



Scientific Research and Consulting

MEMORANDUM

TO: Marc Byers, Byers Scientific & Manufacturing
FROM: Sarah Foster, CPF Associates, Inc.
DATE: December 8, 2017
RE: Screening Health Assessment of Waterless Vapor Phase Odor Control Technology

INTRODUCTION AND SUMMARY

Byers Scientific & Manufacturing has developed a waterless vapor phase odor control technology which releases an Ecosorb® odor control product in gaseous form. Byers requested CPF Associates to conduct a health assessment of this system to evaluate its potential air impacts relative to inhalation criteria derived to be protective of public health. This memo describes the health assessment and its conclusions.

The application scenario evaluated in this study was defined by Byers. It assumed that Ecosorb® CNB 100, a proprietary odor control product, would be fed into the vapor phase odor control technology at a rate of 2.5 gallons per day and, once volatilized, would be distributed as a gas through a pipe. Air flow through the pipe would be generated by a fan set at roughly 300 cubic feet per minute and the product would be released from upward-facing holes spaced at nine foot intervals along the length of the pipe. The pipe would be placed around the outside perimeter of a building at a height of 10-15 feet (3.0-4.6 m). The total pipe length would vary from about 575-3,150 feet (175-960 m), depending on the building's footprint. The composition of CNB 100 was provided to CPF by its manufacturer, OMI Industries, under the understanding that this is confidential business information.

The assessment was a screening-level evaluation that relied on conservative, health-protective assumptions. These assumptions are expected to overestimate potential air concentrations, exposures and risks associated with the evaluated scenario.

The assessment showed that operation of the Byers-defined application scenario would not be expected to pose public health concerns. Potential air concentrations calculated using a screening-level model in the immediate vicinity of the distribution pipe were below available health-protective inhalation criteria.

SCREENING HEALTH ASSESSMENT

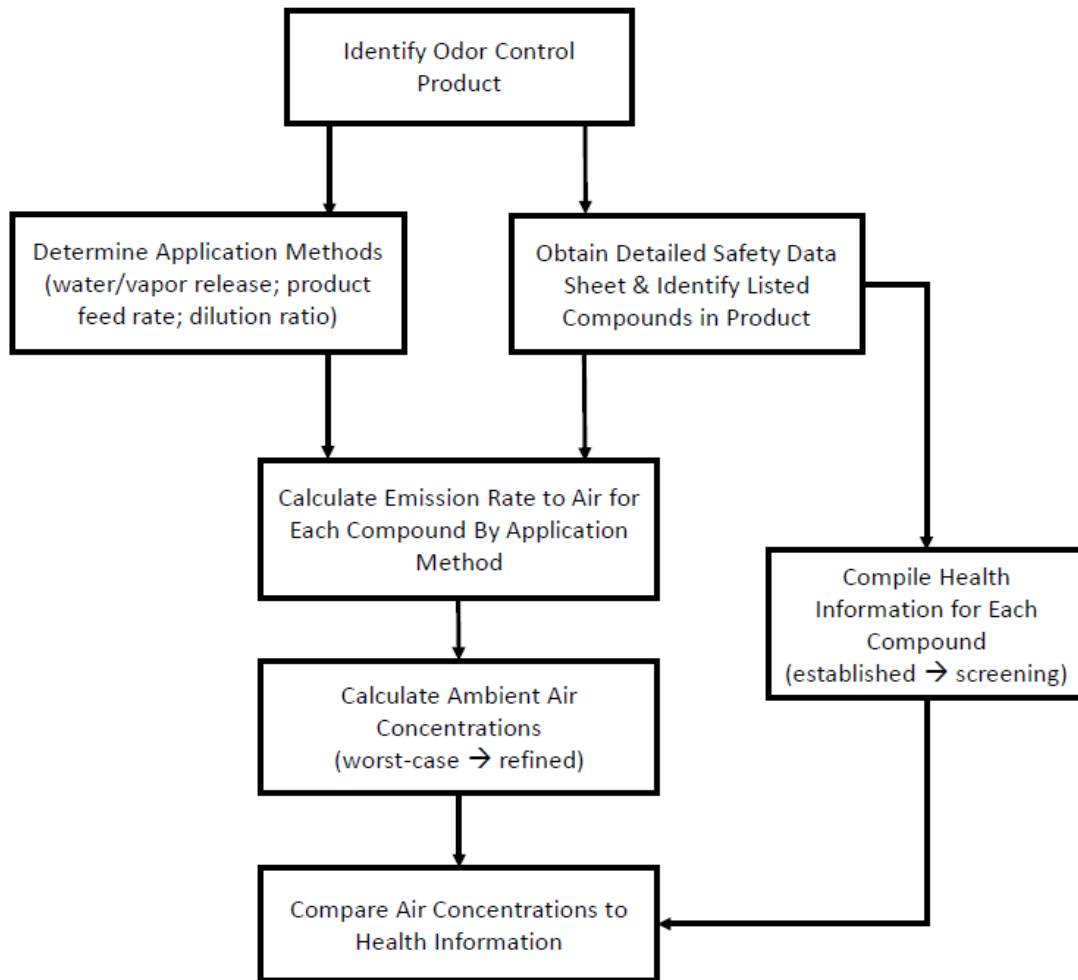
Methodology

CPF has developed a methodology to evaluate odor control product use at landfills and other potentially odiferous facilities. This methodology is based on well-accepted health risk assessment principles and has been used to objectively assess more than one dozen odor control products delivered using a variety of application systems.



A flow chart of the methodology is provided in Figure 1. Broadly defined, the methodology combines information about odor control product composition, odor control application methods, health effects information and modeled ambient air concentrations to evaluate the potential for public health concerns via inhalation.

Figure 1
Overview of Odor Control Product Health Assessment Methodology



Consistent with standard health risk assessment practice, the methodology can be applied in a stepwise fashion of increasing refinement, as warranted. The initial screening-level evaluation employs conservative, health-protective assumptions which are intended to overestimate potential air concentrations, exposures and potential risks. If the screening-level evaluation does not demonstrate a potential for health concerns, then no further assessment is needed. If not, more refined evaluations can be performed to further evaluate an odor control system under more realistic conditions.

Assessment of Byers Vapor Phase Odor Control System

Application Method

In this assessment, a screening-level evaluation was conducted of an application setup defined by Byers. It was assumed that Ecosorb® CNB 100, an odor control product, would be fed into the vapor phase odor control technology at a rate of 2.5 gallons per day and, once volatilized, would be distributed as a gas inside a pipe of variable length, with air flow generated by a fan set at roughly 300 cubic feet per minute. The pipe would be placed around the outside perimeter of a building, close to but below the roof edge, at a height of 10-15 feet (3.0-4.6 m) and the total pipe length would vary from about 575-3,150 feet (175-960 m), depending on the footprint of the building. The vapor would be released from holes, each roughly 0.16 inch (4 mm) in diameter and facing upwards, placed every nine feet along the pipe length. Due to the pressure created by the fan, the vapor is expected to be emitted at a velocity of more than 100 ft/sec (>45 m/sec) from each hole.

Odor Control Product

The odor control product evaluated was Ecosorb® CNB 100. Its composition was provided to CPF by its manufacturer, OMI Industries, under the understanding that this is confidential business information. The product is comprised of two polysorbate surfactants and a blend of citrus and pine oils with the remainder being water.¹ Both polysorbate surfactants are widely used in hundreds of industrial, consumer, medicinal and personal care products. The Safety Data Sheet (SDS) for CNB 100 is provided in Attachment A. This SDS includes information about the product, its hazards and instructions for handling, disposal, transport, first-aid, fire-fighting and exposure control measures.

Emission Rates into Air

Emission rates into air for the product as a whole and its individual constituents were calculated based on the application setup described above and the Ecosorb® CNB 100 composition. The method for calculating emission rates was designed to ensure that potential air impacts would be overestimated in the interests of health protectiveness. First, it was assumed that 100% of the product would be volatilized in the odor control technology and transported down the distribution pipe. Second, each constituent in CNB 100 was assumed to be present at the maximum percentage provided by OMI. Third, the calculated emission rates from all holes were summed and the resulting cumulative emission rate was then assumed to be released from a shorter section of pipe on only one side of a building, rather than dispersed along the entire pipe surrounding all four building sides. Overall, these assumptions are expected to overestimate potential emission rates, and thus also air concentrations.

Ambient Air Concentrations

Potential air concentrations were calculated in the immediate vicinity of the distribution pipe using a screening method called a box model. This approach assumes that emissions are completely mixed in a

¹ The percentages of each polysorbate surfactant and the citrus/pine oil blend in Ecosorb CNB 100 are a proprietary trade secret, however, they were provided to CPF for the purposes of this analysis. In accordance with a Confidentiality Agreement, this composition is not specifically provided in this memo. The product's Safety Data Sheet is included in Attachment A.

box having a specified width and height through which wind is blowing.² It is generally considered more likely to overestimate than underestimate concentrations because the model does not take into account air mixing and dispersion outside the box, atmospheric reactions or settling (deposition). All of these processes, which naturally occur in the outdoor environment, would result in lower concentrations than those modeled. As a result, the air concentrations due to emissions are expected to be overestimated.

For this assessment, the box was defined to conservatively estimate potential air concentrations that might occur in the immediate vicinity of the distribution pipe (i.e., within roughly 15 feet). It was assumed to extend outward 15 feet (4.57 m) from the side of the building and upwards to a building height of 18 feet (5.5 m), with air flowing through this cross-section at a velocity of 1 mile per hour (0.447 m/sec), representative of a calm wind speed. Air concentrations would be lower if a larger box and higher wind speed were used.³

Health Criteria for Odor Control Product

The next step in the assessment involved compilation of available health criteria for the odor control product and its constituents. These criteria reflect concentrations in air (in mg/m³) or average daily intakes (in mg/kg body weight/day) that are protective of public health. They are developed by regulatory agencies and public health scientists based on scientific information about the toxicity of chemical substances. When these values are derived, safety factors are generally incorporated to ensure that they are protective of human health.

Numerous information sources were searched to identify available health effects criteria.⁴ Criteria were able to be identified for all constituents in Ecosorb® CNB 100 - either for the listed constituent itself (each polysorbate surfactant) or for a component in the constituent (citrus and pine oil blend). For example, for the blend of pine and citrus oils, dominant components in orange, lime, lemon, tangerine, grapefruit and pine oils were identified from published studies, and then acute short-term inhalation criteria were compiled as available for each of these. Among the dominant components, acute short-term inhalation criteria were available for limonene, α -terpineol, and α - and β -pinene. The lowest among these three criteria (59 mg/m³) was selected to evaluate the entire oil blend.

In addition to identifying criteria for constituents in Ecosorb® CNB 100, the results from acute inhalation toxicity studies were used to derive an inhalation criterion for the product as a whole. Acute inhalation toxicity studies have been conducted for two Ecosorb® products that are used to

² American Society for Testing and Materials (ASTM). 1994. Emergency Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites. Philadelphia, PA. ES 38-94.

³ The equation for calculating air concentrations in the simple well-mixed box model is: $Ca = (ER * 1,000) / (H * W * V)$, where Ca = Air concentration (mg/m³), ER = Emission rate (g/sec), 1,000 = Conversion factor (1,000 mg/g), H = Box height (5.5 m), W = Box width (4.57 m), and V = Air velocity through box (0.447 m/sec).

⁴ Information sources searched included: California Environmental Protection Agency (CALEPA) Reference Exposure Levels (RELs), US Environmental Protection Agency's (USEPA) Risk-Based Screening Levels (RSLs), USEPA's Acute Exposure Guideline Levels (AEGs), American Industrial Hygiene Association's Emergency Response Planning Guidelines (ERPGs), Temporary Emergency Exposure Limits (TEELs) developed by the DOE Office of Emergency Management, US National Library of Medicine PubChem databases, European Union and European Food Safety Authority assessments on food additives, Safety Assessments prepared by Cosmetic Ingredient Review Expert Panels, and Japan Food Safety Commission reports on food additives.



formulate CNB 100 (Ecosorb® 606 and Ecosorb® 206). The acute inhalation toxicity studies examined the occurrence of adverse effects on rats exposed to each product for four hours at a high concentration in aerosolized form (2,220 mg/m³ for Ecosorb® 606 and 2,080 mg/m³ for Ecosorb® 206). Observations of the test animals for 12 different health endpoints (ranging from lacrimation to tremors to death) were tabulated during the exposure period and for 14 days after the exposure ceased. No adverse effects were observed at either tested air concentration. The lowest of the two no observed adverse effect levels (NOAELs) was divided by an uncertainty factor of 100 to derive the criterion for this assessment (21 mg/m³).⁵

Compare Air Concentrations to Health Information

The potential for a health concern was evaluated by comparing the calculated air concentrations to the health information. If the calculated air concentration for a compound or odor control product is lower than the corresponding inhalation health criterion, adverse public health effects would not be expected to occur under the assumed odor control application scenario. If an air concentration exceeds its criterion, this does not mean that adverse effects will occur among the general public because of the conservative assumptions included in both the derivation of the criterion and the calculation of air concentrations. Rather it indicates that further investigation may be warranted, using more refined and realistic assumptions, to help determine whether or not levels in air may present a potential public health concern.

In this analysis, the potential air concentrations calculated in the immediate vicinity of the distribution pipe were below the available health-protective criteria. As noted above, the air concentrations were calculated using a screening-level box model and assuming total emissions from a pipe around four sides of a building were all released from a shorter section of pipe along only one side of a building. The calculated air concentration of the product as a whole was two times lower than its criterion. The concentrations of the individual constituents in CNB 100 were lower than their respective criteria by factors of 370 to 1,760.

Discussion of Uncertainties

The results of health assessments inherently reflect some uncertainty because of the complexities involved in the analysis. In accordance with standard practice, key uncertainties affecting this assessment are discussed here. In general, uncertainties in health assessments, including this one, are addressed by using conservative (i.e., health protective) assumptions which collectively produce results much more likely to be overestimated than underestimated. This adds a margin of safety to the results.

Conservative assumptions used in this assessment have been noted above, such as concentrating all emissions from a pipe around four sides of a building into one pipe section along only one building side, assigning small dimensions (i.e., 15 feet by 18 feet) to the simple box model, assuming each constituent was present in the product at the maximum percent noted by OMI, and assessing the blend of citrus and pine oils using only the lowest available inhalation health criterion among those for dominant components of these oils. Deriving a health-protective criterion for the product as whole

⁵ Consistent with screening-level methods for deriving reference air concentrations, the uncertainty factor of 100 incorporated one factor of 10 for animal to human extrapolation and another factor of 10 for human variability.



based on a NOAEL from a toxicity study that evaluated only one exposure level was another conservative assumption, because the actual NOAEL may be much higher. Some uncertainties were not explicitly addressed in this study, such as whether the form of emissions might vary in extremely cold temperatures (e.g., gas versus aerosols), whether the composition of volatilized constituents might vary after long periods of operation and the effect of buildings on dispersion and mixing of emissions. The modeling of air concentrations was conducted for one building using a simple screening-level model with conservative input assumptions; more refined calculations of potential air concentrations could be estimated using more sophisticated methods (e.g., refined air dispersion modeling, wind tunnel modeling or computational fluid dynamic modeling). Overall, these uncertainties are not expected to change the conclusions of this assessment.

This assessment addressed only the inhalation route of exposure with a focus on the general public. Not considering other exposure routes (e.g., dermal) is appropriate given that the general public would not be expected to come into contact with the odor control product in any manner other than through the air. With respect to occupational situations, which were not addressed here, this product should only be used in accordance with its SDS, any label instructions, and regulatory requirements of Cal/OSHA.

Conclusions

Based on the methods and assumptions used, this screening-level assessment showed that operation of the Byers-defined application scenario would not be expected to pose public health concerns. Potential air concentrations calculated using a screening-level model in the immediate vicinity of a distribution pipe were below available health-protective inhalation criteria. The calculated air concentration of the product as a whole was two times lower than its criterion. The concentrations of evaluated individual constituents in CNB 100 were lower than their respective criteria by factors of 370 to 1,760.

ABOUT CPF ASSOCIATES

CPF Associates, Inc. is an independent Maryland-based scientific and research consulting firm with in-depth experience and expertise in the health and environmental evaluation of air emission sources, waste management technologies, industrial facilities and waste sites. CPF applies state-of-the-art scientific tools - risk assessment, life-cycle analysis, epidemiology and environmental impact analysis - to address public health and environmental issues. In over 30 years of professional association, the CPF Principals have conducted hundreds of projects for energy-from-waste (EfW) facilities, landfills, incinerators, biosolids management facilities, recycling plants, transfer stations and other types of treatment units. The principal investigator for this assessment was Ms. Sarah Foster, a Principal with CPF Associates. Internal review was provided by Dr. Paul Chrostowski, also a Principal with CPF.

ATTACHMENT A
SAFETY DATA SHEET



ECOSORB CNB 100

Safety Data Sheet

according to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations

Date of issue: 12/04/2017 Version: 1.0

SECTION 1: Identification

1.1. Identification

Product form : Mixture
Product name : ECOSORB CNB 100

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture : Odor Neutralizer
Recommended use : Odor Neutralizer
Restrictions on use : None known

1.3. Details of the supplier of the safety data sheet

Manufacturer

OMI Industries
1300 Barbour Way
Rising Sun, IN 47040 - U.S.A
T 1-847-304-9111

1.4. Emergency telephone number

Emergency number : 1-800-662-6367, Monday - Friday 8 am to 5 pm CST

SECTION 2: Hazard(s) identification

2.1. Classification of the substance or mixture

GHS-US classification

Not classified

2.2. Label elements

2.3. Other hazards

Other hazards not contributing to the classification : None under normal conditions. Keep out of reach of children.

2.4. Unknown acute toxicity (GHS US)

Not applicable

SECTION 3: Composition/Information on ingredients

3.1. Substances

3.2. Mixtures

This mixture does not contain any substances to be mentioned according to the criteria of section 3.2 of HazCom 2012

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures general : Call a poison center/doctor/physician if you feel unwell.
First-aid measures after inhalation : Move to fresh air if necessary.

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- First-aid measures after skin contact : Wash skin with plenty of water.
First-aid measures after eye contact : Rinse eyes with water as a precaution.
First-aid measures after ingestion : Call a poison center/doctor/physician if you feel unwell.

4.2. Most important symptoms and effects, both acute and delayed

- Symptoms/effects : None under normal use.
Symptoms/effects after inhalation : No effects known.
Symptoms/effects after skin contact : No effects known.
Symptoms/effects after eye contact : No effects known.
Symptoms/effects after ingestion : No effects known.
Symptoms/effects upon intravenous administration : No other effects known.

4.3. Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

SECTION 5: Firefighting measures

5.1. Extinguishing media

- Suitable extinguishing media : Dry powder. Foam. Carbon dioxide.
Unsuitable extinguishing media : No unsuitable extinguishing media known.

5.2. Special hazards arising from the substance or mixture

- Fire hazard : Not flammable.
Reactivity : The product is non-reactive under normal conditions of use, storage and transport.

5.3. Advice for firefighters

- Firefighting instructions : Cool tanks/drums with water spray/remove them into safety.
Protection during firefighting : Do not attempt to take action without suitable protective equipment. Self-contained breathing apparatus. Complete protective clothing.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

- General measures : Stop leak if safe to do so.

6.1.1. For non-emergency personnel

- Protective equipment : Gloves and safety glasses recommended.
Emergency procedures : Ventilate spillage area.

6.1.2. For emergency responders

- Protective equipment : Do not attempt to take action without suitable protective equipment. For further information refer to section 8: "Exposure controls/personal protection".

6.2. Environmental precautions

Avoid release to the environment. Prevent liquid from entering sewers, watercourses, underground or low areas.

6.3. Methods and material for containment and cleaning up

- For containment : Collect spillage.
Methods for cleaning up : Take up liquid spill into absorbent material.
Other information : Dispose of materials or solid residues at an authorized site.

6.4. Reference to other sections

For further information refer to section 13. For further information refer to section 8: "Exposure controls/personal protection".

SECTION 7: Handling and storage

7.1. Precautions for safe handling

- Precautions for safe handling : Ensure good ventilation of the work station. Wear personal protective equipment.
- Hygiene measures : Do not eat, drink or smoke when using this product. Always wash hands after handling the product.

7.2. Conditions for safe storage, including any incompatibilities

- Technical measures : Does not require any specific or particular technical measures.
- Storage conditions : Store in a well-ventilated place. Keep cool.
- Incompatible products : Oxidizing agent. Strong acids.
- Incompatible materials : Keep away from strong acids and strong oxidizers.
- Storage temperature : 4 - 29 °C 40°F and 85°F Allowing product to freeze may cause layering.
- Heat-ignition : KEEP SUBSTANCE AWAY FROM: heat sources. ignition sources.
- Information on mixed storage : KEEP SUBSTANCE AWAY FROM: (strong) acids. oxidizing agents.
- Storage area : Keep container in a well-ventilated place. Store in a cool area. Keep out of direct sunlight. Store in a well-ventilated place.
- Special rules on packaging : Keep only in original container.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

8.2. Exposure controls

- Appropriate engineering controls : Ensure good ventilation of the work station.

8.3. Individual protection measures/Personal protective equipment

- Personal protective equipment : Gloves and safety glasses recommended.
- Hand protection : Protective gloves. Recommended.
- Eye protection : Safety glasses. Recommended.
- Skin and body protection : None under normal use.
- Respiratory protection : Respiratory protection not required in normal conditions.
- Thermal hazard protection : Not applicable.
- Environmental exposure controls : Avoid release to the environment.
- Other information : Do not eat, drink or smoke during use.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	: Liquid
Appearance	: White liquid.
Color	: White
Odor	: Characteristic odour
Odor threshold	: No data available
pH	: 6 - 8.5
Melting point	: Not applicable
Freezing point	: No data available
Boiling point	: ≈ 99 °C
Flash point	: No data available
Relative evaporation rate (butyl acetate=1)	: No data available
Flammability (solid, gas)	: Not applicable.
Vapor pressure	: No data available
Relative vapor density at 20 °C	: No data available
Relative density	: ≈ 0.99
Solubility	: Soluble in water.
Partition coefficient n-octanol/water	: No data available
Auto-ignition temperature	: No data available
Decomposition temperature	: No data available
Viscosity, kinematic	: ≈ 1 cSt
Viscosity, dynamic	: No data available
Explosion limits	: No data available
Explosive properties	: No data available
Oxidizing properties	: No data available

9.2. Other information

No additional information available

SECTION 10: Stability and reactivity

10.1. Reactivity

The product is non-reactive under normal conditions of use, storage and transport.

10.2. Chemical stability

Stable under normal conditions.

10.3. Possibility of hazardous reactions

No dangerous reactions known under normal conditions of use.

10.4. Conditions to avoid

None under recommended storage and handling conditions (see section 7).

10.5. Incompatible materials

Oxidizing agent. Strong acids.

10.6. Hazardous decomposition products

Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Likely routes of exposure : Inhalation; Dermal

Acute toxicity : Not classified

Skin corrosion/irritation : Not classified
pH: 6 - 8.5

Serious eye damage/irritation : Not classified
pH: 6 - 8.5

Respiratory or skin sensitization : Not classified.

Germ cell mutagenicity : Not classified

Carcinogenicity : Not classified

Reproductive toxicity : Not classified

Specific target organ toxicity – single exposure : Not classified

Specific target organ toxicity – repeated exposure : Not classified

Aspiration hazard : Not classified

Potential Adverse human health effects and symptoms : No other effects known.

Symptoms/effects after inhalation : No effects known.

Symptoms/effects after skin contact : No effects known.

Symptoms/effects after eye contact : No effects known.

Symptoms/effects after ingestion : No effects known.

Symptoms/effects upon intravenous administration : No other effects known.

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : The product is not considered harmful to aquatic organisms or to cause long-term adverse effects in the environment.

12.2. Persistence and degradability

ECOSORB CNB 100	
Persistence and degradability	Biodegradability in water: no data available.

12.3. Bioaccumulative potential

ECOSORB CNB 100	
Bioaccumulative potential	Not established.

12.4. Mobility in soil

ECOSORB CNB 100	
Ecology - soil	The product is predicted to have high mobility in soil. Soluble in water.

12.5. Other adverse effects

No additional information available

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Regional legislation (waste)	: Disposal must be done according to official regulations.
Waste treatment methods	: Dispose of contents/container in accordance with licensed collector's sorting instructions.
Sewage disposal recommendations	: Disposal must be done according to official regulations.
Product/Packaging disposal recommendations	: Avoid release to the environment.
Ecology - waste materials	: Avoid release to the environment.

SECTION 14: Transport information

Department of Transportation (DOT)

In accordance with DOT

Not regulated

Transportation of Dangerous Goods

Not regulated

Transport by sea

Not regulated

Air transport

Not regulated

SECTION 15: Regulatory information

15.1. US Federal regulations

ALL COMPONENTS OF THIS PRODUCT ARE LISTED, OR EXCLUDED FROM LISTING, ON THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY TOXIC SUBSTANCES CONTROL ACT (TSCA) INVENTORY

15.2. International regulations

CANADA

ECOSORB CNB 100

Listed on the Canadian DSL (Domestic Substances List)

EU-Regulations

ECOSORB CNB 100

Listed on the EEC inventory EINECS (European Inventory of Existing Commercial Chemical Substances)

National regulations

ECOSORB CNB 100

Listed on the AICS (Australian Inventory of Chemical Substances)
 Listed on PICCS (Philippines Inventory of Chemicals and Chemical Substances)
 Listed on NZIoC (New Zealand Inventory of Chemicals)
 Listed on the Japanese ENCS (Existing & New Chemical Substances) inventory
 Listed on the Korean ECL (Existing Chemicals List)
 Listed on INSQ (Mexican National Inventory of Chemical Substances)

15.3. US State regulations

California Proposition 65 - This product does not contain any substances known to the state of California to cause cancer, developmental and/or reproductive harm

SECTION 16: Other information

Training advice : Normal use of this product shall imply use in accordance with the instructions on the packaging.

Other information : None.

ABBREVIATIONS AND ACRONYMS:	
ATE	Acute Toxicity Estimate
BCF	Bioconcentration factor
IATA	International Air Transport Association
IMDG	International Maritime Dangerous Goods
LC50	Median lethal concentration
IARC	International Agency for Research on Cancer
OECD	Organisation for Economic Co-operation and Development
LD50	Median lethal dose
SDS	Safety Data Sheet
STP	Sewage treatment plant

Hazard Rating

Health : 0 Minimal Hazard - No significant risk to health

Flammability : 0 Minimal Hazard - Materials that will not burn

Physical : 0 Minimal Hazard - Materials that are normally stable, even under fire conditions, and will NOT react with water, polymerize, decompose, condense, or self-react. Non-Explosives.

Personal protection : B
B - Safety glasses, Gloves

This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not therefore be construed as guaranteeing any specific property of the product