DRAFT

Engineering Report of Nonylphenol (NP) and Nonylphenol Ethoxylates (NPEs) In Response to Section 21 Petition

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Background

Pursuant to Section 21 of the Toxic Substance Control Act ("TSCA"), 15 U.S.C. § 2620, The Sierra Club ; The Environmental Law & Policy Center; The Pacific Coast Federation of Fishermen's Association; The Washington Toxics Coalition; Physicians for Social Responsibility; and UNITE HERE (formerly the Union of Needle trades, Industrial and Textile Employees and the Hotel Employees and Restaurant Employees International Union) has petitioned the Environmental Protection Agency ("EPA") to exercise its authority under TSCA Section 4 and 6(a) to:

1. Require manufacturers and importers to conduct specific health and safety studies;
2. Require labeling on all products containing nonoylphenols (NPs) and nonylphenol ethoxylates (NPEs); and
3. Limit the use of NP and NPE where the use presents an unreasonable risk to public health and the environment, given available alternatives

1.0 Scope

In support of the EPA's review of this Section 21 petition, this report presents a screen-level assessment of environmental releases and occupational exposures to NPEs from industrial and institutional laundries. A limited literature search for available information and data was conducted to complete this assessment.

Of particular concern in the Section 21 petition was potential occupational exposure of workers handling NPE at industrial and institutional laundries. NPEs are common non-ionic surfactant used in the industry. Note that while NP is a raw material for NPEs and a degradation product of NPEs, it is not used at industrial and institutional laundries. Therefore, this assessment, while it covers releases of both chemicals, will only address occupational exposures to NPEs. This assessment is primarily based on CEB's Chemicals Used in Water-Based Washing Operations at Industrial and Institutional Laundries Generic Scenario (CEB, 2006a) and the associated data and information collected for its development.

The literature search for this assessment resulted in limited information. Monitoring data on nonylphenol ethoxylates (NPEs) from institution and industrial laundries was not available. Thus, estimation methods were utilized from CEB's Chemicals Used in Water-Based Washing Operations at Industrial and Institutional Laundries Generic Scenario (CEB, 2006a).

2.0 Production Volume, Use and Environmental Releases of NP and NPEs

This section presents estimated quantities of NP and NPEs produced in the United States, the primary uses of NP and NPEs, the sources of environmental releases from these uses, and an estimated quantity released to the environment. While more detailed data are available from proprietary sources like SRI that may assist EPA in more accurately estimating the potential releases of NP and NPE.

Nonylphenol (NP)

In 1998, approximately 230 million pounds of NP were produced with an anticipated annual growth of 2 percent (Harvilicz, 1999). According to the 2002 Inventory Update Reporting (IUR) Public Database, between 100 and 500 million pounds of NP were produced in 2002 (EPA, 2007). The primary use of NP is as an intermediate for NPEs, resin plastics, resin stabilizers, and phenolic oximes (European Commission, 2002).

Since NP is primarily used as an intermediate and because of its low volatility (9.42×10^{-5} torr at 25ºC (SRC, 2007)), direct releases of NP are anticipated to be low. While some releases may occur from equipment cleaning, container residue, spills, and other transfer losses, direct releases of NP are generally anticipated to be less than five percent of the production volume.

Nonylphenol Ethoxylates (NPEs)

U.S. consumption of NPEs in 2000 was 461 million pounds (Chemical Market Reporter, 2002). NPEs are used as emulsifiers, wetting agents, and dispersants. NPEs along with octylphenol ethoxylates (OPEs) are categorized as alkylphenol ethoxylates (APEs). Approximately 55 percent of APEs are used in industrial applications: plastics and elastomer production (polymer stabilization), paper (pulping and de-inking), textiles (cleaning, spinning, weaving and finishing), and agriculture wetting agents. Approximately 30 percent are used in institutional cleaning products and laundry detergents, and about 15 percent are used in household products such as laundry detergents and hard surface cleaners. Of the APEs produced, approximately 80 percent are NPEs and 20 percent are OPEs (Ying et al.2002).

Emulsifier in Paints

NPE can be used as an emulsifier for the formulation of latex emulsions, which are subsequently blended into paints and other products. Some releases of NPEs will occur during latex emulsion and paint formulation from container residue, equipment cleaning, filter wastes; however, the majority of the release of NPE will occur during the application of the paint containing NPE. Paints and coatings can be spray, roll, or brush applied. If the NPE is spray applied, releases as high as 80 percent of the production volume may occur from overspray, equipment cleaning, and other sources in automobile

refinishing operations (CEB, 1996). However, releases may be less than 10 percent for roll and brush applied architectural paints. While the media of release will depend of the type of coating (e.g., solvent-based, water-based) and the control technologies utilized (e.g., water-curtain, dry filter), water releases are likely for NPEs, because they are primarily used in water-based paints.

Paper Manufacturing

NPEs can be found as a component of many chemicals used in the pulp and paper industry including drainage aids, felt washing additives, antifoaming agents, retention aids, latex coating emulsifiers, and deinking aids (MDEQ, 2000). Most of these additives are not designed to remain on the finished paper product; rather, they are processing aids. Therefore, up to 100 percent of the NPE used in this industry may be released to a wastewater treatment plant. Pulp and paper mills typically have sophisticated wastewater treatment plants (CEB, 2004).

Textile Manufacturing

NPEs are used as a surfactant for textile manufacturing operations such as yarn spinning, weaving, and finishing. Again, NPEs are not designed to be incorporated into the finished textile; rather, they are processing aids. Therefore, up to 100 percent of the NPE used in this industry may be released to a wastewater treatment plant (OECD, 2002).

Agricultural Applications

NPEs are used as emulsifiers and wetting agents in pesticides at concentrations from less than one percent to 20 percent (Environment Canada, 2002). Pesticide formulation can be applied to fields using a variety of application methods including boon sprayers, roperwick applicators, spray guns, or aircraft (CEB, 1993). While almost all of the NPEs used in pesticides will be applied to land, the environmental fate of these NPEs may depend on several conditions including wind speed (how much blows off the target area), precipitation (did it rain immediately after application), location of runoff collection ponds, and soil types.

Laundry Detergents and Cleaning Products

NPEs are a common surfactant used in industrial, institutional, and consumer laundry detergents and other consumer cleaning products. Surfactants are surface-active agents that reduce the tension at the surface between the water and the fabric to be cleaned. The surfactant's main function is to suspend the soil that has been removed from the surface, but it also plays a key role in loosening soil (OECD, 2002; EPA, 1999). Since the purpose of NPE is to remain in the wash water, it may be assumed that almost all of the NPE used in laundry detergents and cleaning products could be released to water. Discharges from the use of industrial, institutional, or consumer laundry

detergents may be sent through municipal wastewater treatment systems prior to discharge to the environment.

Summary of Environmental Releases of NPEs

With the exception of the portion of NPEs used in paints and other latex emulsions, the uses of NPEs generally result the entire use volume being discharged. Therefore, up to 461 million pounds of NPE (2000 U.S. consumption) may be discharged. A fraction of the NPE used in paints may be released (10-80%). However, note that most discharges of NPEs will be sent through some type of wastewater treatment prior to release to the environment.

3.0 Occupational Exposures to NPEs at Industrial and Institutional Laundries

Of particular concern in the Section 21 Petition was potential occupational exposure of workers handling NPEs at industrial and institutional laundries. NPEs are common non-ionic surfactant used in the industry. Note that while NP is a raw material for NPEs and a degradation product of NPEs, it is not used at industrial and institutional laundries. Therefore, this assessment focuses on occupational exposures to NPEs. This assessment is primarily based on CEB's Chemicals Used in Water-Based Washing Operations at Industrial and Institutional Laundries Generic Scenario (CEB, 2006a).

Industry Description and Market Size

Laundries can be classified into two main categories: industrial and institutional. These categories are defined by location. Industrial laundries are off-premise laundries that wash soiled laundry received from a hospital, repair shop, doctor's office, etc. Institutional laundries are commonly referred to as on-premise laundries (OPL) and are laundries located within a hospital, nursing home, hotel, or other facility. Table 1 presents information on the number and size of industrial and institutional laundry facilities in the United States.

Table 1. Scale of Laundry Facilities in the United States

Laundry Category	Facility Type	Number of Facilities (sites)	Percent With OPLs	Amount of Dry, Clean Laundry Processed (kg/site-yr)	
				Average	Range
Industrial	Linen Supply	1,053[a]	-	3,300,000[b]	190,000 – 15,000,000[b]
Industrial	Industrial Launderers	3,117[a]	-	3,000,000[b]	110,000 – 11,000,000[b]
Institutional	Hospitals	6,200[c]	18[c]	2,180,000[c]	NA
Institutional	Nursing Homes/Assisted Living	54,000[c]	86[c]	406,000[d]	NA
Institutional	Hotels	46,295[a]	~100[d]	402,000[d]	NA

NA – Not available.
a – Source: USCB, 2004.
b – Source: EPA, 1994.
c – Source: Laundry Today, 2004.
d – Source: CUWCC, 2006.

Additionally, NPEs may be used as a surfactant in dry-cleaning operations. While the extent of the use of NPEs in dry-cleaning is unknown, there were approximately 27,000 dry-cleaning establishments in the United States in 2004 (USCB, 2004).

In 1999, NPE represented approximately 40 percent of all surfactants used in industrial laundries, according to a survey of 13 of the 17 largest wash chemical vendors in the United States (Dunlap, 2001).

Process Description

The greatest potential for occupational exposure to NPEs at industrial and institutional laundries occurs during chemical transfers into the washers. Laundries may receive cleaning products in bags, cardboard boxes, or drums of various types and sizes as a solid powder or liquid solution (Renescu and Kerr, 1993). However, most of the cleaning products are liquid, received in drums, totes, or bulk tanker trucks (UTSA, 2005). Liquid products have been replacing solid products over the past few decades and now make up over 90 percent of all industrial wash chemicals utilized in the United States (CEB, 2006b). Table 2 presents the prevalence of liquid wash chemicals at industrial laundries, based on a 2005 survey of 141 industrial laundries conducted by Uniform & Textile Service Association (UTSA).

Table 2. Physical Form of Wash Chemicals Utilized by Industrial Laundries

Type of Facility	Percent of Facilities
Liquid wash chemicals utilized exclusively	88.7
Solid wash chemicals utilized exclusively	8.5
Liquid and solid wash chemicals utilized	2.8

Source: UTSA, 2005.

Liquid wash chemicals are almost exclusively loaded into the washing machine using a liquid injection system (UTSA, 2005). Solid wash chemicals are typically manually loaded into the washing machine. In most larger facilities and smaller facilities, liquid products are pumped directly from their transport containers into the washing machine. Automatic liquid injection systems reduce worker exposure during the washing process, but workers may face dermal exposure when connecting chemical transfer lines or transferring the liquid chemicals from the transport container to storage tanks. If liquid injection systems are not used, workers manually scoop or pour solid or liquid products into the washing machine, either directly from its transport container, or from a transfer container (such as a pail for easy transport around the facility) prior to being loaded into the machine. During manual loading, workers may undergo a dermal exposure and possible inhalation exposure to powder chemicals. During both automatic and manual transfer operations, inhalation of vapors is not expected because NPEs are non-volatile. Table 3 presents the prevalence of liquid injection systems at industrial laundries, based on a 2005 survey of 141 industrial laundries conducted by UTSA.

Table 3. Prevalence of Liquid Injection Systems at Industrial Laundries

Application Method	Percent of Facilities
Liquid Injection System	91.5
Manual wash chemical loading	8.5

Source: UTSA, 2005.

Note that NPEs can be used in both water-based laundering operations and organic-solvent based laundering operations (i.e., dry-cleaning). While the potential releases from these operations will be different, the occupational exposures from unloading/transfers will be similar.

Concentration of NPE in Laundry Detergents

Most industrial and institutional laundry cleaning products contain over 90 percent of a primary chemical and only small quantities of other chemicals. This allows the facility to adjust the wash chemistry to the specific needs of the load. Therefore, the concentration of NPEs in liquid laundry products can be assumed to be 100 percent for conservative exposure estimates (CEB, 2006a).

Solid products are typically "pre-built", meaning the solid powder contains alkalis, water conditioners, surfactants, and other laundry chemicals in one formulation. Solid products contain approximately 30-35 percent surfactants (CEB, 2006a). Consumer "pre-built" laundry detergents contain approximately 28 percent NPEs (Environment Canada, 2002).

Number of Workers

In May 2006, approximately 217,580 laundry and dry-cleaning workers were employed in the United States (BLS, 2007). Please note the following about this estimate:

- As discussed previously, NPEs represented approximately 40 percent of all surfactants used in industrial laundries in 1999. Due to efforts to phase out NPE at industrial laundries (e.g., Cintas Corporation's voluntary phase out (Sierra Club, 2007)), this percentage may be significantly less today. Therefore, many of these workers are likely not exposed to NPEs.

- Data provided by UTSA indicates that less than six percent of workers at industrial laundries typically have direct contact with wash chemicals during unloading. Note that these data are only representative of industrial laundries and may not apply to institutional laundries or dry-cleaners. While data from the Bureau of Labor and Statistics does not include management personnel and route drives, it may include spot treaters, dyers, and folders of textiles who may not have direct contact with NPEs.

Occupational Exposure Estimates

As stated in the Section 21 Petition, no monitoring data were identified for inhalation or dermal exposure to NPEs at industrial or institutional laundries. The Chemical Engineering Branch (CEB) investigated the following sources for potential data:

- *Chemicals Used in Water-Based Washing Operations at Industrial and Institutional Laundries Generic Scenario* (CEB, 2006a) and associated data and information collected for its development;

- Toxicology Data Network (ToxNet, http://toxnet.nlm.nih.gov/) - This website operated by the U.S. National Library of Medicine allows users to search several databases for information on toxic chemicals including the Hazardous Substance Databases, Toxicology Literature Online, and Toxics Release Inventory;

- The Occupational Safety and Health Administration's (OSHA) website (http://www.osha.gov/);

- The National Institute for Occupational Safety and Health's (NIOSH) website (http://www.cdc.gov/niosh/); and,

- Other documentation provided by EPA (e.g., Section 21 Petition, Toxic Chemicals of National Concern Dossier, NPE Market Summary).

Dermal Exposure

As discussed previously NPE may be present at concentrations up to 100 percent in liquid detergents and up to 28 percent in solid detergents. Using the default methods presented in the *Chemicals Used in Water-Based Washing Operations at Industrial and Institutional Laundries Generic Scenario* (CEB, 2006a), screening-level dermal exposures of up to 1,800 mg of NPEs/day for workers handling liquid detergents and up to 900 mg of NPE/day for workers handling solid detergents may be estimated. For facilities with liquid injection systems, this exposure will only occur when drums and other shipping containers are being changed (two to three times a week). If manual loading occurs, exposure will occur daily. Please note that these estimates do not account for the use of personal protective equipment (PPE). See the Generic Scenario for additional discussion of the background and limitations of these estimates.

Inhalation Exposure

Inhalation exposure is expected to be low for NPEs in liquid detergents due to the low volatility of NPEs, even at the higher operating temperatures of the washers (130°F). However, dusts may be generated when solid powder detergents containing NPEs are loaded into the washers. In the absence of monitoring data, an estimated potential inhalation exposure may be calculated utilizing the OSHA Particulate Not Otherwise Regulated (PNOR) Permissible Exposure Limit (PEL) for nuisance dust (15 mg/m^3). A breathing rate of 1.25 m^3/hr, an 8-hour shift and a NPE concentration in the powder detergent, the potential inhalation exposure is estimated to be 42 mg/day. This estimation approach is used to approximate potential inhalation exposures in the absence of data, if the quantity of powder handled is greater than 154 kg/day. According to the *Chemicals Used in Water-Based Washing Operations at Industrial and Institutional Laundries Generic Scenario* (CEB, 2006a), an average of 154 kg of solid powder detergents may be used per site per day.

Personal Protective Equipment

The Chemical Engineering Branch (CEB) visited an industrial laundry on February 14, 2006 for the development of the Generic Scenario. At the site, workers wore gloves and a faceshield while moving drums and connecting chemical transfer lines. PPE was not worn during other operations at the facility (CEB, 2006b). A guide for occupational safety at industrial laundries recommends the following PPE:

- Skin and eye protection when handling corrosive substances;
- Respirator protection when handling substances which produce dusts or vapors that can be inhaled; and
- Skin protection if worker's hands are constantly immersed in water or wash solutions containing detergents and other chemicals. (DIR, 1994)

However, these situations are not typical for most activities at industrial and institutional laundries. Utilizing these PPE recommendations and observed practices will likely reduce the exposures estimated in this section.

4.0 References

BLS, 2007. U.S Department of Labor, Bureau of Labor and Statistics. Occupational Employment Statistics, National Employment and Wage Statistics for Laundry and Dry-Cleaning Workers (Occupation Code 51-6011), http://www.bls.gov/oes/current/oes516011.htm. Last updated April 2007.

CUWCC, 2006 California Urban Water Conservation Council. *A Report on Potential Best Management Practices*. January 2006.

CEB, 1993. *Generic Scenario: Application of Agricultural Pesticides*. U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, Chemical Engineering Branch, 1993.

CEB, 1999. *Generic Scenario for Automobile Spray Coating*. U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, Chemical Engineering Branch, 1996.

CEB, 2004. *Draft Generic Scenario for Use of Additives in Papermaking*. U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, Chemical Engineering Branch, 2004.

CEB, 2006a. *Chemicals Used in Water-Based Washing Operations at Industrial and Institutional Laundries Generic Scenario*. U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics, Chemical Engineering Branch, 2006.

CEB, 2006b. *Site Visit Report – Nixon Uniform Service and Medical Wear – Industrial and Institutional Laundries Generic Scenario*. U.S. EPA; Office of Pollution Prevention and Toxics; Chemical Engineering Branch; Washington, DC; February 14, 2006.

DIR, 1994. Queensland Government Department of Industrial Relations. Guide for Drycleaning and Laundry Workplaces. August, 1994.

Dunlap, 2001. Dunlap, D. "Past Performances, Promising Future", *Industrial Launderer*; June 2001, pg. 37-40.

Environment Canada, 2002. *Canadian Environmental Quality Guidelines for nonylphenol and its ethoxylates*. National Guidelines and Standards Office, Environmental Quality Branch. August 2002.

EPA, 1999 "Catalogue and Assessment of Components and Ingredients in Laundry Detergent Formulations." U.S. Environmental Protection Agency. June 1999.

EPA, 1994 *1994 Industrial Laundries Detailed Questionnaire Database*. U.S. Environmental Protection Agency, Office of Water, Engineering and Analysis Division. 1994.

EPA, 2007. 2002 Inventory Update Reporting (IUR) Public Database record for CAS #84852153. U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics. Available online at http://www.epa.gov/opptintr/iur/tools/data/2002-vol.htm. Last updated March 2007.

European Commission, 2002. *Summary Risk Assessment Report: 4-nonylphenol (branched) and nonylphenol*. European Commission, Joint Research Centre, Institute for Health and Consumer Protection, 2002.

Harvilicz, H. 1999. "NPE demand remains strong despite environmental concerns in Europe." *Chemical Market Reporter*. October 18, 1999. p15.

Laundry Today, 2004 "Special Report on Laundry Facilities in Healthcare Industries", Laundry Today, Volume 8, Edition 4, April 2004. *http://www.laundrytoday.com/archives/vol_8_4/special_report.htm* (last confirmed October 2006).

MDEQ, 2000. "Pulp and Paper Industry Voluntarily Reduces Use of Nonylphenol Ethoxylates." Michigan Department of Environmental Quality, Environmental Assistance Division, December 2000.

OECD, 2002. Organisation for Economic Co-operation and Development (OECD). *Draft Emission Scenario Document on Industrial Surfactants*. February 2002.

Renescu and Kerr, 1993. "Industrial Laundries Pollution Prevention Demonstration Project; A Partnership with Industry." Water Environment Federation Pre-Conference Seminar. October 1993.

Sierra Club, 2007. "Press Release: Groups Demand EPA Action on Gender-Bending Chemicals". http://www.sierraclub.org/pressroom/releases/pr2007-06-05.asp (last confirmed June 2007).

SRC, 2007. Syracuse Research Corporation, PhysProp Database, record for CAS #84852153. *http://www.syrres.com/esc/physdemo.htm* (last confirmed June 2007).

USCB, 2004. U.S. Census Bureau. 2004 County Business Patterns. *http://censtats.census.gov/cbpnaic/cbpnaic.shtml* (last confirmed October 2006).

UTSA, 2005. Uniform and Textile Service Association. "Comments on Chemicals Used in Water-based Washing Operations at Industrial and Institutional Laundries – Generic Scenario for Estimating Occupational Exposures and Environmental Releases – December 8, 2004 Draft", September 16, 2005.

G. Ying, B. Williams, R. Kookana, 2002. "Environmental Fate of Alkylphenols and Alkylphenol Ethoxylates." *Environment International*. 28 (3) p215-226.