethyl alcohol	N / A	N / A
	Hydrogen peroxide (3%)	N / A	N / A	3% H_2O_2	N / A	N / A
	Bleach	N / A	N / A	5.25% Sodium hypoclorite	N / A	N / A
	Phenol 5%	N / A	N / A	An alcohol related to “phenolics” as per List-N but not identical to those contained within disinfectants	N / A	N / A
COMMERCIAL DISINFECTANTS	Accel Five TB	(74559-1)-N	Hydrogen peroxide	Hydrogen peroxide ≈0.5% (<1.5%)	1	RTU
	Optcide[3] or Micro-Kleen	(70144-1) -N	QAC; IPA	IPA (10-30%), Butoxyethanol (1-5%), two kinds of quatamines, ethanol, surfactants	2	RTU
	Cavicide	(46781-6) -N	QAC; IPA	IPA (17%), EG-MBE (1-5%), benzethonium chloride (0.28%)	2	RTU
	Spor-Klenz	(1043-119)-N	Hydrogen peroxide; Peroxyacetic acid	Acetic acid (<10%), peracetic acid (≈0.08%) and hydrogen peroxide (≈1%)	10	RTU
	GL-100	Not on an EPA List	QAC	Two kinds of quaternary amines (≈0.8% per amine, from label)	1 @ 200ppm	Dilutable
	Oxivir TB	(70627-56) -N	Hydrogen peroxide	Benzyl alcohol (3-5%), hydrogen peroxide (<1%), surfactant (<1%)	1	RTU
	Clorox Fuzion (aka : GNR)	(67619-30) -N	Sodium hypochlorite	Sodium hypochlorite	1	RTU
	Clorox Quaterernary (aka : Rex)	(67619-20) -N	Quaternary ammonium	DEGMBE (5-10%, a water-soluble oil), 2 quat amines (<0.2% per amine)	10	RTU
	Clorox Germicidal Bleach Cleaner	(56392-7) -N	Sodium hypochlorite	Sodium hypoclorite	1	RTU
	Clorox Hydrogen Peroxide Disinfectant	(67619-24) -N	Hydrogen peroxide	Hydrogen peroxide	1	RTU
	Clorox Citrace Spray (aka: Saginaw)	(67619-29) -N	Ethanol	Ethanol	5	RTU

***RTU (Ready To Use)**

Table 3 - List of floorings tested

FLOORING ID	Type	Color	Surface Profile
AB NFUSE	Rubber (non-SBR)	Linen ABS-41	Embossed
MIRRA LVT	LVT	Sable	Embossed
RUBBER SBR-1	Rubber (SBR)	Very Light Grey / Off White	Smooth
RUBBER SBR-2	Rubber (SBR)	Very Light Beige	Embossed
LINOLEUM-1	Linoleum	Grey Marbled	Smooth

Results

Agents that Caused No Change on Any Floor Covering

The seven agents in Table 4 had no effect in terms of attack, color or tarnish on the floor coverings tested. This simplifies our work since discussions about non-affecting agents won’t require further elaboration.

Table 4 - Agents that provided no significant staining on the resilient products tested

Name	Bleach	Clorox Citrace	Clorox Fuzion	Clorox H_2O_2 Disinf.	Ethanol	Hydrogen Peroxide	Rubbing Alcohol
Main Ingredient	NaOCl 5.25%	Ethanol	NaOCl	H_2O_2	Ethanol	H_2O_2 3%	70% IPA

Surface Attack

For the attack parameter, we sought to determine if the surface underwent cracking, deformation or significant degradation. Not surprisingly, due to the nature of resilient floors and the fact that they are the product of choice in healthcare applications, none of the tested disinfecting agents provided surface attack, as shown in Table 5.

Table 5- Results for surface attack

	Accel Five TB		Cavicide		Clorox Germic. BC		Clorox Quaternary		GL-100		Opticide3		Oxivir TB		Phenol 5%		Spor-Klenz	
	H_2O_2		QAC / IPA		NaOCl		QAC		QAC		QAC / IPA		Benzyl alcohol / H_2O_2		Phenol		Acetic Acid/H_2O_2	
	1h	24h	1h	24h	1h	24h	1h	24h	1h	24h	1h	24h	1h	24h	1h	24h	1h	24h
AB NFUSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MIRRA LVT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RUBBER SBR-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RUBBER SBR-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LINOLEUM-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Discoloration

Disinfectants are clear liquids absent of dyes, so color changes were not a highly observed occurrence in our tests, as shown in Table 6. A color change when testing with clear liquids is often an indication of a chemical surface modification. Accel Five TB and Clorox Germicidal Bleach Cleaner caused a discoloration in the form of whitening for one floor covering in Table 6. For those disinfectants, however, hydrogen peroxide and bleach are the active ingredients and when tested in the pure state, those ingredients did not cause whitening on any floor covering. Thus, it seems like the overall disinfectant formulation may not always provide the same result when compared to some of the individual ingredients when tested alone on the surface.

Table 6- Results for color change

	Accel Five TB		Cavicide		Clorox Germic. BC		Clorox Quaternary		GL-100		Opticide3		Oxivir TB		Phenol 5%		Spor-Klenz	
	H_2O_2		QAC / IPA		NaOCl		QAC		QAC		QAC / IPA		Benzyl Alcohol / H_2O_2		Phenol		Acetic Acid / H_2O_2	
	1h	24h	1h	24h	1h	24h	1h	24h	1h	24h	1h	24h	1h	24h	1h	24h	1h	24h
AB NFUSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MIRRA LVT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RUBBER SBR-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RUBBER SBR-2	0	1	0	0	1	3	0	0	2	2	0	0	0	0	0	0	0	0
LINOLEUM-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Tarnish (Gloss Change)

Tarnish, represented by a gloss change, was the most common form of staining found when testing disinfectants. As shown in Table 7, at least three formulated disinfectants, as well as phenol 5%, caused a tarnish effect on more than one of the floor coverings tested.

Photoset 1 illustrates the difference between ABPURE Nfuse that received a tarnish rating of "0" versus RUBBER SBR-1 that received a rating of "2" when testing Clorox Quaternary, using a dwell time of 24 hours.

Table 7- Results for tarnish

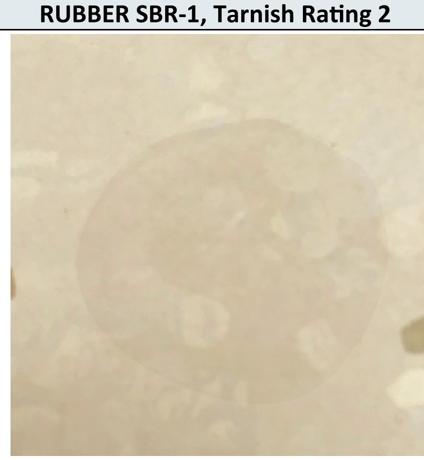
	Accel Five TB		Cavicide		Clorox Germic. BC		Clorox Quaternary		GL-100		Opticide3		Oxivir TB		Phenol 5%		Spor-Klenz	
	H_2O_2		QAC / IPA		NaOCl		QAC		QAC		QAC / IPA		Benzyl Alcohol / H_2O_2		Phenol		Acetic Acid /H_2O_2	
	1h	24h	1h	24h	1h	24h	1h	24h	1h	24h	1h	24h	1h	24h	1h	24h	1h	24h
AB NFUSE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
MIRRA LVT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0
RUBBER SBR-1	0	0	0	0	0	0	2	2	2	2	0	0	1	0	0	0	0	1
RUBBER SBR-2	0	0	0	1	0	0	2	1	1	2	0	1	1	1	1	1	0	1
LINOLEUM-1	0	0	0	0	0	0	0	1	0	1	0	0	1	1	3	2	0	0

From the above results, we can see that phenol 5% caused some issues. But Table 1 indicates that disinfectants based on such products were used in only 11 of the 431 disinfectants on EPA List-N as of June 28, 2020, which makes the result less problematic in most instances. Such results seem to indicate the need for an awareness about the cleaning and disinfecting chemistries that will be used on flooring products prior to specification. GL-100 is the only non-ready-to-use (RTU) disinfectant examined, and it was tested in an undiluted form for maximum effect. So, that result is also less of a present concern.

Photoset 1 – Tarnish rating of 0 versus a rating of 2

ABPURE Nfuse, Tarnish Rating 0

RUBBER SBR-1, Tarnish Rating 2



ABPURE Nfuse received a tarnish rating of "0" versus RUBBER SBR-1 that received a rating of "2" when testing Clorox Quaternary, using a dwell time of 24 hours.

From Table 7, some QAC-containing disinfectants were found to cause no effect on most floor coverings. Table 8 provides some information about the QAC-containing disinfectants tested in this study. It shows that different QAC types can be used from one disinfectant manufacturer to another and that formula ingredient variations are to be expected. Considering the results in Table 7 and the data in Table 8, it seems difficult to predict conclusively if a QAC-containing disinfectant might cause tarnishing on floor-covering surfaces just by knowing which disinfectant chemical ingredients make up its composition.

Table 8- Examining the QAC-containing disinfectants more closely

Disinfectant	Observation	QAC CAS#, (%)	Other Notable Ingredients
Cavicide	Low-tarnish frequency	121-54-0 (0.28%)	IPA (≈17%) / Ethylene glycols
Clorox Quaternary	High-tarnish frequency	85409-23-0 (<0.2%) 53516-76-0 (<0.2%)	Ethylene glycols
GL-100	High-tarnish frequency (undiluted)	CAS not available (≈1.6% total QAC content)	n / a
Optcide[3]	Low-tarnish frequency	68391-01-5 (unknown %) 85409-23-0 (unknown %)	IPA (10-30%) Ethylene glycols

As already noted, disinfectants have dwell times that are often much shorter than 60 minutes and 24 hours. We, therefore, ran some additional tests to gather more information. For the results in the left region of Photoset 2, we tested the effects of 20-, 40- and 60-minute dwell times of Clorox Quaternary on RUBBER SBR-1 and ABPURE Nfuse using a 0.5-inch application area. On the right side, we applied the same disinfectant using a 2.5-inch application area once a day for 20 minutes over three consecutive days.

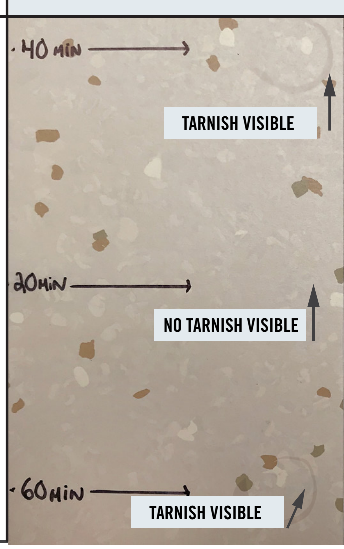
For RUBBER SBR-1, we found that one 20-minute dwell time did not affect the surfaces, but tarnish did occur for 40- and 60-minute dwell times. We also found that successive 20-minute dwell times did not cause tarnishing inside the entire dwell area, but, instead, an outer perimeter ring of tarnishing developed. On the other hand, no tarnishing was observed for ABPURE Nfuse.

Photoset 2 – Extra tests with Clorox Quaternary

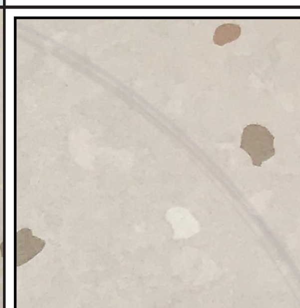
RUBBER SBR-1

RUBBER SBR-1 exposed to Clorox Quaternary for either a 20-, 40- or 60-minute dwell time. RUBBER SBR-1 experienced tarnish when exposed to Clorox Quaternary for 40 and 60 minutes. No tarnish was observed when exposed to one 20-minute dwell time.

SINGLE 20-, 40- and 60-minute dwell times (0.5-inch diameter)

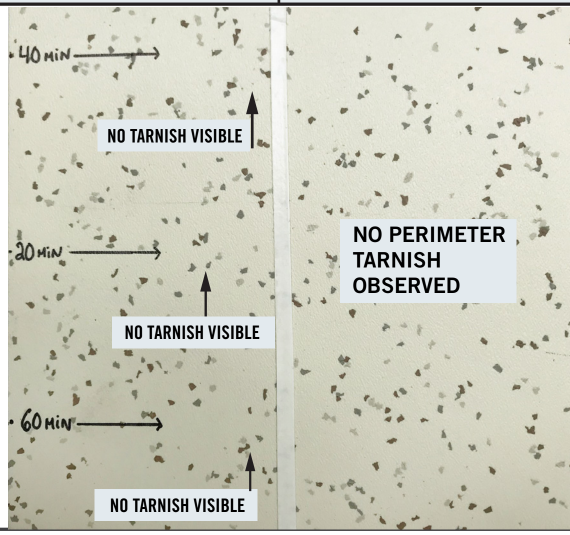


3 x 20-minute dwell, one dwell per day (half circle 2.5-inch diameter)



RUBBER SBR-1 exposed to one 20-minute Clorox Quaternary dwell cycle per day over three days. The inside area is unaffected but the outer perimeter now exhibits signs of tarnish.

Photoset 2 - Extra Tests with Clorox Quaternary (continued)

ABPURE Nfuse	**SINGLE 20-, 40- and 60-minute dwell times (0.5-inch diameter)**	**3 x 20-minute dwell, one dwell per day (half circle 2.5-inch diameter)**	
ABPURE Nfuse exposed to Clorox Quaternary for either a 20-, 40- or 60-minute dwell time. NO TARNISH WAS OBSERVED.			ABPURE Nfuse exposed to one 20-minute Clorox Quaternary dwell cycle per day over three days. NO TARNISH WAS OBSERVED.

From Photoset 2 and other results above, it is argued that not all floor coverings interact with a particular disinfectant in the same way. Also, for a case when tarnish did occur (RUBBER SBR-1, Photoset 2), shorter dwell times (20 minutes) seemed to result in a less visible effect, although some cumulative effects could be possible when those short times were employed frequently.

While it was found that some floor covering surfaces were less susceptible than others to chemical modifications, it was also found that some disinfectants provided no surface modification on any of the tested floor coverings, with others providing effects on multiple flooring surfaces. Therefore, we observed cause / effect relationships where floorings and disinfectants played both individual and combined roles as a function of their own material and chemical properties.

When it comes to real-world flooring disinfection, however, we might also expect the presence of other variables that are currently unknown, perhaps some being unique to different facilities and others that are less controlled than what is performed in a lab study. Because of that, our results suggest that some systems will be more robust than others, but we cannot predict what the exact outcomes will be.

With that in mind, it is argued that maximum robustness should occur when both the floor covering and the disinfectants employed, each individually provide the lowest probability for surface modifications. It is also argued that tables, like those presented above, are a means of providing such information for designers and future research.

Our results indicate that ABPURE Nfuse had the most chemically stable surface when the tested disinfectants were applied. This is expected because chemical stability was required for another property—uncommonly high color stability—for which the product was designed. This was achieved and patented years ago by using a non-SBR elastomer that is known for use where material durability and performance are required, especially in the face of oxidation and extreme conditions.

As opposed to typical SBR-based formulas, ABPURE Nfuse is cross-linked without sulfur, which helps to promote color stability. Another chemical factor is that sulfur cross-linked SBRs contain a multitude of double bonds that enable oxidative degradations.[7-9] Whereas the elastomer used to make ABPURE is known for its resistance to oxidation and is typically found in products where rubber physical properties must be maintained under strenuous environmental conditions.

Conclusions

The EPA's List-N, which identifies specific disinfectants for use against SARS-CoV-2, contained more than 431 disinfectants as of June 28, 2020, when this report was written, and the number will continue to increase. Thus, it seems impractical for any flooring manufacturer to evaluate every substance on that list, even when using the established type of test normally used for such investigations. The challenge becomes exponentially greater when trying to assess the result of cumulative disinfection cycles over time.

Nonetheless, as compared to the linoleum and SBR rubber floors that were investigated, our findings indicate that ABPURE Nfuse had the greatest tendency to remain unchanged when exposed to disinfectants. This is not surprising when considering that the ABPURE Nfuse rubber formula makes use of an elastomer that is known for maintaining its physical properties by exhibiting a superior resistance to chemical oxidative degradation.

That being said, we are unable to know the resistance limit of even the most stable polymeric and elastomeric materials when faced with frequent and persistent disinfection spanning long time periods.

Whenever possible, it is thus recommended that disinfection be performed using disinfectants known to cause the least "collateral" damage to many floor coverings. Therefore, a disinfectant providing the least surface modification to a range of flooring products is considered more favorable than one showing impacts to more flooring types. A more favorable outcome is also expected when using a flooring material that is less sensitive to degradation from the onset.

References

1. CDC. Rational Approach to Disinfection and Sterilization: Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008 (Update: May 2019); Available from: https://www.cdc.gov/infectioncontrol/guidelines/disinfection/. (Unless otherwise noted all links provided herein are current as of 05/08/2020)
2. EPA. List-N: Disinfectants for Use Against SARS-CoV-2 (COVID-19). 2020; Available from: https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2-covid-19.
3. Singh., S., Floor Finish Selection in Hospital Design: A Survey of Facility Managers, Texas A&M, August 2017 https://core.ac.uk/download/pdf/147122231.pdf
4. Fukuzaki, S., Mechanisms of Actions of Sodium Hypochlorite in Cleaning and Disinfection Processes. Biocontrol Science, 2006. **11**(4).
5. McDonnell, G. and A.D. Russell, Antiseptics and Disinfectants: Activity, Action and Resistance. Clinical Microbiology Reviews, 1999. **12**(1).
6. Gerba, C.P., Quaternary Ammonium Biocides: Efficacy in Application. Applied and Environmental Microbiology, 2015. **81**(2).
7. Piton, M. and A. Rivaton, Photooxidation of Polybutadiene at Long Wavelengths. Polymer Degradation and Stability, 1996. **53**.
8. Xiang, K., et al., Thermal Ageing Behavior of Styrene Butadiene Random Copolymer: A study on the Ageing Mechanism and Relaxation Properties. Polymer Degradation and Stability, 2012. **97**.
9. Guo, L., et al., Thermal Oxidative Degradation of Styrene-Butadiene Rubber (SBR) studied by 2D Correlation Analysis and Kinetic Analysis. Journal of Thermal Analysis and Calorimetry, 2014. **115**: p. 647.

About American Biltrite

American Biltrite manufactures durable commercial flooring and industrial rubber for distribution throughout the United States, Canada and many other countries. With manufacturing centralized in Sherbrooke (Quebec, Canada), our flooring division primarily serves architects and designers in the healthcare, educational and institutional sectors. Our industrial division manufactures rubber parts for a wide range of industrial manufacturers including the healthcare, pharmaceutical, transportation and construction industries, among others. An advanced research and development center, technical expertise and flexible manufacturing capabilities form the core of American Biltrite. We answer the needs of our customers with flexible, customized solutions and continuous product development and innovations.

Through nearly 100 years of careful growth, American Biltrite has developed a reputation for the quality of its products and the sincerity of its commitment to customer service. With ISO 9001 accreditation since 1996 and ISO 14001 accreditation since 2011, plus FloorScore® certification and a wide range of products that help meet LEED requirements, American Biltrite continues to strive to improve its processes and the products our customers need.