



CALL FOR COMMENTS ON PROPOSED STANDARD REVISIONS: Exemption for Titanium Dioxide in Solid, Enzyme-Based Cleaning Products

As of April 8, 2019, Green Seal® is inviting feedback on proposed revisions to a number of its standards that cover enzyme-based cleaning products. We are seeking comments from all stakeholders, including industry experts, public health researchers, product designers, raw material suppliers, product testing laboratories, purchasers, end users, and the general public.

Document Guide:

- Instructions for Comment Submission [Below]
- Revision Proposal Summary [[Page 2](#)]
- Tracked Changes of Proposed Revisions in Green Seal Standards [[Pages 3 to 8](#)]
- Research Record and Rationale for Exemption of Potential Hazard [[Pages 9 to 10](#)]
- Current Exemptions for Titanium Dioxide in Other Green Seal Standards [[Page 11](#)]
 - Sanitary Paper (GS-1); Paints, Coatings, Stains, and Finishes (GS-11); and Personal Care Products (GS-50)

Instructions for Submitting Comments:

Extension, Phase 2:

As of May 10, Green Seal has extended the deadline for comments to Monday, May 20, 2019, at 8 PM ET.

Please submit all comments to standards@greenseal.org using the subject line:

- “Comments on Titanium Dioxide Exemption.”

For questions about this process or proposal, or requests for extensions, please contact:

- Brie Welzer, Standards Program Manager, bwelzer@greenseal.org.

Green Seal® is the leading U.S. ecolabel, symbolizing transparency, integrity, and proven environmental leadership. We develop life-cycle-based standards and certify products and services that can prove they meet our strict criteria for human health, reduced environmental impacts, and effective performance. Operating as a nonprofit since its founding in 1989, Green Seal has certified thousands of products and services in over 450 categories, and is specified by countless schools, government agencies, businesses and institutions.

Standard Revision Proposal Summary:

Green Seal proposes to add an exemption for titanium dioxide specifically for enzyme-based cleaning products that are sold in solid form. This chemical compound is currently prohibited as an ingredient in most Green Seal standards due to its classification as a Possible Human Carcinogen (Group 2B) by the International Agency for Research on Cancer (IARC).¹ This exemption proposal is based on the results of a two-party Green Seal study:

1. A market review of enzyme-based cleaning products,
2. An analysis of the current Green Seal requirements and resulting human health protections defined for enzyme-based cleaning products.

Market Review Summary

- Titanium dioxide is a common ingredient in enzyme-based cleaning products that are sold in solid form. The compound is not known to be an ingredient in liquid detergents.
- Titanium dioxide is an ingredient in both conventional products and those products that make claims of environmental preferability.
- Products formulated with titanium dioxide exist on both Industrial and Institutional (“I&I”) and Household markets.

Lifecycle Review: Health Impacts Summary

Titanium dioxide is a hazard to human health solely due to its classification as a “Possible Human Carcinogen” via inhalation exposure. The proposed revision accounts for this hazard and includes limitations that reduce the potential of user exposure to, and inhalation of, titanium dioxide.

Lifecycle Review: Environmental Impacts Summary

The presence of titanium dioxide is not considered a significant environmental impact for this product category; its estimated impact is insignificant compared to other environmental impacts of cleaning products. Titanium dioxide is not classified as an environmental hazard: it is not known to be toxic to aquatic life or to bioaccumulate.

Research Conclusion and Revision Justification

The presence of titanium dioxide is not a significant lifecycle impact for cleaning products; the compound is a common ingredient in enzyme-based cleaning products in solid form. Based on our assessment, the absence of titanium dioxide is not an indicator of environmental preferability in this product category, therefore, Green Seal proposes to include an exemption for titanium dioxide, therefore allowing this ingredient in enzyme-based cleaning products sold in solid form.

Exemptions for Titanium Dioxide are Proposed in the Following Green Seal Standards

- GS-8, Standard for Household Cleaning Products
- GS-37, Standard for Cleaning Products for Industrial and Institutional Use
- GS-48, Standard for Laundry Care Products for Household Use
- GS-51, Standard for Laundry Care Products for Institutional Use
- GS-52, Standard for Specialty Cleaning Products for Household Use
- GS-53, Standard for Specialty Cleaning Products for Industrial and Institutional Use

¹ IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 93, 2010, <https://monographs.iarc.fr/iarc-monographs-on-the-evaluation-of-carcinogenic-risks-to-humans-28/>

Proposed Revisions to Standards

Green Seal proposes the following revisions to the standards listed above:

- In the Carcinogens Criterion: A reference to the limited exemption will be added.
- In the Enzyme Annex: The sub-header will change from “Sensitization and Asthma” to “Exemptions.”
- In the Enzyme Annex: A second sentence that defines the limitations of the exemption for titanium dioxide shall be added.

Text in the boxes below show the details of the proposed revisions.

The **red text** shows proposed additions. The text ~~with strikethrough lines~~ are proposed deletions.

Proposed Revisions to GS-8, Standard for Cleaning Products for Household Use

3.2 Prohibition of Carcinogens, Mutagens, and Reproductive Toxins. The undiluted product shall not contain any *ingredients* that are *carcinogens*, *mutagens* or *reproductive toxins*. For the purposes of this standard, naturally occurring elements and chlorinated organics, which may be present as a result of chlorination of the water supply, are not considered *ingredients* if the concentrations are below the applicable maximum contaminant levels in the National Primary Drinking Water Standards found in 40 CFR Part 141.

Note: Refer to Annex C for the limited exemption of titanium dioxide in products that contain *enzymes*.

ANNEX C – Enzymes (Normative)

Products Containing Enzymes. Products that contain *enzymes* shall meet all of the following:

- A. Enzyme Form.** *Enzymes* in the product shall be in liquid form or an encapsulated solid (or other dust-free solid) with a minimum diameter of 0.15 mm. Smaller diameters may be permitted for solid products if they are demonstrated to result in airborne *enzyme* concentrations equivalent to or less than encapsulated solids with a 0.15mm diameter.
- B. Enzyme Source.** The source from which *enzymes* were derived shall be identified to a species level and disclosed to the certification program.
- C. Enzyme Source Microorganisms.** For *enzymes* derived from *microorganisms*, documentation shall be provided that the source *microorganism* is absent from the finished product. Test methodology and results shall be documented in sufficient detail and provided to the certification program. If the product does not conform to this provision, then all *microorganisms* shall meet the requirements in Annex D herein.
- D. Exemptions ~~Sensitization and Asthma.~~**
Enzymes are exempt from being categorized as *asthmagens* or *respiratory sensitizers*.
 Titanium dioxide⁸ is exempted from the prohibition on *carcinogens* (criterion 3.2) when it is present only due to the use of *enzymes* and only for products sold in solid form, e.g., powders, bars, tablets.
- E. Labeling Requirements.** Products containing *enzymes* shall include the following on the product label: A declaration that the “product contains enzymes”, in addition to the listing in the ingredient line A statement that immune-compromised individuals or those with asthma should avoid exposure to products containing *enzymes* from both direct use and incidental contact during or shortly after application of these products and instruction, when necessary or appropriate, for follow-up treatment
- F. Industrial Hygiene.** Documentation shall be provided to the certification organization that demonstrates that the manufacturer has implemented an industrial hygiene plan intended to minimize concentrations of and exposure to airborne *enzymes* (e.g., engineering controls, work practices, and personal protective equipment) and monitor the air concentrations of the *enzyme/s* and worker illness/sensitization due to the *enzyme/s*. An example of best practices that may be applicable for this plan is available at AISE.

Proposed Revisions to GS-37, Standard for Cleaning Products for Industrial and Institution Use

3.3 Carcinogens, Mutagens, and Reproductive Toxins. The *undiluted product* shall not contain any *ingredients* or *components* that are *carcinogens*, *mutagens*, or *reproductive toxins*. The *undiluted product* shall not contain any *ingredients* that, according to published uses,² are typically added for the purpose of releasing substances into a raw material or the final product, if those substances are *carcinogens*.

Note: Refer to Annex D for the limited exemption of titanium dioxide in products that contain *enzymes*.

ANNEX D – Enzymes (Normative)

Products Containing Enzymes. Products that contain *enzymes* shall meet all of the following:

A. Enzyme Form. *Enzymes* in the product shall be in liquid form or an encapsulated solid (or other dust-free solid) with a minimum diameter of 0.15 mm. Smaller diameters may be permitted for solid products if they are demonstrated to result in airborne *enzyme* concentrations equivalent to or less than encapsulated solids with a 0.15mm diameter.

B. Enzyme Source. The source from which *enzymes* were derived shall be identified to a species level and disclosed to the certification program.

C. Enzyme Source Microorganisms. For *enzymes* derived from *microorganisms*, documentation shall be provided that the source *microorganism* is absent from the finished product. Test methodology and results shall be documented in sufficient detail and provided to the certification program. If the product does not conform to this provision, then all *microorganisms* shall meet the requirements in Annex D herein.

D. Exemptions ~~Sensitization and Asthma.~~

Enzymes are exempt from being categorized as *asthmagens* or *respiratory sensitizers*.

Titanium dioxide⁸ is exempted from the prohibition on *carcinogens* (criterion 3.3) when it is present only due to the use of *enzymes* and only for products sold in solid form, e.g., powders, bars, tablets.

E. Labeling Requirements. Products containing *enzymes* shall include the following on the product label: A declaration that the “product contains enzymes”, in addition to the listing in the ingredient line A statement that immune-compromised individuals or those with asthma should avoid exposure to products containing *enzymes* from both direct use and incidental contact during or shortly after application of these products and instruction, when necessary or appropriate, for follow-up treatment

F. Industrial Hygiene. Documentation shall be provided to the certification organization that demonstrates that the manufacturer has implemented an industrial hygiene plan intended to minimize concentrations of and exposure to airborne *enzymes* (e.g., engineering controls, work practices, and personal protective equipment) and monitor the air concentrations of the *enzyme/s* and worker illness/sensitization due to the *enzyme/s*. An example of best practices that may be applicable for this plan is available at AISE.

² Published uses include sources such as peer-reviewed research, industry practice, or manufacturer documentation.

Proposed Revisions to GS-48, Laundry Care Products for Household Use

3.5 *Carcinogens and Reproductive Toxins. The *undiluted product* shall not contain any *components* that are *carcinogens* or *reproductive toxins*. The *undiluted product* shall not contain any *components* at 0.01% or more that, according to published uses,³ are typically added for the purpose of releasing substances into a raw material or the final product, if those substances are *carcinogens*.

Note: Refer to Annex C for the limited exemption of titanium dioxide in products that contain *enzymes*.

ANNEX C – Enzymes (Normative)

Products Containing Enzymes. Products that contain *enzymes* shall meet all of the following:

A. Enzyme Form. *Enzymes* in the product shall be in liquid form or an encapsulated solid (or other dust-free solid) with a minimum diameter of 0.15 mm. Smaller diameters may be permitted for solid products if they are demonstrated to result in airborne *enzyme* concentrations equivalent to or less than encapsulated solids with a 0.15mm diameter.

B. Enzyme Source. The source from which *enzymes* were derived shall be identified to a species level and disclosed to the certification program.

C. Enzyme Source Microorganisms. For *enzymes* derived from *microorganisms*, documentation shall be provided that the source *microorganism* is absent from the finished product. Test methodology and results shall be documented in sufficient detail and provided to the certification program. If the product does not conform to this provision, then all *microorganisms* shall meet the requirements in Annex D herein.

D. Exemptions Sensitization and Asthma.

Enzymes are exempt from being categorized as *asthmagens* or *respiratory sensitizers*.

Titanium dioxide⁸ is exempted from the prohibition on *carcinogens* (criterion 3.5) when it is present only due to the use of *enzymes* and only for products sold in solid form, e.g., powders, bars, tablets.

E. Labeling Requirements. Products containing *enzymes* shall include the following on the product label: A declaration that the “product contains enzymes”, in addition to the listing in the ingredient line A statement that immune-compromised individuals or those with asthma should avoid exposure to products containing *enzymes* from both direct use and incidental contact during or shortly after application of these products and instruction, when necessary or appropriate, for follow-up treatment

F. Industrial Hygiene. Documentation shall be provided to the certification organization that demonstrates that the manufacturer has implemented an industrial hygiene plan intended to minimize concentrations of and exposure to airborne *enzymes* (e.g., engineering controls, work practices, and personal protective equipment) and monitor the air concentrations of the *enzyme/s* and worker illness/sensitization due to the *enzyme/s*. An example of best practices that may be applicable for this plan is available at AISE.

³ Published uses include sources such as peer-reviewed research, industry practice, or manufacturer documentation.

Proposed Revisions to GS-51, Laundry Care Products for Industrial and Institutional Use

3.5 *Carcinogens and Reproductive Toxins. The *undiluted product* shall not contain any *components* that are *carcinogens* or *reproductive toxins*. The *undiluted product* shall not contain any *components* at 0.01% or more that, according to published uses,⁴ are typically added for the purpose of releasing substances into a raw material or the final product, if those substances are *carcinogens*.

Note: Refer to Annex E for the limited exemption of titanium dioxide in products that contain *enzymes*.

ANNEX E – Enzymes (Normative)

Products Containing Enzymes. Products that contain *enzymes* shall meet all of the following:

- A. Enzyme Form.** *Enzymes* in the product shall be in liquid form or an encapsulated solid (or other dust-free solid) with a minimum diameter of 0.15 mm. Smaller diameters may be permitted for solid products if they are demonstrated to result in airborne *enzyme* concentrations equivalent to or less than encapsulated solids with a 0.15mm diameter.
- B. Enzyme Source.** The source from which *enzymes* were derived shall be identified to a species level and disclosed to the certification program.
- C. Enzyme Source Microorganisms.** For *enzymes* derived from *microorganisms*, documentation shall be provided that the source *microorganism* is absent from the finished product. Test methodology and results shall be documented in sufficient detail and provided to the certification program. If the product does not conform to this provision, then all *microorganisms* shall meet the requirements in Annex D herein.
- D. Exemptions ~~Sensitization and Asthma.~~**
Enzymes are exempt from being categorized as *asthmagens* or *respiratory sensitizers*.
 Titanium dioxide⁸ is exempted from the prohibition on *carcinogens* (criterion 3.5) when it is present only due to the use of *enzymes* and only for products sold in solid form, e.g., powders, bars, tablets.
- E. Labeling Requirements.** Products containing *enzymes* shall include the following on the product label: A declaration that the “product contains enzymes”, in addition to the listing in the ingredient line A statement that immune-compromised individuals or those with asthma should avoid exposure to products containing *enzymes* from both direct use and incidental contact during or shortly after application of these products and instruction, when necessary or appropriate, for follow-up treatment
- F. Industrial Hygiene.** Documentation shall be provided to the certification organization that demonstrates that the manufacturer has implemented an industrial hygiene plan intended to minimize concentrations of and exposure to airborne *enzymes* (e.g., engineering controls, work practices, and personal protective equipment) and monitor the air concentrations of the *enzyme/s* and worker illness/sensitization due to the *enzyme/s*. An example of best practices that may be applicable for this plan is available at AISE.

⁴ Published uses include sources such as peer-reviewed research, industry practice, or manufacturer documentation.

Proposed Revisions to GS-52, Standard for Specialty Cleaning Products for Household Use

3.5 *Carcinogens and Reproductive Toxins. The *undiluted product* shall not contain any *components* that are *carcinogens* or *reproductive toxins*. The *undiluted product* shall not contain any *components* at 0.01% or more that, according to published uses,⁵ are typically added for the purpose of releasing substances into a raw material or final product, if those substances are *carcinogens*.

Note: Refer to Annex C for the limited exemption of titanium dioxide in products that contain *enzymes*.

ANNEX C – Enzymes (Normative)

Products Containing Enzymes. Products that contain *enzymes* shall meet all of the following:

A. Enzyme Form. *Enzymes* in the product shall be in liquid form or an encapsulated solid (or other dust-free solid) with a minimum diameter of 0.15 mm. Smaller diameters may be permitted for solid products if they are demonstrated to result in airborne *enzyme* concentrations equivalent to or less than encapsulated solids with a 0.15mm diameter.

B. Enzyme Source. The source from which *enzymes* were derived shall be identified to a species level and disclosed to the certification program.

C. Enzyme Source Microorganisms. For *enzymes* derived from *microorganisms*, documentation shall be provided that the source *microorganism* is absent from the finished product. Test methodology and results shall be documented in sufficient detail and provided to the certification program. If the product does not conform to this provision, then all *microorganisms* shall meet the requirements in Annex D herein.

D. Exemptions ~~Sensitization and Asthma~~.

Enzymes are exempted from the requirements for *Asthmagens* (3.8) and *Respiratory sensitizers* (3.9) herein.

Titanium dioxide⁸ is exempt from the requirements on *carcinogens* (3.5) when it is present only due to the use of *enzymes* and only for products sold in solid form, e.g., powders, bars, tablets.

E. Labeling Requirements. Products containing *enzymes* shall include the following on the product label: A declaration that the “product contains enzymes”, in addition to the listing in the ingredient line A statement that immune-compromised individuals or those with asthma should avoid exposure to products containing *enzymes* from both direct use and incidental contact during or shortly after application of these products and instruction, when necessary or appropriate, for follow-up treatment

F. Industrial Hygiene. Documentation shall be provided to the certification organization that demonstrates that the manufacturer has implemented an industrial hygiene plan intended to minimize concentrations of and exposure to airborne *enzymes* (e.g., engineering controls, work practices, and personal protective equipment) and monitor the air concentrations of the *enzyme/s* and worker illness/sensitization due to the *enzyme/s*. An example of best practices that may be applicable for this plan is available at AISE.

⁵ Published uses include sources such as peer-reviewed research, industry practice, or manufacturer documentation.

Proposed Revisions to GS-53, Standard for Specialty Cleaning Products for Industrial and Institutional Use

3.5 *Carcinogens and Reproductive Toxins. The *undiluted product* shall not contain any *components* that are *carcinogens* or *reproductive toxins*. The *undiluted product* shall not contain any *components* at 0.01% or more that, according to published uses,⁶ are typically added for the purpose of releasing substances into a raw material or final product, if those substances are *carcinogens*.

Note: Refer to Annex D for the limited exemption of titanium dioxide in products that contain *enzymes*.

ANNEX D – Enzymes (Normative)

Products Containing Enzymes. Products that contain *enzymes* shall meet all of the following:

- A. Enzyme Form.** *Enzymes* in the product shall be in liquid form or an encapsulated solid (or other dust-free solid) with a minimum diameter of 0.15 mm. Smaller diameters may be permitted for solid products if they are demonstrated to result in airborne *enzyme* concentrations equivalent to or less than encapsulated solids with a 0.15mm diameter.
- B. Enzyme Source.** The source from which *enzymes* were derived shall be identified to a species level and disclosed to the certification program.
- C. Enzyme Source Microorganisms.** For *enzymes* derived from *microorganisms*, documentation shall be provided that the source *microorganism* is absent from the finished product. Test methodology and results shall be documented in sufficient detail and provided to the certification program. If the product does not conform to this provision, then all *microorganisms* shall meet the requirements in Annex D herein.
- D. Exemptions. ~~Sensitization and Asthma.~~**
- *Enzymes* are exempted from the requirements for *Asthmagens* (3.8) and *Respiratory Sensitization* (3.9) herein.
 - Titanium dioxide⁸ is exempt from the requirements for *carcinogens* (3.5) when it is present only due to the use of *enzymes* and only for products sold in solid form, e.g., powders, bars, tablets.
- E. Labeling Requirements.** Products containing *enzymes* shall include the following on the product label:
 A declaration that the “product contains enzymes”, in addition to the listing in the ingredient line
 A statement that immune-compromised individuals or those with asthma should avoid exposure to products containing *enzymes* from both direct use and incidental contact during or shortly after application of these products and instruction, when necessary or appropriate, for follow-up treatment
- F. Industrial Hygiene.** Documentation shall be provided to the certification organization that demonstrates that the manufacturer has implemented an industrial hygiene plan intended to minimize concentrations of and exposure to airborne *enzymes* (e.g., engineering controls, work practices, and personal protective equipment) and monitor the air concentrations of the *enzyme/s* and worker illness/sensitization due to the *enzyme/s*. An example of best practices that may be applicable for this plan is available at AISE.

[8] Titanium Dioxide: EC Number 236-675-5, CAS Number 13463-67-7

⁶ Published uses include sources such as peer-reviewed research, industry practice, or manufacturer documentation.

Research Record

Titanium Dioxide, Overview

Titanium dioxide is a common colorant that is added to many types of products to whiten, brighten, and opacify. The compound is approved as a color additive by the US Food and Drug Administration for use in food, drugs, cosmetics, and medical devices.⁷ It is a common ingredient in household products including sunscreen, toothpaste, and makeup, and is added in food-grade form to whiten and opacify foods such as mayonnaise, yogurt, and powdered sugar.

Hazard Classification of Titanium Dioxide

Titanium dioxide is currently prohibited as an ingredient in Green Seal standards due to its classification as a Possible Human Carcinogen (Group 2B) via inhalation, as defined and listed by the International Agency for Research on Cancer (IARC).⁸

Green Seal standards for paints, personal care products, and bathroom tissue⁹ list exemptions for titanium dioxide because it is a functional ingredient with no readily-available functional alternatives; the compound is listed in the standard as fully exempted in all case or is exempted with qualifications. The term “exempt” in these cases means that this compound is therefore allowed as an ingredient in products certified to these standards. *Note: See excerpts of these standards and the titanium dioxide exemptions on Page 5 of this document.*

Titanium Dioxide in Enzyme-Based Cleaning Products, Household and Institutional

According to Green Seal’s market research and interviews with industry experts, titanium dioxide is an ingredient within “dry enzyme blends” – the active ingredients in solid enzyme-based cleaning detergents. Examples of solid cleaning products include powders, bars, and tablets. There are no known cases where titanium dioxide is added to a cleaning product for purposes other than its use as an enzyme whitener. Green Seal and those interviewed for this study were not aware of cases in which titanium dioxide is an ingredient in liquid enzyme blends or in liquid cleaning products.

Existing Protections that Limit User Exposure to Hazard

The classified human health hazard of titanium dioxide is specific to the inhalation exposure pathway. Green Seal’s standards currently set requirements intended to limit the potential for user inhalation of enzymes because certain enzymes are classified as respiratory sensitizers.¹⁰ Requirements that limit the potential of user exposure to enzymes are the following:

- solid enzymes must be in an encapsulated form;
- solid enzymes must be no smaller than .15 mm;
- products that contain enzymes cannot be sold in or with spray packaging.

By ensuring an encapsulated form, the generation of inhalable (airborne) dust is limited. By ensuring a larger size enzyme, the potential for respiration (the particles entering the lungs) is limited. The known presence of titanium dioxide in solid enzyme-based cleaning products is specific to its presence within the enzyme granule. According to industry experts, it is not feasible for titanium dioxide to exist outside of the enzyme granule and

⁷ Summary of Color Additives for Use in the United States in Foods, Drugs, Cosmetics, and Medical Devices, <https://www.fda.gov/forindustry/coloradditives/coloradditiveinventories/ucm115641.htm>

⁸ IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 93, 2010, <https://monographs.iarc.fr/iarc-monographs-on-the-evaluation-of-carcinogenic-risks-to-humans-28/>

⁹ GS-11, Standard for Paints, Coatings, Stains, and Sealers, GS-50 for Personal Care Products, GS-1 for Sanitary Paper Products

¹⁰ Definition of Respiratory Sensitizer in Green Seal Standards: A substance designated as leading to hypersensitivity of the airways following inhalation of the substance and meeting the classification criteria of Category 1 *respiratory sensitization* (H334), in accordance with the GHS.

carry out its enzyme-whitening function. Therefore, Green Seal proposes that the current protections that limit the potential of user inhalation of enzymes also effectively limit the potential for user exposure to, and inhalation of, titanium dioxide. To ensure this, the proposed exemption is restricted to cases in which the titanium dioxide is present as an ingredient in the final products when it is present only due to the use of enzymes, i.e. when the titanium dioxide is a raw material additive of the enzyme itself, rather than a separately added ingredient in the final product.

For human health protections specific to manufacturing workers, Green Seal lists detailed requirements of an industrial hygiene plan. Although the documentation requirement states that it is specific to limiting worker exposure of enzymes, this requirement will effectively limit worker exposure to titanium dioxide, as described in the paragraph above.

Environmental Impacts

The presence of titanium dioxide is an insignificant lifecycle impact in comparison to other impacts of cleaning products. Titanium dioxide is expected to be harmful to the environment during the raw material extraction and processing phases,¹¹ with impacts expected to be equivalent to other mining and chemical purification activities. Specific to the use and disposal phases, titanium dioxide is not known to be toxic to aquatic life or to bioaccumulate. After review of the major environmental impacts of titanium dioxide, Green Seal does not consider the absence of titanium dioxide to be a definitive requirement for environmentally-preferable cleaning products.

Examples of significant environmental issues for cleaning products include the eutrophication of waterways due to the release of phosphates; the use and transportation of water in highly diluted cleaning products; surfactants of high concern such as alkylphenol ethoxylates (APEOs) and nonylphenol ethoxylates (NPES), which are toxic to aquatic life, bio-accumulative, and reproductively toxic; ingredients that are non-biodegradable; and volatile organic compounds that are pre-cursors to smog.

Environmental and Health Leadership Aspects of Enzyme-Based Cleaning Products

Enzyme-based cleaning products have reduced environmental and human health impacts compared to conventional detergents. Enzymes in cleaning products allow for lower content of surfactants and builders – which are more environmentally hazardous components, in particular, phosphates.¹² In general, enzymatic cleaners are more neutral and therefore less caustic to skin and less damaging to fabrics.¹³ they work effectively in lower temperatures¹⁴– reducing energy expenditure of the laundry process. According to the American Cleaning Institute, “about 90% of the energy the washing machine uses goes towards heating the water.”¹⁵ Enzymes are effective in very low concentrations which lower the potential of user inhalation, and the potential for respiratory sensitization.

Environmental Leadership Aspects of Solid Cleaning Products:

Solid detergents are more stable than liquids, allowing products to be sold in bulk without requiring as many preservatives – resulting in reduced packaging waste. In many household ready-to-use cleaning products, cleaning products are made from 80 percent water,¹⁶ and result in unnecessary carbon emissions from the shipping of water.

¹¹ Titanium, <https://mineralseducationcoalition.org/elements/titanium/>

¹² More Sustainable Detergents Through Reformulation, *Household and Personal Care Today*, 2008

¹³ The role of enzymes in modern detergency, *Journal of Surfactants and Detergents*, <https://link.springer.com/article/10.1007/s11743-998-0058-7>

¹⁴ Cold-water laundry detergent is a hot idea - *Technology Solutions*, ACS Publications,

¹⁵ Cold Water Saves, https://www.cleaninginstitute.org/clean_living/cold_water_saves.aspx

¹⁶ The Chemistry of Cleaning, Essential Industries, <https://www.essind.com/general-cleaners/the-chemistry-of-cleaning/>

Current Exemptions for Titanium Dioxide in Other Green Seal Standards

Several Green Seal product standards include stated exceptions to titanium dioxide:

Sanitary Paper Products, GS-1 Standard, Last Issued in 2018

3.5.3 Carcinogens, Mutagens, and Reproductive Toxins. The product shall not contain any *functional papermaking additives* or contaminants that are *carcinogens, mutagens, or reproductive toxins* or that are known to produce or release *carcinogens*. **An exception shall be made for titanium dioxide** and carbon black used in colorants.

Personal Care and Cosmetic Products, GS-50 Standard, Last Issued in 2013

3.5 Carcinogens and Reproductive Toxins. The *undiluted product* shall not contain any *components* that are *carcinogens* or *reproductive toxins*. The product shall not contain any *components* known to produce or release *carcinogens* or *reproductive toxins*. **An exception shall be made for titanium dioxide.** An exception shall also be made for essential vitamins and minerals, which shall not exceed the lowest *tolerable upper limit* in the product.

Paints, Coatings, Stains, and Sealers, GS-11 Standard, Last Issued in 2015

3.1 Carcinogens, Mutagens, and Reproductive Toxins. The product shall not contain any *ingredients* that are *carcinogens, mutagens, or reproductive toxins*. **Exemption: An exception shall be made for titanium dioxide** and, for products that are pre-tinted by the manufacturer, carbon black. As allowed under this exception, carbon black shall be less than or equal to 1% by weight of the product.¹⁷

¹⁷ Titanium Dioxide: EC Number 236-675-5, CAS Number 13463-67-7