Chapter 4: Selection of Products, Dispensing Equipment, and Application Systems

Chapter 4.A. Introduction

One of the key strategies in reducing the use of toxic products is to prevent their purchase. After an infection-control program is developed, purchasing the right products enables implementation.

The documents in this chapter can be used to identify hazardous ingredients in products; to compare equipment, supplies, and less-toxic products; and to select the best methods for applying the products.

How to Begin

Work with custodial staff to identify current products that concern them due to performance, air quality, toxicity, hazards, storage requirements, and so forth. Also, involve them in choosing and trying out the new, safer products. It may be difficult for staff to buy-in to new products or a new program if they do not understand why they must give up products that have previously worked well for them.

The process of identifying and switching to less hazardous alternative products and equipment may involve one or more of the following processes:

1. A phased-in approach: Replace products as they are finished, or replace equipment when the old equipment is no longer useful.
2. End-of-year switch: Start working with the school's existing vendor to evaluate the current program and set up a pilot, or start with new products from a new vendor when old contracts expire and new ones begin.
3. Begin with a new system: Initiate the purchase of preferred equipment, supplies, and products as part of a larger purchasing process for a new area or building. Many schools are using this approach when seeking Leadership in Energy and Environmental Design (LEED, a green-building certification system) credits for a Green Housekeeping Plan.

There is no correct way to begin; each situation is unique. It may take time to explore vendors, products and equipment. Some schools start with one or more products; others replace products for a floor or a whole building.

Possible Phases of the Switch

The switch often starts with obtaining one third-party-certified concentrate that can be diluted for cleaning the following areas:

- bathroom/ restroom
- all-purpose
- carpet spotter/extraction
- glass and window
- neutral floor

The next phase of the switch might be to obtain third-party-certified, specialty cleaning products:

- heavy-duty cleaner
- wax stripper

- floor sealer and finish
- hand soaps
- graffiti removers
- metal cleaners
- whiteboard cleaners

The Environmental Protection Agency, Design for Environment Program is certifying disinfectant products that meet their standards for safer products. See *Chapter 4.B. Comparing Disinfectants: Comparison Chart for Hard-Surface Disinfectants Registered by the Environmental Protection Agency* and *Appendix B.5. Selecting Disinfectants for Hard Surfaces: Checklist* for more information on selecting disinfectants.

Microfiber

Purchasing microfiber equipment requires having a laundering system in place or using a rental company that offers microfiber. Microfiber needs laundering after each use. It must be washed separately from other laundry using only mild detergent. Bleach, dryer sheets, or fabric softener should not be used.

Small, conventional washing machines or small, affordable machines designed just for microfiber that fit into custodial closets can be purchased for this purpose. Washing microfiber by hand and hanging to dry is also an option.

Resources

Consider using the Massachusetts Operational Services Division (OSD) Environmentally Preferable Products (EPP) program and contracts when exploring options. Five other states, including New Hampshire, Rhode Island, Vermont, New York, and Connecticut, have joined Massachusetts in adopting these contracts. The OSD has contracted with vendors for many EPPs. The OSD screens these products and equipment for cost, performance, and environmental health and safety criteria, and requires that vendors provide training and technical assistance on the use of the products. The EPP contract manager is an excellent resource regarding these contracts and can provide information on how to use them. See *Appendix D.1. Organizations* for information on how to contact the EPP program and view the resources available to help with purchasing.

Other states may have their own environmentally preferable purchasing contracts. For resources on products and equipment that have been certified by third-party organizations to be environmentally preferable, see *Appendix B.1. Green Product Certification and Labeling: Quick Reference*.

Think Long-Term

Although some of the new supplies and technologies may cost more at the beginning, the hidden or long-term savings should be considered. These savings include life-cycle costs, improved performance, and the savings from reduced injuries, time, and labor. *Chapter 6.C. Using Microfiber Cloths and Mops for Infection Control* provides information on the amount of savings available over time by using microfiber supplies.

Chapter 4.B. Comparing Disinfectants: Comparison Chart for Hard-Surface Disinfectants Registered by the Environmental Protection Agency

This chart was designed to provide "at-a-glance" information comparing the most common types of disinfectants used in school settings and the most current, less-hazardous alternative products on the market today. Because the market rapidly changes, with new products constantly emerging, a blank chart at the end of this section is provided for use in comparing products not listed here.

One important tool that will help in the selection of the least-toxic disinfectant is the Environmental Protection Agency's (EPA) Design for the Environment (DfE) logo for Antimicrobial Pesticide Products. Products must be registered with EPA's Office of Pesticides Program and meet the Safer Choice Standard in order to qualify for the DfE logo. See notes below. Approved products and active ingredients are posted at the EPA Web site: https://www.epa.gov/pesticide-labels/design-environment-logo-antimicrobial-pesticide-products. Another certifying agency is Green Seal, an independent third-party certifier of cleaning and other products - https://greenseal.org/certified-products-services

There is a **Notes* section at the end of the chart that provides additional information on the criteria used to compare the disinfectants.

TIP FOR USING ALL DISINFECTANTS

Best practices advise pre-cleaning all surfaces before disinfecting.

New information on SARS-CoV-2, the virus that causes COVID-19, is being released daily. Check the TURI.org website for updates.

	AVOID		USE WITH CAUTION				PREFERRED		
Disinfectant Character-istics	**Bleach - sodium hypochlorite**	**Quaternary Ammonium Compounds – QACs or Quats**	**Thymol** (e.g. Benefect®)**	**Hydrogen Peroxide - H2O2 and Peroxyacetic Acid - PAA (e.g. Oxycide Daily Disinfectant Cleaner)**	**Hypochlorous Acid*** (e.g. Brutabs /PurTab/CDiff ViroTab Tablets)**	**Hypochlorous Acid*** (e.g. Force of Nature, Envirocleanse A)**	**Hydrogen Peroxide (e.g. Oxivir TB)**	**Ethanol (e.g. Purell Professional Surface Disinfectant)**	**Citric Acid (e.g. CleanCide and Betco GE Fight Bac- same product privately labeled)**
Status of DfE review*	Will not pass DfE screen (see below)	Will not pass DfE screen (see below)	Will not pass DfE screen (see below)	H2O2 and PAA have passed the DfE screen individually but not together (see below)	Has not been evaluated using the DfE screen (see below)	Has not been evaluated using the DfE screen (see below)	Active ingredient has passed DfE screen (see below)	This product has passed DfE screen (see below)	CleanCide has passed DfE screen (see below)
Product description	EPA-registered chlorine bleach (use only EPA-registered products for disinfecting)	Names of individual QACs include - Benzalkonium chloride, Alkyl dimethyl benzyl ammonium chlorides, Benzyl-C12-18-alkyldimethyl, chlorides, Didecyl dimethyl benzyl ammonium chlorides	Benefect® is an EPA registered product with natural disinfecting characteristics	Oxycide Daily is an EPA registered disinfectant/sanitizer using a combination of hydrogen peroxide and peroxyacetic acid Some products using this combination of active ingredients use high levels of (15% active) peroxyacetic acid	EPA registered disinfectant and sanitizer, bleach alternative Generated from sodium dichloro-isocyanurate tablets	EPA registered disinfectants, bleach alternative. Generated by a combination of salt, acid and water electrolyzed in an application device	EPA registered hydrogen peroxide product in synergy with a blend of commonly used detergent ingredients	EPA registered ethanol-based mixture designed to disinfect hard surfaces and sanitize soft surfaces	EPA registered disinfectants formulated for hard, nonporous surfaces

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Disinfectant Character-istics	**Bleach - sodium hypochlorite**	**Quaternary Ammonium Compounds – QACs or Quats**	**Thymol** (e.g. Benefect®)**	**Hydrogen Peroxide - H2O2 and Peroxyacetic Acid - PAA (e.g. Oxycide Daily Disinfectant Cleaner)**	**Hypochlorous Acid*** (e.g. Brutabs /PurTab/CDiff ViroTab Tablets)**	**Hypochlorous Acid*** (e.g. Force of Nature, Envirocleanse A)**	**Hydrogen Peroxide (e.g. Oxivir TB)**	**Ethanol (e.g. Purell Professional Surface Disinfectant)**	**Citric Acid (e.g. CleanCide and Betco GE Fight Bac- same product privately labeled)**
CDC disinfection level*	Intermediate-level disinfectant	Low-level disinfectant	Intermediate-level disinfectant	High-level disinfectant	Low to high-level disinfectant depending on the product	Low-level disinfectant	Product-specific low- or intermediate-level disinfectant	Product-specific low- or intermediate-level disinfectant	Product-specific low- or intermediate-level disinfectant
EPA Acute toxicity category*	Category I	Category III	Category IV	Category III or IV, product specific	Category III	Category III	Category III or IV, product specific	Category IV	Category IV
Storage	If used for disinfecting purposes, bleach should not be stored longer than 3 months	Stable in storage	Stable in storage 2-year shelf life	Store concentrate in a well-ventilated place Keep container tightly closed Store away from other materials	Stable in storage Shelf life up to 5 years	Stable in storage Tablets/capsules for some products have a 3-year shelf life Read product label	Stable in storage 2-year shelf life	Stable in storage 3-year shelf life	Stable in storage

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Effectiveness	Effective against most bacteria and some viruses Some products are registered as effective against the virus causing COVID-19, HIV, HBV, H1N1, MRSA, and TB Read product label for specific claims	Generally effective against a broad spectrum of microbes, including MRSA and H1N1, but typically not proven effective against spores Read product label for effectiveness against TB and the virus causing COVID-19 or check the EPA's List N	Effective against a broad spectrum of microbes including H1N1, TB, and MRSA **Benefect®** is effective against the virus causing COVID-19	Effective against a broad spectrum of microbes including C.Diff, norovirus, and the virus causing COVID–19 Read product label for specific claims	Generally effective against a broad spectrum of microbes including H1N1, MRSA, and HIV Read product label for specific claims against the virus causing COVID-19 or check the EPA's List N	Generally effective against a broad spectrum of microbes including H1N1, MRSA, and HIV Read product label for specific claims against the virus causing COVID–19 or check the EPA's List N	Effective against a broad spectrum of microbes, including H1N1, norovirus, MRSA, and the virus causing COVID-19 Read product label for specific claims, including effectiveness against TB	Effective on hard and some soft surfaces against a broad spectrum of microbes including H1N1, MRSA, and the virus causing COVID-19 Read product label for specific claim	Effective against a broad spectrum of microbes including H1N1, MRSA, HIV, and the virus causing COVID–19 Read product label for specific claims
Contact time* **For examples** *Read product labels for recommended contact times*	30 second –10 minute contact time for virus causing COVID-19	Generally 10-minute contact time for virus causing COVID-19	10-minute contact time	3 minutes for virus causing COVID–19 5 minutes for other microbes.	1 minute to 10 minutes	Generally 5-10 minute contact time	30 seconds to 10-minute contact time	30 second contact time for virus causing COVID–19	5 minute contact time for virus causing COVID–19

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Health effects	Mixing with ammonia, QACs, and other acidic products can create poisonous gas[5] Corrosive to eyes and skin[6] Generates chlorine gas when in use, which is a respiratory irritant and an asthmagen,	Can cause contact dermatitis and nasal irritation Certain QACs (including benzalkonium chloride, dodecyl-dimethyl-benzyl ammonium chloride, and lauryl dimethyl benzyl ammonium chloride) are respiratory sensitizers and associated with asthma	Skin sensitizer	"The combination of hydrogen peroxide and peroxyacetic acid (peracetic acid) has caused the initial onset of asthma in some individuals while triggering asthma symptoms in others. Avoid products that contain the combination of these ingredients." Toxics Use Reduction Iinstitute	Mixing with ammonia, QACs, and other acidic products can create poisonous gas May cause eye, skin and respiratory irritation Generates chlorine gas, which is a respiratory irritant and an asthmagen, when in use	Mixing with ammonia, QACs, and other acidic products can create poisonous gas Force of Nature has been third-party certified by GreenSeal to meet environmental and human health criteria for safer products (See notes)	DfE has approved hydrogen peroxide as an active ingredient meeting the Safer Choice standards (See below)	DfE has certified this and other products using ethanol as the active ingredient as meeting the Safer Choice standards (See below)	DfE has certified this and other products using citric acid as the active ingredient as meeting the Safer Choice standards (See below)

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Environ-mental Health Effects	Very toxic to aquatic organisms	Very toxic to aquatic organisms See the product SDS Associated with antimicrobial resistance	Toxic to aquatic organisms	Toxic to aquatic organisms	The product is considered harmful to aquatic organisms	The product is not considered harmful to aquatic organisms or to cause long-term adverse effects in the environment	Some toxicity to aquatic organisms Some products using this technology have been approved by DfE to meet environmental and human health criteria (see below)	This product has been approved by DfE to meet environmental and human health criteria (see below)	Citric acid, in the concentrations found in antimicrobial cleaning products, is not known to have any aquatic toxicity or other environmental risks.
Exposure controls*	PPE and/or increased ventilation should be used	Requires PPE and proper ventilation	No special requirements; regular ventilation is adequate	Oxycide Daily Disinfectant Cleaner requires no special protective equipment when diluted following label instructions Concentrate requires eye protection, gloves and a respirator	Requires PPE and increased ventilation	PPE and/or increased ventilation should be used for some products. Regular ventilation is adequate for others. See SDS for individual products.	No special requirements; regular ventilation is adequate	No special requirements	No protective equipment is needed under normal use conditions.

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Additional disadvantages	May damage floor finishes, carpets, clothing, and other fibers when used in higher concentrations Has an unpleasant odor Must be stored separately from ammonia and flammable products Rinsing is required in applications where direct skin or oral contact can occur (e.g., children's toys)	Thorough rinsing required See product label for specifics	Not widely available through vendors Strong odor	Concentrate requires special handling and storage	May cause skin irritation in some people Oxidizer	May cause skin irritation in some people Oxidizer	Rinsing is required if direct skin or oral contact can occur (e.g., children's toys)	Flammable	May be mildly irritating to skin and eyes

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Advantages	Inexpensive; readily available The same product can be used for routine and special-event tasks, by changing the concentration	Readily available	Noncorrosive No rinsing or wiping required	Readily available Comes as a concentrate No rinsing required	Readily available Reduced exposure to chlorine as compared to bleach Read label for rinsing requirements	Readily available Stable source of HOCl prolongs the microbicidal effect Reduced exposure to chlorine as compared to bleach No rinsing required	Readily available Noncorrosive in diluted form; some products are odorless No rinsing required except if direct skin or oral contact can occur (e.g., children's toys)	Readily available No rinsing required	No rinsing or wiping is required, except on direct food contact surfaces or toys which require a potable water rinse after treatment

Abbreviations: CDC, Centers for Disease Control and Prevention ;; HBV, hepatitis B virus; H1N1, a subtype of influenza virus A; HIV, human immunodeficiency virus; MRSA, methicillin-resistant *Staphylococcus aureus*; SDS, Safety Data Sheet; PPE, personal protective equipment; QAC, quaternary ammonium compounds; TB, tuberculosis. (Although tuberculosis is not a common microbe found in schools, products that are registered to kill tuberculosis will inactive most microbes.)

Notes:

CDC disinfection level – The CDC defines three levels of disinfection (i.e., the use of a chemical procedure that eliminates virtually all recognized pathogenic microorganisms but not necessarily all microbial forms [e.g., bacterial endospores] on inanimate objects):

- *High-level disinfection* kills all organisms, except high levels of bacterial spores, and is effected using a chemical germicide cleared for marketing as a sterilant by the FDA. Typically not used for generalized disinfecting.
- *Intermediate-level disinfection* kills mycobacterium, most viruses, and bacteria using a chemical germicide registered as a "tuberculocide" by the EPA.
- *Low-level disinfection* kills some viruses and bacteria using a chemical germicide registered as a hospital disinfectant by the EPA.

Costs – When comparing costs, life-cycle costs must be considered. Although a product may be less expensive to buy, its negative impact on surface materials may require replacing hard surfaces more frequently, may increase worker's compensation claims, and may cause environmental damage.

Design for the Environment is a program of the **EPA's** Office of Pesticide Programs. EPA established the Design for the Environment (DfE) program for pesticide products to help consumers find products that have been reviewed by EPA and found to meet the DfE's Safer Choice standards. DfE allows qualifying antimicrobial products to carry a logo on their labels that indicates the product meets this criteria. DfE qualifying products:

- are in the least-hazardous classes (i.e., III and IV) of EPA's acute toxicity category hierarchy;
- are unlikely to have carcinogenic or endocrine disruptor properties;
- are unlikely to cause developmental, reproductive, mutagenic, or neurotoxicity issues;
- all ingredients have been reviewed, including inert ingredients;
- do not require the use of Agency-mandated personal protective equipment;
- have no unresolved or unreasonable adverse effects reported;
- have no unresolved efficacy failures (associated with the Antimicrobial Testing Program or otherwise);
- have no unresolved compliance or enforcement actions associated with it; and
- have the identical formulation as the one identified in the DfE application approved by EPA.

**Products must be submitted to DfE in order to be reviewed for approval. Some products such as those using Thymol as the active ingredient were not approved because of issues such as genotoxicity, developmental toxicity, and repeated dose toxicity endpoints.
*** Referring to products that have not been reviewed, Safer Choice notes that chemicals associated with health impacts are not allowed in products that would bear the DfE label.

Contact time – Contact time is product specific. All disinfectants are tested and labeled for the specific amount of time they must remain in contact with the surface to kill the microbes. The times listed are approximate only.

Green Seal® is a non-profit environmental standard development and certification organization. Its flagship program is the certification of products, services, restaurants, and hotels. Certification is based on Green Seal standards, which contain performance, health, and sustainability criteria.

EPA toxicity categories require the following warnings –

Signal Word	Category	On the Basis of
DANGER, POISON (skull and crossbones)	I Highly toxic	Oral, dermal, or inhalation toxicity
WARNING	II Moderately toxic	Skin or eye irritation or dermal sensitization
CAUTION	III Slightly toxic	The results of all required acute toxicity studies
CAUTION	IV Relatively nontoxic	The results of all required acute toxicity studies

Information – Sources of information include the SDS; The Toxics Use Reduction Institute (TURI)- https://www.turi.org/; Green Seal - https://greenseal.org/certified-products-services?s=+force+of+nature; Design for the Environment - https://www.epa.gov/pesticide-labels/design-environment-logo-antimicrobial-pesticide-products and product information sheets.

pH – pH is a measure of how acidic or basic a product is. Look for products with a neutral pH of 7 or as close to this number as possible.

PPE – PPE may be required for the concentrated form of some products but not for the ready-to-use or pre-diluted form. Check the label and the MSDS.

Blank Comparison Chart

Disinfectant Characteristics	Product and Active Ingredient	
Status of active ingredient under DfE review		
Product description		
CDC disinfection level		
EPA toxicity category		
Storage		
Effectiveness		
Contact time		
Health effects		

Disinfectant Characteristics	Product and Active Ingredient	
Exposure controls		
Environmental issues pros and cons		
Additional disadvantages		
Additional Advantages		

References

1. Alicia Culver (Responsible Purchasing Network,) Chris Geiger, Ph.D. (Department of the Environment), Deanna Simon (Green Purchasing Institute) "Safer Products and Practices for Disinfecting Surfaces.) Available at: https://sfenvironment.org/sites/default/files/fliers/files/sfe_th_safer_products_and_practices_for_disinfecting.pdf

2. University of Oklahoma Health Sciences Center, Environmental Health and Safety Office, "Another Angle on Bleach Shelf Life." *Saf-T-Gram* 8, no. 1 (2001): 2. Available at: http://www.ouhsc.edu/ehso/saf-t-gram/Spring01.pdf.

3. Spartan Chemical Company, Inc., Material Safety Data Sheet, "Steriphene II Brand Disinfectant Deodorant." Available at: http://www.spartanchemical.com/sfa/MSDSRep.nsf/0/ebe0e15bf7c02fc285256ea0005451f3!OpenDocument.

4. Environmental Protection Agency, Pesticides: Regulating Pesticides, "Selected EPA-Registered Disinfectants." Available at: http://www.epa.gov/oppad001/chemregindex.htm.

5. Agency for Toxic Substances & Disease Registry, Managing Hazardous Materials Incidents, "Medical Management Guidelines for Calcium Hypochlorite/Sodium Hypochlorite." Available at: http://www.atsdr.cdc.gov/MHMI/mmg184.html.

6. The Clorox Company, Material Safety Data Sheet, "Clorox Regular-Bleach." Available at: http://www.thecloroxcompany.com/products/msds/bleach/cloroxregularbleach0505_.pdf.

7. California Office of Environmental Health Hazard Assessment, Proposition 65, Safe Drinking Water and Toxic Enforcement Act of 1986. Available at: http://oehha.ca.gov/prop65.html.

8. Scorecard, The Pollution Information Site, "Chemical Profiles." Available at: http://www.scorecard.org/chemical-profiles/.

9. National Institute for Occupational Safety and Health, "Guidelines for Protecting the Safety and Health of Health Care Workers." No. 88-119. Available at: http://www.cdc.gov/niosh/docs/88-119/chemical.html.

10. Association of Occupational and Environmental Clinics, "Exposure Code Lookup." Available at: http://www.aoecdata.org/ExpCodeLookup.aspx.

11. Sunbelt Chemicals, Material Safety Data Sheet, "5.25% Sodium Hypochlorite Solution (Household Bleach)." Available at: http://www.masseywholesale.com/msds/britebleach.pdf.

12. National Institute for Occupational Safety and Health, International Chemical Safety Cards, "Phenol." Available at: http://www.cdc.gov/niosh/ipcsneng/neng0070.html.

13. State of Ohio Environmental Protection Agency, Pollution Prevention Fact Sheet, "Persistent Bioaccumulative and Toxic Chemicals: Phenol." No. 99, 2002. Available at: http://www.epa.ohio.gov/portals/41/p2/mercury_pbt/fact99.pdf.

14. Pesticide Action Network North America, Pesticides Database, Pesticide Products, "Spartec Quaternary Ammonium Sanitizer, disinfectant." Available at: http://www.pesticideinfo.org/Detail_Product.jsp?REG_NR=00087500081&DIST_NR=000875.

15. R.Ventullo and R. Larson, "Adaptation of Aquatic Microbial Communities to Quaternary Ammonium Compounds." *Applied and Environmental Microbiology* 51, no. 2 (1986): 356–61. Available at: http://aem.asm.org/cgi/content/abstract/51/2/356.

16. Clorox Professional Products Division, Health Center: SARS, "Cleaning & Sanitation in Daycare Facilities, Schools and Universities." Available at: http://www.cloroxprofessional.com/healthcenter/sars6.shtml.

17. L. Crawford, Z. Yu, E. Keegan, et al, "A Comparison of Commonly Used Surface Disinfectants." *Infection Control Today* November 1, 2000. Published online. Available at: http://www.infectioncontroltoday.com/articles/0b1feat2.html.

18. Toxics Use Reduction Institute, Surface Solutions Cleaning Laboratory Effective and Safer Disinfection Products. Available at: https://www.turi.org/Our_Work/Cleaning_Laboratory/COVID-19