PROPOSED STANDARD FOR FLOOR-CARE PRODUCTS: FINISHES AND COMPATIBLE STRIPPERS USED FOR INDUSTRIAL AND INSTITUTIONAL PURPOSES

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Annually, Americans spend over $1 billion on floor-care products, and the institutional/commercial cleaning industry employs 2-3 million janitors. Many of the cleaning products used today include ingredients that have negative impacts on indoor air quality and human health. These ingredients may include carcinogens, asthmagens, skin and eye irritants, and endocrine disrupters, which are associated with cancer, reproductive disorders, and other human health issues. Floor-care products contain many of the same ingredients. Hazardous cleaning and maintenance products frequently injure janitorial workers. A recent study associated 12 percent of work-related asthma cases with exposure to cleaning products (Rosenman et al., 2003).

The purpose of this standard is to reduce the following from the use of floor-care products:

- ingredient toxicity and other hazards to human health,
- air quality impacts,
- toxicity and other impacts to the aquatic environment, and
- other impacts associated with packaging and transportation.

This report documents the development of criteria for a floor-care products standard, specifically for floor finishes and strippers, based on specific performance and environmental attributes.

In preparing this standard, Green Seal compiled information on acrylic polymer floor finishes and strippers currently available on the market for resilient/vinyl tile flooring (not including floor cleaners, sealers, or spray buff products). We compiled MSDS information and surveyed the manufacturers of these products to gather information on the ingredients found in their finishes and strippers. We reviewed potential environmental and health impacts of commonly used ingredients and alternatives.

Section 1 provides an overview of floor finishes and strippers currently on the market. Section 2 discusses environmental, health, and other concerns associated with floor-care products and describes attributes of environmentally preferable products. Section 3 reviews other available environmental standards and criteria for floor-care products. Finally, Section 4 presents the proposed standard for floor care products (finishes and strippers).

Section 1
Overview Of Floor Finishes and Strippers

A typical floor-covering maintenance system consists of a finish, a stripper, and compatible cleaners. Until recently, a sealer was also routinely used after stripping and prior to applying a finish. Natural waxes were used through the 1930s as floor finishes and have been around since the days of the Romans and the Egyptians. These were primarily carnuba waxes, which consist of a hard, brittle vegetable wax (from the carnuba palm) blended with resin. These are buffable, drying to a slight haze, and abrasive-resistant. Synthetic wax/polymer finishes followed carnuba wax, and were sometimes used in conjunction with carnauba wax in the 1940s and 1950s. The improved result was a dry, bright finish. Acrylic polymers were introduced in the 1950s. During the 1950s and '60s, polymeric chains and zinc cross-linkages in those chains were introduced to improve the resistance of finishes to alkaline cleaners used in daily mopping(Boehland, 2003; IHM Services, 2003; ChemCor, 2004).

Although early metal-free finishes were less glossy, less durable, and more expensive than zinc-containing finishes, technological advances have brought the performance and price of metal-free finishes to comparable levels. But finishes with metal-free polymers are still less common than conventional finishes containing zinc (Boehland, 2003).

Floor finishes and strippers must be designed to work together in an overall system of environmentally preferable floor care. The products used to strip – and then refinish – resilient flooring vary widely in their formulations, levels of performance, and potential health and environmental impacts. Creating an environmentally responsible ("green") floor finish or stripper that performs effectively can be challenging; green floor care products are those that contain fewer harmful components than their counterparts. For example, a traditional floor-finish stripper has a volatile organic compound (VOC) level greater than 10%, commonly between 15% and 30%. A green floor finish remover, by contrast, may have a VOC content of 6%, and still be effective in removing finish. Other ways that floor finishes and strippers can be made more environmentally preferable include reducing or eliminating toxic ingredients that may affect plants and animals as well as harmful substances that can accumulate in the environment.

1.1 Basic characteristics of finishes

Floor finishes put a protective, safe, and attractive coating over the surface of the tile, which protects the floor, increases stain and water resistance, and makes cleaning easier. Most floor finishes are water-based products suitable for use on almost all floors not harmed by water and typically consist of polymers, waxes, solvents, and other components. Table 1 presents a list of ingredients reported on floor finish product MSDSs. Common types of ingredients are discussed further in the following sections.

Table 1. Floor Finish Ingredients reported on product MSDSs

Ingredient name; synonyms	CAS Registry Number	No. of products (out of 62)	Conc. range, if specified (wt. %)
Tributoxy ethyl phosphate	78-51-3	33	0-6
Diethylene glycol ethyl ether; diethylene glycol monoethyl ether	111-90-0	30	1-8
Acrylate copolymer Acrylic polymer; Acrylic copolymer; Acrylic copolymer emulsion; Acrylic emulsion; Polyacrylic emulsion; Aqueous acrylic emulsion	67366-74-9 N/A 63744-68-3 25987-66-0	25	10-45
Dipropylene glycol methyl ether; dipropylene glycol monomethyl ether	34590-94-8	23	0-10
Diethylene glycol monomethyl ether; diethylene glycol methyl ether; diethylene glycol	111-77-3	21	1-9
Polyethylene; Polyethylene wax; Alkenes, polymd. emulsion; Alkene polymd.; Polyethylene emulsion 2-propoenoic acid, polymer with ethane	9002-88-4 68441-17-8 68527-08-2 68527-80-2 N/A 9010-77-9	15	0-10
Zinc oxide	1314-13-2	11	<0.1 to <0.9
Styrene acrylic copolymer; styrene acrylic emulsion; styrene acrylic polymer	N/A 25987-66-0	9	10-60
Diethylene glycol monobutyl ether; 2-(2-ethoxyethoxy)-ethanol; diethylene glycol butyl ether	112-34-5	5	0-10
Ethylene glycol	107-21-1	6	0.8-5
Isothiazolinone preservative	N/A	6	0-1
Wax; waxes; paraffin wax	64742-43-4 8002-74-2	5	1-5
Dimethyl siloxanes and silicones	63148-62-9	5	0-1
Telomer B monoether with polyethylene glycol	65545-80-4	5	0-1
Dibutyl phthalate	84-74-2	4	1-5
Zinc ammonium carbonate	38714-47-5 40861-29-8	4	1-5
Acrylic terpolymer, ammonium salt	N/A	4	0-5
Polypropylene wax; hydrocarbon wax	64743-00-6	3	0-7
Propylene glycol phenyl ether	770-35-4	2	0-1
Aliphatic hydrocarbon petroleum naphtha	64742-88-7	2	30-90
Ethylene copolymer	68441-73-6 67892-91-5	2	1-5
Resin; epoxy resin	N/A	2	Not specified

Ingredient name; synonyms	CAS Registry Number	No. of products (out of 62)	Conc. range, if specified (wt. %)
Rosin, fumarated, polymer with glycerol	68152-57-8	2	Not specified
Modified rosin ester	65997-10-6 N/A	2	Not specified
Octyl phenoxy polyethoxy ethanol	9036-19-5	2	0-1
Fragrance	N/A	2	0-1
Ammonium laureth sulfate	32612-48-9	2	1-5

1.1.1 Solids

In water-based floor finishes, solids are whatever is left on the floor after the coating cures. Solids are usually expressed as a percentage of weight. The higher the solids content, the more coating is on the floor after it dries. These may be urethane resins, acrylics, or a blend, which contribute to various performance characteristics. More solids do not necessarily equate to better performance, durability, gloss, or finish coats required (BCW, 2002; Kintish, 1991). Finish product MSDSs reported a range of solids from 11 to 30 percent.

1.1.2 Polymer Emulsions

The solids portion of floor finishes generally contains a minimum of 50% polymer. A polymer is a very large molecule that is made of smaller units called monomers. In acrylic floor finishes, an acrylic or acrylic/styrene polymer eventually forms the film. Floor finish polymers have specific characteristics of hardness, leveling, film-forming temperature, gloss, and durability. The polymer (plastic) emulsion backbone of the floor finish is most responsible for the finish's strength, durability, and shine, as well as other performance characteristics such as scuff, detergent, and slip resistance. Consequently, the inherent properties of the polymers determine to a large degree the performance of the floor finish itself. Metal cross-linked polymers (most commonly zinc) were developed to help maintain an acceptable level of floor protection and appearance. Prior to using metal cross-linking, floor-finish manufacturers used polymers that were frequently damaged by daily mopping with alkaline cleaners. Today's polymer finishes generally are made with zinc cross-linked polymers. Zinc is typically used for metal cross-linking because it is inexpensive, non-reactive, has no color attributes, and is efficient (IHM Services, 2003; Whitacre, 2001; McFadden, undated; ChemCor, 2004). Zinc may be present in concentrations up to 5,000 parts per million in floor finish. Zinc is coming under scrutiny because of its inclusion in the U.S. Environmental Protection Agency (EPA)'s 65 Toxic Pollutants and 126 Priority Pollutant lists associated with the Clean Water Act.

1.1.3 Wax Emulsions

The primary function of wax (5 to 20 percent) in the formulation is to provide a more buffable finish. Wax emulsions are crucial to durability, burnishability, black-mark resistance and slip resistance. Wax emulsion choices can also affect the color of the finish. But wax also makes the film softer and more susceptible to scuffing and dirt pickup. Synthetic polyethylene or polypropylene waxes have replaced natural waxes in many finishes because of their improved consistency in color, performance, and availability (IHM Services, 2003; Whitacre, 2001; ChemCor, 2004).

1.1.4 Solvents

These consist primarily of coalescing agents (glycol ethers, glycol ether esters, and ester-alcohols) and plasticizers (tributoxyethyl phosphate and dibutyl phthalate). Coalescing agents allow the polymer molecules suspended in the emulsion to come together into a continuous film without flaws or imperfections on the floor, and they stay behind for a short time after the water has evaporated to soften and bring the polymer molecules together into a continuous and tough film. Plasticizers are less volatile than coalescing agents and make the floor finish more flexible and impact resistant (Anon., 2001). The most commonly-reported solvents on floor finish MSDSs include the following three glycol ethers:

- Diethylene glycol ethyl ether
- Dipropylene glycol methyl ether
- Diethylene glycol methyl ether

1.1.5 Other components of floor finishes

The primary function of the other ingredients in the formulation of high-speed finishes is to promote application or wetting and leveling properties of the finish on the floor. Alkali-soluble resins (5 to 15 percent) are added to improve the ability of a finish to level and are mixed with ammonia or other amines. Surfactants are used as wetting agents and help the liquid spread. Waterborne urethanes are used in floor finishes where chemical and water resistance, impact resistance, and flexibility are required. Co-solvents, defoamers, ultraviolet stabilizers, and preservatives make up the balance of the finish. All of these ingredients play an important role in producing a safe, attractive, easy-to-use, and easy-to-remove finish (IHM Services, 2003; ChemCor, 2004).

1.2 Basic characteristics of strippers

Floor strippers are used to remove finishes for a thorough cleaning of the floor surface. Strippers are formulated to dissolve and suspend the floor finish without damaging the floor surface itself. There are two basic mechanisms that occur simultaneously to remove finish: an amine attacks the zinc crosslinking while a solvent – usually glycol ethers and/or alcohols – dissolves and reliquifies the finish. Common types of ingredients in strippers include amines, solvents, alkaline builders, and surfactants, described further below. Table 2 presents ingredients reported on 29 stripper product MSDSs.

Strippers are formulated to work with specific types of floor finishes. For that reason, the stripper should be specific to the system with which it is being used (Shaw, 1998). For example, many modern acrylic polymers do not need to be removed as often, because of improved wear characteristics — sometimes allowing facilities to go two or more years without replacing the finish (Locco et al., 2000). The avoidance of stripping or the increase of intervals between strippings represents an important contribution to environmental and health protection, and also helps to save money (Oehme and Klade, 2003).

1.2.1 Amines

Amines react with zinc to unlock or “unzip” the metal crosslinked polymers in the floor finish. Ammonia was originally used in stripper formulations for this purpose. Today, other

amines, commonly monoethanolamine (MEA), are used to replace aqueous ammonia in strippers. Although MEA is free of a strong ammonia odor, direct contact may cause severe eye irritation or burns, it may be absorbed through the skin in harmful amounts, and inhalation may irritate the respiratory tract and cause central nervous system effects such as dizziness or headache. MEA was reported on 25 out of 29 stripper MSDSs, while ammonia or ammonium hydroxide was not reported.

1.2.2 Solvents

Stripper formulations commonly use glycol ethers and/or alcohols as solvents. The most commonly reported solvents in the products we surveyed are 2-butoxy ethanol and benzyl alcohol.

1.2.3 Alkaline builders

Most strippers have a high pH (a measure of hydrogen ions in a solution), from about 10 to 14 but usually around 12. Strippers need to be alkaline (pH 10 or higher) because they are generally more effective in an alkaline environment. Alkaline builders (e.g., trisodium phosphate, sodium carbonate, and sodium metasilicate) and caustics (sodium hydroxide or potassium hydroxide) may be used to assist in this process.

1.2.4 Surfactants

Surfactants are used to assist in "wetting" the finish film (Essential Industries, Inc., 2004). Surfactants reported in strippers include alcohol ethoxylates in two products and nonylphenyl ethoxylate in one product.

Table 2. Floor Stripper Ingredients reported on product MSDSs

Ingredient name; synonyms	CAS Registry Number	Number of products (out of 30)	Reported concentration range (wt. %)
Monoethanolamine; ethanolamine	141-43-5	26	1 - 30
Ethylene glycol monobutyl ether; 2-butoxy ethanol	111-76-2	16	5 - 30
Sodium metasilicate	6834-92-0	11	1 - 17
Benzyl alcohol (alpha-hydroxy-toluene)	100-51-6	7	2 - 60
Potassium hydroxide	1310-58-3	7	0.3 - 10
Anionic hydrotrope; sodium xylene sulfonate	1300-72-7	7	0.5 - 15
Ethylene glycol phenyl ether	122-99-6	4	1 - 5
n-Butoxypropanol	5131-66-8	2	5
Dipropylene glycol butyl ether	29911-28-2	2	1 - 10
Isopropyl alcohol	67-63-0	2	1 - 10
Alcohol ethoxylate; nonionic alcohol ethoxylate	68439-46-3; NJ TSRN 7613759-02	2	1 – 7

Section 2
Environmentally Preferable Floor Care Products

Concerns and desirable attributes pertaining to floor-care product performance; human health, air quality, or water quality impacts; specific ingredient concerns; and impacts from packaging and transportation are discussed in this section.

2.1 Performance

A floor finish may have the desired initial aesthetics and environmentally preferable attributes, but users of these products need to consider the application properties for a particular surface, as well as whether it will be durable for the traffic conditions of the facility. In addition, with labor accounting for up to 95% of a building's operating costs, any product characteristics that reduce labor are very attractive. Properly formulated floor finishes can save labor time by easing finish application and reducing the frequency of stripping and recoating operations.

Due to the large number of possible floor-maintenance products, traffic patterns, and soil types, the compatibility of floor finishes with the user's maintenance requirements is not specifically addressed in this standard. Product users should follow the manufacturer's instructions on compatibility with the floor surface to be finished and other floor maintenance products to be used. Environmentally preferable products may require initial training of janitorial staff to ensure adequate performance; because these products reduce or avoid many of the harsh chemicals that make other products work so quickly, environmentally preferable floor-care products may require different methods.

A common concern of those responsible for floor care is the durability and performance of zinc-free floor finishes. Although zinc-free finishes may have less toxic formulations, some users contend that they may be less durable and thus require more frequent stripping and refinishing. This could result in increased exposure for floor-maintenance personnel and introduce more toxins to the environment in the long run. Life-cycle analysis (LCA) is used to address the full environmental and health impacts of this type of scenario, in order to lead to responsible design of products that does not undermine the environmental and health goals that manufacturers and users of green products seek to promote. An industry-sponsored LCA is currently underway to evaluate the performance and relative impacts of zinc-free finishes compared with zinc-formulated finishes.

2.1.1 Slip resistance

Slip resistance is widely recognized as an important safety factor. Over 1 million Americans seek emergency room treatment for accidental falls annually. The majority of these are same-level falls, and most of the people are over the age of 60. This issue is growing in importance as the elderly proportion of the population increases (NFSI, 2004). In 2000, 565

people died from same level falls (slipping, tripping, or stumbling), which is comparable to the number of deaths from drowning in a swimming pool (NSC, 2003).

ASTM method D-2047 was developed by the floor finish industry specifically to test floor finishes for slip resistance. It uses the James Machine and the criterion is a static coefficient of friction (SCOF) of 0.5 for a dry surface finish. A comparable test method is Underwriters Laboratories (UL) 410.

The 0.5 SCOF standard was established in 1946, and was initially developed for leather shoes on dry, waxed floors. Today, less than 6 percent of shoe soles are leather and acrylic polymer finishes, which are more slippery when wet than when dry, have replaced wax. The Americans with Disabilities Act established a SCOF requirement of 0.6 for level surfaces, but did not specify either wet or dry conditions or a specific test method. This value has since been withdrawn.

The National Floor Safety Institute (NSFI) developed what they consider a more up-to-date, accurate, and portable test than the James Machine test, for general use on walkway surfaces (not just specifically for floor finishes), under more realistic use conditions (NFSI 101-A). It uses the NFSI Universal Walkway Tester. The NFSI has set a standard of 0.6 SCOF on wet surfaces "to meet a higher level of safety" than the 0.5 dry SCOF standard. NFSI has a grant from the Consumer Products Safety Commission to start an elderly slip prevention education program later this year, which will recommend the NFSI standard and test method (Kendzior, 2004).

For this standard, it is recommended that, at a minimum, floor finishes should meet ASTM D 2047 or UL 410 for slip resistance. The NFSI 101-A represents a stricter standard and is recommended as an alternative criterion.

2.1.2 Other performance measures

Green Seal seeks comment on other appropriate performance criteria for floor finishes or strippers for which standard test methods are available.

2.2 Human Health Hazards

In establishing a standard for floor care products, it is important to ensure that the products do not present a threat to human health or safety. Human-health and safety standards include acute toxicity, carcinogenicity, reproductive toxicity, skin and eye damage (corrosion), skin sensitization (contact dermatitis), and flammability. This section reviews human health and safety issues relevant to typical floor finish and stripper formulations and recommends criteria for Green Seal's environmental labeling standard for industrial and institutional floor-care products.

2.2.1 Acute toxicity

Agencies that have developed systems for classifying the toxicity of chemicals include the Consumer Products Safety Commission (CPSC), the Environmental Protection Agency (EPA) under the Toxic Substances Control Act (TSCA), the Occupational Safety and Health

Administration (OSHA), and internationally, the Organization for Economic Cooperation and Development (OECD).

These classification systems are generally based on the results of toxicity tests using laboratory animals. An acute oral LD50 is the concentration of a substance, expressed in mass of the substance per mass of the animal, that kills 50 percent of test animals within a specified time following a single oral dose. An acute dermal LD50 is the concentration of a substance, expressed in mass of the substance per mass of the animal, that kills 50 percent of test animals within a specified time when applied to skin. An acute inhalation LC50 is the concentration of a substance in air (gas, vapor, aerosol, fume, or dust) that kills 50 percent of test animals when inhaled continuously for a specified exposure period.

OECD has published the Harmonized Integrated Classification System for Human Health and Environmental Hazards of Chemical Substances and Mixtures (OECD, 2001), which is intended for international use. This integrated hazard classification system for chemicals divides acute toxicity hazards into five categories (Table 3). Category 5 represents chemicals with relatively low acute toxicity, but which still may present a danger to vulnerable populations.

For the purposes of this standard, Green Seal recommends use of the OECD criteria, because they were developed by an international organization. Specifically, the criteria for Category 5 chemicals are recommended; the oral toxicity criterion is LD50 > 2,000 mg/kg, and the toxicity criterion for inhalation of vapor is LC50 > 20 mg/L. Because dermal toxicity data are rarely available, and Green Seal does not wish to require additional animal testing, Green Seal is not including the criterion for dermal toxicity. Furthermore, products that pass the oral toxicity criterion will generally pass the dermal toxicity criterion.

Table 3. Toxicity levels in the Globally Harmonized System classification (OECD, 2001)

	Category 1	Category 2	Category 3	Category 4	Category 5
Oral (mg/kg)	5	50	300	2,000	5,000
Dermal (mg/kg)	20	200	1,000	2,000	
Vapors (mg/L)	0.5	2.0	10	20	

2.2.2 Carcinogenicity

The potential for a chemical to cause cancer in humans is evaluated by cancer weight-of-evidence (WOE) classifications and by cancer potency factors, typically determined from laboratory or epidemiological studies.

In assessing the carcinogenic potential of a chemical, EPA classifies the chemical into one of the following groups, according to the WOE from epidemiologic, animal, and other supporting data, such as genotoxicity test results. EPA categories are listed below[1]:

1 EPA has recently revised its guidelines, providing for more descriptive classifications as chemical carcinogenicity profiles are added or revised [EPA, 1999a].

- Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
- Group B: Probable Human Carcinogen (B1 - limited evidence of carcinogenicity in humans; B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans).
- Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
- Group D: Not Classifiable as to Human Carcinogenicity (inadequate or no evidence).
- Group E: Evidence of Non-Carcinogenicity for Humans (no evidence of carcinogenicity in adequate studies).

The International Agency for Research on Cancer (IARC) uses a similar WOE method for evaluating potential human carcinogenicity based on human data, animal data, and other supporting data. A summary of the IARC carcinogenicity classification system includes:

- Group 1: Carcinogenic to humans.
- Group 2A: Probably carcinogenic to humans.
- Group 2B: Possibly carcinogenic to humans.
- Group 3: Not classifiable as to human carcinogenicity.
- Group 4: Probably not carcinogenic to humans.

Both classification schemes represent judgments regarding the likelihood of human carcinogenicity (i.e., the extent to which the available data support the hypothesis that a substance causes cancer in humans).

The National Toxicology Program (NTP) was established in 1978 by the Secretary of Health and Human Services to coordinate toxicology research and testing activities within the Department, to provide information about potentially toxic chemicals to regulatory and research agencies and the public, and to strengthen the science base in toxicology. The NTP publishes the Annual Report on Carcinogens, which is a consensus list of chemicals that are either known or reasonably expected to cause cancer in humans. Several federal agencies are represented in the group that determines the chemicals for the report, including EPA, Occupational Safety and Health Administration (OSHA), the Food and Drug Administration, the Agency for Toxic Substances and Disease Registry (ATSDR), and the National Cancer Institute (NTP 1998a).

OSHA, under 29 CFR 1990.112, classifies potential carcinogens as either of the following:

- Category I Potential Carcinogen: the substance meets the definition of a potential occupational carcinogen in (1) humans, or (2) in a single mammalian species in a long-term bioassay where the results are in concordance with some other scientifically evaluated evidence of a potential carcinogenic hazard, or (3) in a single mammalian species in an adequately conducted long-term bioassay, in appropriate circumstances where the Secretary determines the requirement for concordance is not necessary. Evidence of concordance is any of the following: positive results from independent

testing in the same or other species, positive results in short-term tests, or induction of tumors at injection or implantation sites.

- Category II Potential Carcinogens: the substance meets the above criteria, but the evidence is only "suggestive" or only found in a single mammalian species without evidence of concordance.

Green Seal recommends that the products do not contain any potential, possible, probably, reasonably anticipated, or known human carcinogens as defined by any of the following agencies: IARC, NTP, EPA, and OSHA.

Of ingredients reported on the product MSDSs compiled for this evaluation, EPA classifies 2-butoxy ethanol as a possible human carcinogen (WOE Class C). 2-Butoxy ethanol was reported in half of the strippers for which we reviewed MSDSs.

2.2.3 Reproductive toxicity

California, under the Safe Drinking Water and Toxic Enforcement Act of 1986, is required to list chemicals known to the State to cause cancer or reproductive toxicity. In listing chemicals, the state relies on other authoritative bodies, such as EPA and IARC, and its own panel of experts. Under the law, a chemical is considered to cause reproductive toxicity when there is either human evidence or when studies in animals indicate that an association between the toxic agent and reproductive effects in humans is biologically plausible (California Code of Regulations, Title 22, Division 2, Subdivision 1, Chapter 3, Sections 12000, et seq.).

Green Seal recommends that products do not contain any chemicals known to cause reproductive toxicity as listed by the State of California.

In the floor finish and stripper products for which we reviewed MSDSs, two glycol ethers were reported that are listed as reproductive toxins:

- 2-methoxyethanol or ethylene glycol monomethyl ether (EGME), and
- 2-ethoxyethanol or ethylene glycol monoethyl ether (EGEE).

(Although not reported on any product MSDSs, the acetates of these compounds are also listed as reproductive toxins.)

2.2.4 Damage to skin and eyes

The CPSC, OSHA, OECD, and the cosmetics industry have developed criteria for skin and eye irritation. The CPSC defines an irritant as a compound that is not a corrosive but induces a local inflammatory reaction in normal living tissue as a result of immediate, prolonged, or repeated contact (16 CFR Part 1500.3). It states that skin irritants should be defined using the Draize skin test with rabbits (16 CFR Part 1500.42). The CPSC defines corrosive as any substance that, in contact with living tissue, will cause destruction of tissue by chemical action (16 CFR Part 1500.3). It uses the Draize test method to determine corrosivity and states that, when the compound is tested on the intact skin of the albino rabbit, the structure of the tissue at the site of contact is destroyed or changed irreversibly in 24 hours or less. OSHA uses the same

criteria as CPSC and references the CPSC definitions and protocols in defining skin and eye irritants (29 CFR Part 1910.100, App A).

The OECD considers a material corrosive to the skin if, using the results of animal testing, the material produces destruction of skin tissue (namely, visible necrosis through the epidermis and into the dermis) in one or more of three tested animals after exposure up to a four-hour duration [OECD Test Guide (TG) 404]. Corrosive reactions are typified by ulcers, bleeding, bloody scabs, and, by the end of observation at 14 days, discoloration due to blanching of the skin.

The OECD considers a material corrosive to the eye if it causes irreversible effects on the eye including persistent corneal opacity, discoloration of the cornea, adhesion, and interference with the function of the iris or other effects that impair sight. In this context, persistent lesions are considered those that are not fully reversible within an observation period of normally 21 days (OECD, TG 405). The OECD also recommends searching the literature and considering skin irritation test results before testing eye irritation/corrosion to avoid any unnecessary animal testing.

EPA, OSHA, and the CPSC have endorsed the use of synthetic skin for skin corrosion testing to reduce animal testing. Furthermore, peer-reviewed non-animal test methods for skin and eye corrosion have been developed. These include the Human Skin Construct systems (Liebsch et al. 2000; Fentem et al. 1998) for skin irritation/corrosion and the bovine corneal opacity and permeability test (BCOP) (Sina et al. 1995) for eye irritation/corrosion.

Green Seal would like to reduce animal testing; therefore, it recommends the Human Skin Construct systems test (Liebsch et al. 2000; Fentem et al. 1998) for skin corrosion and the BCOP test (Sina et al. 1995) for eye corrosion.

Although pH is not the only determining factor, acids and bases are often corrosive to skin and eyes. OECD (2001) classifies materials with a pH of less than 2 or over 11.5 as potentially corrosive. Floor finish product typically report a pH from 7.6 to 9.5. Strippers, however, are formulated with a high (alkaline) pH. Most stripper products reported a pH above 11.5, some as high as 13.5 or 14, although several were identified with a pH at or below 11.5.

Green Seal recommends product pH should be within the range of 2 to 11.5.

2.2.5 Skin sensitization

A sensitizer is a chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical. A person can become sensitized to a chemical by inhaling it or from dermal exposure. Some of the responses to sensitizers include contact dermatitis and inflammation of the mucus membranes. According to the US Bureau of Labor Statistics, occupational skin diseases (mostly in the form of contact dermatitis) are the second most common type of occupational disease, accounting for 14% of all occupational diseases (BLS, 1999).

Currently, structure-activity relationships or in vitro models for sensitization are not yet available to replace animal test methods. To reduce the amount of animal testing in product screening, a 1% ingredient level for known sensitizers has been recommended (Schlede et al., 1999) and is used by the EU (EC, 1999). If a product contains a known skin sensitizer at a concentration > 1%, then the product as a whole is considered a skin sensitizer.

2.2.6 Flammability

Some solvents in high enough concentrations can cause a floor finish to burn easily or be flammable. Flash point is a commonly used measure of flammability and is defined as the temperature at which vapor will ignite when an external flame is applied under specified test conditions.

Flammable and combustible substances must be handled with extreme caution. The CPSC defines a flammable substance as one with a flashpoint between 20 and 100 °F and a combustible substance as one with a flashpoint between 100 and 150 °F (16 CFR Part 1500.3(c)(6)). OSHA defines several classes of combustible liquids. The Department of Transportation allows liquids to be tested to determine if the liquid can sustain a flame instead of relying on flashpoint.

Green Seal recommends that a product not be flammable or combustible, therefore, the undiluted floor-care product should have a flashpoint above 150° F.

2.3 Air Quality Impacts

The volatile component of finishes and strippers may impact both indoor air quality and contribute to atmospheric impacts such as stratospheric ozone depletion or photochemical smog.

2.3.1 Ozone depletion

The use of ozone-depleting compounds (ODCs) as propellants in aerosol products such as cleaners has largely been banned by Section 610 of the Clean Air Act due to concern over their role in depleting the ozone layer. Other Green Seal standards (e.g., GS-34, GS-37) specifically prohibit the use of ozone-depleting compounds in products. No ozone-depleting compounds were reported in finish or stripper products for which ingredient information were available from either MSDS or additional manufacturer-supplied data. Green Seal is not specifically prohibiting ODCs in the standard at this time because ozone-depleting substances are not expected to be used in floor-care product formulations. If ODCs are found to be present in a product, the product will be excluded under the general provision in all Green Seal standards for "Unanticipated Environmental Impacts," which addresses any other features that significantly increase a product's impact on the environment.

2.3.2 Volatile organic compounds

VOCs have two different, but overlapping, definitions. One definition is simply organic (carbon-based) compounds that readily evaporate under normal conditions. Many floor maintenance products contain high levels of VOCs that contribute to indoor air pollution, which

can greatly impact human health. According to EPA, most people spend up to 90% of their time indoors. VOCs can cause nose and lung irritation, rashes, headaches, nausea, and asthma.

When considering the specific issue of ground-level ozone and photochemical smog, however, VOCs are defined in terms of their photochemical reactivity as well. Under the Clean Air Act, EPA defines VOCs in 40 CFR Section 51.100 as "any compound of carbon, excluding CO, CO_2, carbonic acid, metallic carbides or carbonates and ammonium carbonate, which participates in atmospheric photochemical reactions." The VOCs in floor finishes and strippers volatilize during use and can react with sunlight and atmospheric constituents to form smog and ozone. VOCs found in cleaners include alcohols and many of the glycol ethers.

The VOC content of certain consumer products is tightly regulated in locations such as Southern California. The California Air Resources Board (CARB) regulations for consumer products include the following limits for floor-care products:

- Polishes/waxes for flexible flooring: ≤7% VOC
- Floor wax stripper: light or medium buildup: ≤3% VOC
- Heavy buildup: ≤12% VOC

Other states are adopting these same limits to reduce ozone levels.

Green Seal recommends no more than 7% VOCs for floor finishes (undiluted) and no more than 7% VOCs for strippers at the lowest recommended dilution.

2.4 Water quality

Typically, the liquid waste from stripping finish and then rinsing a floor is discharged to the local wastewater system. Impacts from wastewater containing spent floor finish and stripper may include aquatic toxicity and excess nutrients. Whether ingredients degrade or persist in the environment also determines the extent of the potential impacts.

2.4.1 Aquatic toxicity

Wastewaters that are toxic can harm fish and other aquatic organisms and may interfere with wastewater treatment operations. A common measure of aquatic toxicity is the concentration at which half of the population of test organisms dies within a certain time frame. For example, “LC50 (fish, 96h)” is a common measure of aquatic toxicity that denotes the concentration at which 50% of fish die in 96 hours.

Table 4 presents acute aquatic toxicity data for selected, commonly reported finish and stripper ingredients. With the exception of zinc (and in some cases, benzyl alcohol), common ingredients, when weight percent in a formulation is taken into account, have an acute aquatic toxicity of > 100 mg/L.

2.4.2 Phosphorus (eutrophication)

Eutrophication is caused by the discharge of nutrient-rich wastes into bodies of water. These wastes cause algae blooms and subsequent dissolved-oxygen depletion as the algae dies. This reduction in dissolved oxygen harms aquatic life, leads to fish kills, and poses aesthetic

problems. Phosphates are a major cause of eutrophication in surface waters (Ford 1993). One phosphorus-containing ingredient is often used in finishes – tributoxy ethyl phosphate, which is 7.8 % phosphorus by weight. Green Seal selected a phosphate limit of 0.5%, as phosphorus (P), because it effectively limits the quantity of phosphates and it coincides with the criteria in many state purchasing programs.

2.4.3 Ready biodegradability

Biodegradation can occur aerobically, in the presence of oxygen, or anaerobically, in the absence of oxygen. Some compounds are readily biodegradable with aerobic organisms but are resistant to biodegradation by anaerobic organisms. Several types of tests are used to measure biodegradability, from simple bottle tests to tests that attempt to simulate sewage treatment plant conditions. The International Standards Organization (ISO) has published a number of tests for measuring ultimate biodegradability in aquatic environments. The Organization for Economic Cooperation and Development (OECD) developed a definition for a readily biodegradable compound that states that a compound is readily biodegradable if, in a 28-day test, it biodegrades by 60% or more within 10 days of the time when biodegradation first reaches 10%.

Green Seal recommends that all organic ingredients, excluding the polymers, waxes, and resins used in finishes, should be readily biodegradable.

Table 4. Aquatic toxicity of selected floor finish and stripper ingredients

Ingredient	Product type (finish or stripper) commonly reporting ingredient on MSDS	Reported concentration in product (weight %)	Fish LC50 [(1)] (mg/l)	Daphnia LC50 [(1)] (mg/L)	Individual ingredient toxicity in product as used > 100 mg/L? (Based on available data) [(2)]
Diethylene glycol ethyl ether (111-90-0)	Finishes	1 – 8	5,000 – 26,500	3,340 – 4,670	yes
Diethylene glycol monomethyl ether (111-77-3)	Finishes	1 - 9	5,000 – 7,500	no data	yes
Tributoxy ethyl phosphate (78-51-3)	Finishes	0 - 6	6.8 – 44	no data	yes
2-Butoxy ethanol (111-76-2)	Strippers	5 – 30	1,395 – 1,700	1,720	yes
Benzyl alcohol (100-51-6)	Strippers	2 - 60	10 – 1,050	no data	depends of weight % and dilution
Potassium hydroxide (1310-58-3)	Strippers	0.3 - 10	80 - 165	no data	yes
Monoethanolamine (141-43-5)	Strippers	1 - 30	150 – 5,000	140	yes
Sodium xylene sulfonate (1300-72-7)	Strippers	0.5 - 15	no data	no data	
Sodium metasilicate (6834-92-0)	Strippers	1 – 17	no data	no data	
Zinc and zinc compounds	Finishes	0.1 - 5	0.066 to 40.9 [(3)]	0.068 to 0.80 [(3)]	No
Dipropylene glycol methyl ether (34590-94-8)	Finishes	0 - 10	no data	no data	
Ethylene glycol (107-21-1)	Finishes	0.8 - 5	1,000 – 81,950	6,900 – 57,600	yes
Acrylic polymer (67366-74-9; 63744-68-3; 25987-66-0)	Finishes	10 - 45	no data	no data	

(1) Source: ECOTOX database, queried 10 March 2004, unless otherwise noted
(2) Taking ingredient weight percent into account
(3) Source: EPA, 1987

2.5 Specific ingredient concerns

2.5.1 Zinc and other heavy metals

Zinc, a component of many floor finishes, is a naturally occurring element and an essential nutrient for humans and animals. Although required at low levels, zinc is toxic in higher amounts. Aquatic life is especially sensitive to zinc, and human activities contribute large amounts of zinc to surface waters.

The major anthropogenic sources of zinc to surface water are soil erosion, urban runoff , mine drainage, and municipal and industrial effluents. Human activities account for 70% of soil erosion, and soil particles contain natural traces of zinc. Most zinc from urban runoff originates from buildings and cars (e.g., from galvanized roofing, eroded brakes, and tire rubber). Not surprisingly, large amounts of zinc can run off from current or past zinc mining activities. Finally, a variety of sources contribute to zinc in municipal and industrial effluents. Publicly-owned treatment works (POTWs) are the largest total point source for zinc discharges (ATSDR, 2003). Zinc ranks 7th out of all Toxics Release Inventory (TRI) chemicals for releases to surface water (RTKNET, 2004). Zinc from stripping floor finishes is most often discharged to municipal sewage treatment plants when the stripping and rinsing solutions are poured down the drain.

Concentrations of zinc are usually limited by sewer agencies because zinc in wastewater can lessen the ability of specific bacteria to decompose sewage, inhibiting sewage plant efficiency (Locco et al., 2000). Sewer districts monitor certain zinc-using industrial and institutional customers so they do not exceed threshold levels of zinc in their wastewater. At the treatment plant, some of the zinc precipitates out with sewage sludge, which is then either landfilled or used as fertilizer. Zinc that is not precipitated out in the treatment process is discharged to local receiving waters. Municipal wastewater treatment plants using typical biological treatment processes removed from 20 to 91 percent of zinc (EPA, 1982).

As little as 0.07 mg/l (70 μg/L) of zinc is acutely toxic to some fish and other freshwater organisms (see Table 4). The ambient water quality criteria for zinc, established to protect aquatic life, range from 81 to 120 μg/L for saltwater and freshwater (EPA, 2002). An average influent level of zinc of 0.7 mg/l has been reported in the literature (from 239 U.S. wastewater treatment plants, from all sources of zinc; Minear et al., 1981). Assuming 80% removal through treatment at a POTW, 0.14 mg/l (or 140 μg/L) would be left in the wastewater and be discharged to surface water in the treatment plant effluent. Thus, a plausible effluent concentration of zinc exceeds the ambient water quality criteria and acute toxicity levels for some fish and other aquatic organisms.

Although the floor-finish industry's contribution may be a relatively small proportion of total zinc releases to surface water, the zinc contribution of floor-care products may still represent a toxic burden to aquatic life. Technology is available to manufacture zinc-free floor finishes, which avoid adding to this potentially toxic load of zinc pollution. An added incentive for making zinc-free products is the fact that many U.S. cities, states, universities, and the U.S. Green Building Council have begun to require the use of zinc-free finishes in their custodial cleaning products and service contracts.

In general, the use of zinc (or other metals) in floor-care products results in widely dispersed environmental releases. In addition, many heavy metals are toxic to humans or other organisms, metals do not degrade in the environment, and metal-free alternatives to zinc cross-linked polymers are currently available. Therefore, no heavy metals should be used as ingredients in floor care products. These prohibited metals include zinc, arsenic, lead, cadmium, cobalt, chromium, mercury, nickel, and selenium, as well as other heavy and/or toxic metals.

2.5.2 Glycol ethers

Glycol ethers are commonly used solvents. 2-Butoxy ethanol (also known as ethylene glycol butyl ether or EGBE), ethylene glycol methyl ether (EGME), and ethylene glycol ethyl ether (EGEE) give rise to concerns resulting from prolonged exposure by inhalation and skin contact during cleaning and through possible ingestion by children. EPA considers 2-butoxy ethanol, a common ingredient in floor strippers, to be a possible human carcinogen. In addition, it is easily absorbed through the skin, can break down red blood cells, and can also damage the liver and kidneys. Human exposures to EGME and EGEE (found primarily in floor finishes) have been found to cause birth defects and damage to reproductive organs (OEHHA, 2001; EPA, 1999b).

Properties of the most commonly reported glycol ethers in floor finish and stripper products are presented in Table 5.

Table 5. Acute toxicity, vapor pressure, and other health concerns of commonly-reported[1] glycol ethers in floor finish and stripper products

Chemical name(s) [CAS RN]	LD_{50} Oral (mg/kg)	LD_{50} Skin (mg/kg)	LC_{50} Inhalation (ppm)	Vapor pressure (mmHg @25C)	Other concerns[2] (VOC, reproductive toxin, carcinogen)
Diethylene glycol monoethyl ether [111-90-0]	550	8,500	No toxicity observed at saturation vapor concentration	0.126	VOC, HAP
Diethylene glycol monomethyl ether [111-77-3]	5,500	6,540	(no data available)	0.18	VOC, HAP
Dipropylene glycol monomethyl ether [34590-94-8]	5,135	9,500	>1,213	0.55	VOC, HAP
Diethylene glycol monobutyl ether [112-34-5]	5,660	4,120	(no data available)	0.0219	VOC[3], HAP
Ethylene glycol monobutyl ether; 2-butoxy ethanol [111-76-2]	1,480	400	450	0.88	VOC, HAP, Possible human carcinogen (EPA WOE Class C)
Ethylene glycol phenyl ether [122-99-6]	1,260	5,000	No toxicity observed at saturation vapor concentration	0.03	VOC[3], HAP

[1] Reported on 4 or more finish and/or stripper MSDSs.
[2] VOC: volatile organic compound; HAP: Classified as a hazardous air pollutant under the Clean Air Act.
[3] The California Air Resources Board (CARB) considers glycol ethers with VP < 0.1 mm Hg to be VOC exempt.
Sources: NCMS, 2004; HSDB, 2004; EPA, 2004.

2.5.3 Phthalates

Phthalates are widely used plasticizers. In reviewing product MSDSs, one unidentified plasticizer was reported in a finish product, and dibutyl phthalate was reported in 4 out of 62 finish products. No phthalates were reported as stripper ingredients.

Phthalates are prohibited by Green Seal because of their potential to act as endocrine disrupters.

2.5.4 Alkylphenol ethoxylates

Alkyphenol ethoxylates are nonionic surfactants, typically used in cleaning products, laundry detergents, personal care products, pesticide formulations, paper making, and in aircraft deicing fluids. As a class of compounds, they are slow to completely biodegrade in water, but are bioactivated in the environment (they degrade partially, resulting in a more toxic chemical form.) The most commonly used APEs are nonylphenol ethoxylates (NPEs) and octylphenol ethoxylates (OPEs).

APEs and alkylphenols act as estrogen mimics. A growing number of published studies have linked the occurrence of APEs or their breakdown products (such as alkylphenols) in surface water with biological effects in fish and other aquatic populations. Data on exposure and effects for humans are very limited. However, disruption of the endocrine system in humans can result in reproductive and developmental problems. APEs should be prohibited as ingredients in floor-care products.

APEs are used in some floor-care products. Those reported in products include nonylphenol ethoxylate in one stripper and octyl phenoxy polyethoxy ethanol in two finish products.

2.5.5 Ammonia

Floor strippers may contain aqueous ammonia, which is used to dissolve and remove highly resistant polymer floor finishes. In these alkaline (high pH) formulations, ammonia readily evaporates from solution. Ammonia is a severe respiratory tract irritant, and exposure to fumes may trigger immediate attacks in chemically sensitive individuals such as asthmatics (Cleaningpro, 2004). For that reason, monoethanolamine (MEA) is often used to replace aqueous ammonia in strippers. Although MEA is free of a strong ammonia odor, direct contact may cause severe eye irritation or burns, it may be absorbed through the skin in harmful amounts, and inhalation may irritate the respiratory tract and cause central nervous system effects such as dizziness or headache.

Ammonia is acutely toxic by inhalation, with inhalation LC50s as low as 373 mg/m^3. Ammonia is also toxic to aquatic organisms, with LC50 for fish (rainbow trout fry) as low as 0.068 mg/l, which is comparable in aquatic toxicity to zinc (data source: HSDB, 2004). The acute toxicity criteria recommended for floor-care products (inhalation toxicity of at least 20,000 mg/m^3 and aquatic toxicity at least 100 mg/l) effectively limit the total amount of ammonia that may be present in a product to less than 2% and 0.1 %, respectively. Therefore, a specific ingredient prohibition for ammonia is not recommended.

2.5.6 Urethane and Styrene Polymers

Urethane polymers were not seen on any product MSDSs examined in this evaluation. However, urethanes are reportedly used in floor finishes to improve chemical and water resistance, impact resistance, and flexibility. Polyurethanes coatings made from toluene diisocyanate (TDI) are often used to finish wood floors (which is outside the scope of this standard) and in the clear coat of automotive paints. Diisocyanates are sensitizers at low levels. NIOSH (1996) issued an alert that states: "Workers exposed to diisocyanates may develop serious or fatal respiratory disease." In addition, TDI is possibly carcinogenic to humans (IARC Group 2B). This standard proposes prohibiting sensitizing ingredients in floor-care products, as well as carcinogenic ingredients. Because residual diisocyanates are prohibited by other human health criteria, and urethanes are not typically reported in resilient floor-finish products, no specific ingredient prohibition is proposed for urethane polymers.

Styrene is listed in nine finish product MSDSs as styrene acrylic copolymer, styrene acrylic emulsion, or styrene acrylic polymer, at 10 to 60 percent by weight. Residual styrene monomer may be present in styrene polymers. Monostyrene is a narcotic and central-nervous-system toxin. In addition, styrene is possibly carcinogenic to humans (IARC Group 2B). Because the criterion for carcinogens

prohibits styrene monomer in undiluted products at or above 0.01 percent by weight, no specific ingredient prohibition is proposed for styrene polymers.

2.6 Packaging and transportation

2.6.1 Recyclable packaging

Beyond the product formulation itself, there are packaging attributes that make one product preferable to another. The packaging should be readily recyclable in most areas. The most common product containers are made of high-density polyethylene (HDPE), a plastic that is commonly recycled.

In addition to being recyclable, the packaging should also be made from recycled materials. Many manufacturers use plastic containers that are made from some amount of post-consumer recycled materials.

Products that are sold in bulk often reduce the total amount of packaging needed as well as energy needed to transport the product in fewer shipments. Lightweight flexible packaging (e.g., pouches or bags) may also represent a significant reduction in material use.

2.6.2 Concentrated products

Finishes are typically sold in a ready-to-use form and used without dilution. Strippers are sometimes sold as a concentrate with recommended dilutions ranging up to 1:16, in part depending on the amount of finish to be removed (more dilute to remove light finish build-up, more concentrated for heavy build-up). At this time Green Seal is not requiring that floor finishes or strippers be sold as concentrates.

2.7 Animal testing

Green Seal wants to discourage animal testing and will accept the results of past peer-reviewed or standard tests demonstrating compliance with a criterion. A mixture need not be tested if existing information demonstrates that each of the ingredients complies with a criterion. Additionally, non-animal (in-vitro) test results may be accepted, providing that the test methods are referenced in peer-reviewed literature and the manufacturer provides the reasons for selecting the particular test method.

2.8 Training and Labeling

Proper floor maintenance will increase the life of a floor finish and decrease the frequency of stripping and refinishing. Education of janitorial workers in proper floor cleaning and maintenance methods can reduce the amount of floor-care products used over the long term, and reduce other building hazards such as slippery floors. In some applications, even an environmentally preferable product may still pose some type of health hazard or environmental risk. Training workers to handle hazardous products correctly, to avoid spraying or otherwise contaminating the air with maintenance products, and to dilute products correctly can reduce the risk of chemical injury and the amount of product required for the job.

Proper maintenance procedures can reduce human and environmental exposure to floor-maintenance products in the following ways:

- Modifying the techniques that cleaning staff use can result in use of smaller quantities of the product.

- Scheduling floor-renewal work according to wear patterns rather than simply following a calendar schedule, and following the manufacturer's dilution recommendations could reduce the overall amount of product used.
- If a stripper is to be diluted, following the label directions for proper dilution amounts and procedures.
- Thoroughly rinsing the stripped floor helps to neutralize the surface prior to applying the new floor finish (EPA Region IX et al., 1999; Eco-Efficiency Centre, undated).
- Regular wet-mopping, dusting, and vacuuming preserve the finish and avoid too-frequent stripping (INFORM, 2002).
- Placing doormats at entryways minimizes dirt and grit entering the building.

While great strides have been made in developing environmentally preferable floor-maintenance products, many compounds and materials may still have a harmful effect on human health if applied improperly. It can't be over-emphasized that a floor-maintenance professional must know the proper use and potential hazards of the floor-care products they are using. For even environmentally preferable floor-care products may be corrosive to skin or eyes if not used properly. It is recommended to:

- Always use personal protective equipment such as gloves, eye protection, and suitable footwear.
- Ensure adequate ventilation when using these products. Some building occupants may be sensitive to the vapors or residues from floor-care products. If that is the case, do your stripping work at night, on weekends, or during holidays. Also, open windows if possible and use fans to increase the amount of outside air flowing into the area where you are working. Take care that these fans don't make the new floor finish dry unevenly.
- Floor finish and stripper products should never be disposed of outdoors. It is illegal to pour strippers or any other chemicals on the ground, in a parking lot, or in any other outdoor area.

Environmentally preferable floor maintenance products help protect the environment by reducing toxics, air and water pollution, and solid waste (generated by excessive packaging). The use of environmentally preferable floor products also protects human health by reducing exposure to harmful chemicals.

Section 3
Existing Health and Environmental Performance Standards

3.1 Nordic Ecolabelling

Criteria for the Nordic Ecolabelling standard for filmforming floor-care products (Nordic Ecolabelling Board, 2000) include the following:

- Product requirements: not classified by the EU or Nordic countries as an environmental hazard, very toxic, harmful to health, corrosive, irritant, allergenic, carcinogenic, harmful to reproductive system or genetically harmful, fire hazard or explosion hazard.
- Ingredient concentration limits: ingredients classified as environmentally harmful, plasticizers, low boiling point (<150°C) solvents, aromatic and halogenated solvents, NTA, preservatives, monomers, fluorinated surfactants.
- Prohibited ingredients: EDTA, phosphonates, phthalates, bioaccumulating preservatives, fragrance, colorings, APEO, LAS
- Packaging and labeling: recyclable packaging, no chlorinated plastics, weight-to-utility ratio, follow EU recommendations on product labeling, specify correct dose, recommendations for application and removal.
- Biodegradability: surfactants must be readily biologically and non anaerobically degradable
- Performance: water resistance, cleaning resistance, recoatability, non-slip properties, gloss, removability.

3.2 Environmental Choice Program

Environment Canada's Environmental Choice^{M} program issued a draft certification criteria document (CCD-147) for hard floor and furniture care products, which includes floor finish and strippers, on February 10, 2004. Criteria for finishes and strippers include the following:

- Performance: finishes must meet CAN/CGSB-25.21-M89, Detergent resistant floor polish; strippers must meet CAN/CGSB-2.60-92, remover for water-emulsion floor polish and wax.
- Toxicity: EC50 luminescent bacteria >500 mg/l and oral LD50 >4,000 mg/kg.
- Biodegradability: All finish ingredients must be readily biodegradable apart from the polymer, wax and resin proportion; all stripper ingredients must be readily biodegradable.
- Other hazards: not require warning labels as corrosive.
- Ingredient concentration limits: fluorinated surfactants, VOCs, preservatives.
- Prohibited ingredients: ammonia, zinc (or limit amount), polymers of styrene or urethane (or limit monomer amount), halogenated solvents, aromatic solvents (or limit amount), phthalates, ethylene glycol monomethyl ether or its acetate, ethylene glycol monoethyl ether or its acetate, ethylene glycol monobutyl ether or its acetate, ethylene glycol monopropyl ether or its acetate, EDTA, polyphosphates or phosphonates, APEOs, non-food-grade acids and thickeners, ingredients with sole purpose of changing the scent of a product, carcinogens, reproductive or developmental toxins, and endocrine disruptors.

- Packaging and labeling: includes instructions for safe handling and use, maximizing product performance, proper waste disposal, and recyclability of container/packaging; no chlorinated plastic packaging, packaging with post-consumer recycled content, no propellants, not sold as disposable wipes.

3.3 Massachusetts RFR

A work group organized by the Center for a New American Dream and including Massachusetts; Santa Monica, California; King County, Washington; Minnesota; Seattle, Washington; Pacific Northwest National Laboratory; and others convened to try to develop national consensus-based criteria for environmentally preferable cleaning products. Using GS-37 as a basis, they expanded the criteria to include other cleaning product categories, including floor-care products. Massachusetts was the first of the work group members to issue a request for response (RFR) incorporating the new criteria; those specifications for floor care products are as follows:

Floor finishes

Mandatory:

- The product must be free of zinc and other heavy metals

Desirable:

- No phthalates
- No glycol ethers or ammonia

Floor strippers

Mandatory:

- The product must be free of zinc and other heavy metals

Desirable:

- Product pH between 2.5 and 12
- VOC content not greater than 1%
- No glycol ethers or ammonia

3.4 Green Seal GS-37

GS-37 was developed specifically for industrial and institutional general-purpose, bathroom, and glass cleaners. Although this standard does not include floor-care products, it addresses many similar concerns and use settings. Criteria are summarized as follows:

- Toxicity: oral LD50 > 2,000 mg/kg; inhalation LC50 > 20 mg/L.
- Other hazards: not corrosive to skin or eyes, not a skin sensitizer.
- Prohibited ingredients: carcinogens, reproductive toxins, alkylphenol ethoxylates, dibutyl phthalate, heavy metals (arsenic, lead, cadmium, cobalt, chromium, mercury, nickel, selenium), and ozone-depleting compounds.
- Ingredient concentration limits: VOCs, phosphorus, and fragrances.
- Biodegradability: organic ingredients display ready biodegradability.
- Aquatic toxicity: acute LC50 algae, daphnia or fish > 100 mg/L.
- Packaging and labeling: concentrate (at least 1:8 dilution ratio), primary packaging must be recyclable or manufacturer provides for return and refilling, label clearly states that dilution should be from the cold tap, detailed instructions for proper use, disposal, and use of personal protective equipment.

Section 4
Recommended Standard

4.1 Scope

This standard establishes environmental requirements for industrial and institutional floor-care products. The floor-care products addressed by this standard include floor finish and floor finish stripper. For purposes of this standard, floor finish (also called floor polish) is defined as any product designed to polish, protect, or enhance floor surfaces by leaving a protective wax, polymer, or resin coating that is designed to be periodically removed (stripped) and reapplied. Floor finish stripper (or floor finish remover – referred to here as "stripper") is defined as a product designed to remove floor finish through breakdown of the finish polymers, or by dissolving or emulsifying the finish, polish, or wax. This standard does not address general-purpose cleaners that can be used to clean floors[2], floor sealers, spray buffing products, or products designed to remove floor wax solely through abrasion.

Product users should follow the manufacturers' instructions on compatibility. Each application must be designed to work together in an environmentally preferable system of overall floor care. Therefore, both the finish and its compatible stripper(s) must meet all of these criteria unless otherwise indicated.

Each criterion states whether it applies to the undiluted product or to the product as used. All criteria pertain to both finishes and strippers unless otherwise indicated.

4.2 Definitions

Corrosive. A substance that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact

Dispensing-system concentrate. Products that are designed to be used in dispensing systems that cannot be practically accessed by users.

Ingredient. Any constituent of a product that is intentionally added or known to be a contaminant that comprises at least 0.01% by weight of the product.

Primary packaging. The material physically containing and coming into contact with the product, not including the cap or lid of a bottle.

Product as used. The most concentrated form of the product that the manufacturer recommends for a product's intended use. For example, if a manufacturer recommends a concentrated floor-stripping product be diluted 1:4 with water, the product shall meet the environmental and performance requirements at a dilution of 1:4.

Recyclable package. The package can be diverted from the waste stream through available processes and programs, and can be collected, processed, and returned to use in the form of raw materials or products.

Undiluted product. The most concentrated form of the product produced by the manufacturer for transport outside its facility.

[2] GS-37 addresses general-purpose cleaners, including those that are used to clean floors.

4.3 Product-Specific Performance Requirements

4.3.1 Slip resistance

Floor finish products shall have a static coefficient of friction [SCOF] of at least 0.5 as measured by either ASTM D2047-99 or UL Method 410. Alternatively, a floor finish product can be certified under the NFSI standard UWT-101A.

4.3.2 Additional performance requirements [Reserved]

Green Seal seeks comment on any additional desirable performance criteria, such as detergent resistance, hardness, resistance to scuff marks, gloss, etc.

4.4 Product-Specific Health and Environmental Requirements

4.4.1 Toxic Compounds

The undiluted product shall not be toxic to humans. Dispensing-system concentrates shall be tested as used. A product is considered toxic if any of the following criteria apply:

Oral lethal dose 50 (LD50)	< 2,000 mg/kg
Inhalation lethal concentration (LC50)	< 20 mg/L*

* If the vapor-phase concentration of the product at room temperature is less than 20 mg/L, it should be tested at its saturation concentration. If it is not toxic at this concentration, it passes the inhalation criterion.

The toxicity testing procedures shall follow the protocols put forth by the Organization for Economic Cooperation and Development (OECD) Guidelines for Testing of Chemicals. These protocols include: Acute Oral Toxicity Test (TG 401) and Acute Inhalation Toxicity Test (TG 403). Toxicity shall be measured on the product as a whole.

To demonstrate compliance with this requirement, a mixture need not be tested if existing toxicological information demonstrates that each of the ingredients complies. It is assumed that the toxicity of the individual ingredients is additive and that there are no synergistic effects. The toxicity values are adjusted by the weight of the ingredient in the product and summed using the following formula:

$$TP = \left(\sum_{i=1}^{n} \frac{wt_i}{TV_i} \right)^{-1}$$

Where,
TP = toxicity of the product
wt_i = the weight fraction of the ingredient
TV = the toxicity value for each ingredient (LD_{50}, LC_{50})
n = number of ingredients

Inhalation toxicity will not be required for any compound with a vapor pressure of 1 mmHg or less.

4.4.2 Carcinogens and Reproductive Toxins

The undiluted product shall not contain any ingredients that are carcinogens or that are known to cause reproductive toxicity. Carcinogens are defined as those chemicals listed as known, probable, or

possible human carcinogens by the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP), the U.S. Environmental Protection Agency, or the Occupational Health and Safety Administration. Chemicals known to cause reproductive toxicity are defined as those listed by the State of California under the Safe Drinking Water and Toxic Enforcement Act of 1986 (California Code of Regulations, Title 22, Division 2, Subdivision 1, Chapter 3, Sections 1200, et seq.).

For purposes of this standard, naturally occurring elements and chlorinated organics that may be present as a result of chlorination of the water supply and that are listed as carcinogens or reproductive toxins may be present as impurities if the concentrations are below the applicable maximum contaminant levels in the National Primary Drinking Water Standards found in 40 Code of Federal Regulations (CFR) Part 141.

4.4.3 Corrosiveness

The undiluted product shall not be corrosive to the skin or eyes. Dispensing-system concentrates shall be tested as used. The undiluted cleaning product shall not be corrosive to the skin, as tested using the Human Skin Construct systems (Liebsch et al. 2000; Fentem et al. 1998). The undiluted product shall also not be corrosive to the eye as tested using the bovine opacity and permeability test (BCOP) (Sina et al. 1995) after a 10-minute exposure. Green Seal will also accept the results of other peer-reviewed or standard in vitro or in vivo test methods demonstrating that the product mixture is not corrosive.

The pH of the product shall not exceed 11.5. The pH is measured using a pH meter and Method 9040 in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA Publication SW-846.

4.4.4 Skin Sensitization

The undiluted product shall not be a skin sensitizer, as tested by the OECD Guidelines for Testing Chemicals, Section 406. Dispensing-system concentrates shall be tested as used. Green Seal shall also accept the results of other standard test methods, such as those described in Buehler (1994) or Magnusson and Kligman (1969), as proof that the product or its ingredients are not skin sensitizers. If a product contains a known skin sensitizer at a concentration > 1%, then the product as a whole shall be considered a skin sensitizer, except where explicit data demonstrate that it is not a skin sensitizer.

4.4.5 Flammability

The undiluted product or 99% by volume of the product ingredients shall have a flashpoint above 150°F, as tested using either the Cleveland Open Cup Tester (ASTM D92-97) or a closed-cup method International Standards Organization (ISO) 13736 or ISO 2719. Alternatively, the product shall not sustain a flame when tested using ASTM D 4206.

4.4.6 Air Quality

The product as used shall not contain substances that contribute significantly to the production of photochemical smog, tropospheric ozone, or poor indoor-air quality. Therefore, the volatile organic content of the undiluted finish product shall not exceed 7% by weight, and the volatile organic content of the stripper product, as used, shall not exceed 7% by weight, as determined by California Air Resources Board Method 310.

4.4.7 Toxicity to Aquatic Life

The product as used shall not be toxic to aquatic life. A compound is considered not toxic to aquatic life if it meets one or more of the following criteria:

Acute LC50 for algae, daphnia, or fish >100 mg/L

For purposes of demonstrating compliance with this requirement, aquatic toxicity testing is not required if sufficient aquatic toxicity data exist for each of the product's ingredients to demonstrate that the product mixture complies. Aquatic toxicity tests shall follow the appropriate protocols put forth in ISO 7346.2 or OECD test guidance 203 for fish and in OECD test guidance 201 and 202 for algae and daphnia, respectively.

4.4.8 Eutrophication

Phosphates and phosphonates shall not be present in the product as used in quantities above 0.5% by weight of total phosphorus.

4.4.9 Aquatic Biodegradability

Each of the organic ingredients shall exhibit ready biodegradability in accordance with the OECD definition, except for the polymer, wax, and/or resin portion of a floor finish. Biodegradability shall be measured by one of the following methods: ISO 9439 carbon dioxide (CO2) evolution test, ISO 10708 (two-phase closed-bottle test), ISO 10707 (closed bottle test), or ISO 7827 (dissolved organic carbon removal). Specifically, within a 28-day test, the ingredient shall meet one of the following criteria within 10 days of the time when biodegradation first reaches 10%:

- Removal of dissolved organic carbon (DOC) > 70%
- Biological oxygen demand (BOD) > 60%
- % of BOD of theoretical oxygen demand (ThOD) > 60%
- % CO2 evolution of theoretical > 60%

For organic ingredients that do not exhibit ready biodegradability in these tests, the manufacturer may demonstrate biodegradability in sewage treatment plants using the Coupled Units Test found in OECD 303A by demonstrating dissolved organic carbon (DOC) removal > 90%.

Testing is not required for any ingredient for which sufficient information exists concerning its biodegradability, either in peer-reviewed literature or databases or proving that the ingredient was tested in accordance with standard test procedures.

4.4.10 Packaging

The primary package shall be recyclable. An exception may be made for lightweight flexible packaging (e.g., pouches or bags) that represent a significant reduction in material use.

4.4.11 Prohibited Ingredients

The product shall not contain the following ingredients:

- Alkylphenol ethoxylates
- Phthalates
- Zinc or other heavy metals, including arsenic, lead, cadmium, cobalt, chromium, mercury, nickel, selenium.

4.4.12 Training

The product manufacturer, its distributor, or a third party shall offer training or training materials in the proper use of the product. These shall include step-by-step instructions for the proper dilution, use, disposal, and the use of equipment. Manufacturers shall have product-labeling systems to assist non-English-speaking or illiterate personnel.

4.4.13 Labeling Requirements

Where dilution is required, the manufacturer's label shall state clearly and prominently that dilution with water from the cold tap is recommended and shall state the recommended level of dilution. The manufacturer shall also include detailed instructions for proper use and disposal and for the use of personal protective equipment.

Whenever the Green Seal certification mark appears on a package, the package shall contain a description of the basis for certification. The description shall be in a location, style, and typeface that are easily readable. Unless otherwise approved in writing by Green Seal, the description shall read as follows:

"This product meets Green Seal's standards for industrial and institutional floor-care products based on its reduced human and aquatic toxicity and reduced smog production potential."

4.4.14 Animal Testing

Green Seal wants to discourage animal testing and will accept the results of past peer-reviewed or standard tests demonstrating compliance with a criterion. A mixture need not be tested if existing information demonstrates that each of the ingredients complies with a criterion. Additionally, non-animal (in-vitro) test results may be accepted, providing that the test methods are referenced in peer-reviewed literature and the manufacturer provides the reasons for selecting the particular test method.

Section 5
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