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**Fatty Nitrogen Derived Amines Category
High Production Volume (HPV)
Chemicals Challenge**

**Assessment of Data Availability
and Test Plan**

Prepared for:

**American Chemistry Council's
Fatty Nitrogen Derivatives Panel
Amines Task Group**

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Fatty Nitrogen Derived Amines Category High Production Volume (HPV) Chemicals Challenge Assessment of Data Availability

Introduction

Surfactants have a long history of use and have been studied extensively for environmental fate and effects and human health effects. The Fatty Nitrogen Derived (FND) Amines Category chemicals have surfactant properties (e.g. comprised of hydrophobic and hydrophilic ends, form micelles, alter/reduce surface tension, form oil/water emulsions) and are used primarily in the production of commercial surfactants such as ethoxylated amine surfactants or as chemical intermediates (e.g. for the production of quaternary amines). Some typical applications of FND Amines Category chemicals and/or their derivatives are as degreasers, metal cleaners, metal working fluids, and industrial laundry cleaners.

Definition of Fatty Nitrogen Derived (FND) Amines Structure -Based Chemical Category

The FND Amines Category is comprised of 23 chemicals with unique Chemical Abstracts Service Registry Numbers (CAS RN; see Text Table A). While these long-chain substituted amines are considered appropriately combined in a single category based on their similar properties and toxicity, for aid in review, the chemicals were placed in the following subcategories:

Subcategory I: Primary Alkylamines and Alkyldiamines:

Six long-chain substituted amines (CAS RN 124-22-1, 143-27-1, 68037-91-2, 68155-38-4, 61790-18-9 and 68037-95-6). Two long-chain substituted propanediamines (CAS RN 61791-55-7 and 7173-62-8).

Subcategory II: Dimethylalkylamines:

Five long-chain substituted dimethyl amines (CAS RN 112-75-4, 112-69-6, 124-28-7, 61788-95-2 and 61788-91-8).

Subcategory III: Dialkylmethylamines and Dialkylamines:

Six long-chain disubstituted amines and disubstituted methyl amines (CAS RN 7396-58-9, 67700-99-6, 68153-95-7, 4088-22-6, 61788-63-4 and 68783-24-4).

Subcategory IV: Trialkylamines:

Two long-chain tri-substituted amines (CAS RN 68814-95-9 and 61790-42-9) and two long-chain substituted ethanol, 2,2'-iminobis-amines (CAS RN 61791-31-9 and 61791-44-4).

Data for five primary alkylamines (CAS RN 61788-45-2*, 124-30-1*, 61788-46-3*, 61790-33-8* and 112-90-3*) sponsored by the European Oleochemicals and Allied Products Group (APAG) under the ICCA program (see Task Group letter to EPA dated November 9, 2001) that are chemically identical to the Subcategory I chemicals (albeit with different CAS RN) are included in this review. These chemicals are identified throughout this document by CAS RN and an "*" since they provide extensive supporting information to the FND Amines Category. In addition, six supporting individual chemicals and an FDA-approved

(used in toothpaste) two-chemical mixture, that are not part of the US HPV Chemical Challenge Program, but are structurally closely related to the FND Amines Category chemicals, are included to provide supporting data for the category. These 12 chemicals are termed “supporting chemicals” throughout this document and are defined in Text Table A.

The FND Amines Category chemicals and supporting chemicals are described in the following table. The supporting chemicals are shaded and italicized for ease of identification.

Text Table A: CAS Registry Numbers and Chemical Names

CAS RN	Chemical Name
Subcategory I: Primary Alkylamines and Alkyldiamines	
124-22-1	Dodecylamine
143-27-1	Hexadecylamine
68037-91-2	Amines, C ₁₄₋₁₈ -alkyl
<i>61788-45-2*</i>	<i>Amines, hydrogenated tallow alkyl</i>
<i>124-30-1*</i>	<i>Octadecylamine</i>
<i>61788-46-3*</i>	<i>Amines, coco alkyl</i>
68155-38-4	Amines, C ₁₄₋₁₈ and C ₁₆₋₁₈ -unsatd. alkyl
<i>61790-33-8*</i>	<i>Amines, tallow alkyl</i>
61790-18-9	Amines, soya alkyl
68037-95-6	Amines, C ₁₆₋₁₈ and C ₁₈ -unsatd. alkyl
<i>112-90-3*</i>	<i>Cis-9-Octadecenylamine</i>
61791-55-7	Amines, N-tallow alkyltrimethylenedi-
7173-62-8	1,3-Propanediamine, N-(9Z)-octadecenyl-
<i>3151-59-5</i> <i>+ 36505-83-6</i>	<i>Hexadecylamine hydrofluoride (Hetaflur)</i> <i>9-Octadecen-1-amine hydrofluoride</i>
Subcategory II: Dimethylalkylamines	
<i>112-18-5</i>	<i>1-Dodecanamine, N,N-dimethyl</i>
112-75-4	1-Tetradecanamine, N,N-dimethyl
112-69-6	1-Hexadecanamine, N,N-dimethyl
124-28-7	1-Octadecanamine, N,N-dimethyl
<i>61788-93-0</i>	<i>Amines, coco alkyl dimethyl</i>
61788-95-2	Amines, (hydrogenated tallow alkyl)dimethyl
61788-91-8	Amines, dimethyl soya alkyl
<i>28061-69-0</i>	<i>Octadecen-1-amine, N,N-dimethyl</i>

Text Table A: CAS Registry Numbers and Chemical Names

CAS RN	Chemical Name
Subcategory III: Dialkylmethyamines and Dialkylamines	
7396-58-9	1-Decanamine, N-decyl-N-methyl
67700-99-6	Amines, di-C ₁₄₋₁₈ -alkylmethyl
68153-95-7	Amines, di-C ₁₂₋₁₈ -alkyl
4088-22-6	1-Octadecanamine, N-methyl-N-octadecyl
61788-62-3	<i>Amines, dicoco alkylmethyl</i>
61788-63-4	Dihydrogenated tallow methylamine
61789-79-5	<i>Amines, bis(hydrogenated tallow alkyl)</i>
61789-76-2	<i>Amines, dicoco alkyl</i>
68783-24-4	Amines, ditallow alkyl
Subcategory IV: Trialkylamines	
68814-95-9	Amines, tri-C ₈₋₁₀ -alkyl-
61790-42-9	Amines, tris (hydrogenated tallow alkyl)
61791-31-9	Ethanol, 2,2'-iminobis-, N-coco alkyl derivs.
61791-44-4	Ethanol, 2,2'-iminobis-,N-tallow alkyl derivs.

* These chemicals were removed from the original FND Amines Category because they are sponsored by APAG under the ICCA program.

Structural Information for the FND Amines Category and Supporting Chemicals

The following table presents the molecular formula and molecular weight data for the chemicals with defined structures or average molecular weight data for chemicals without defined structures. The structures for these and the remaining chemicals in the FND Amines Category are provided in Table 1.

Text Table B: Molecular Formula and Molecular Weight of Chemicals with Defined or Representative Structures

CAS RN	Name	Molecular Formula	Molecular Weight ^a
Subcategory I: Primary Alkylamines and Alkyldiamine			
124-22-1	Dodecylamine	C ₁₂ H ₂₇ N	185
143-27-1	Hexadecylamine	C ₁₆ H ₃₅ N	241
61788-45-2*	<i>Amines, hydrogenated tallow alkyl</i>		263
124-30-1*	<i>Octadecylamine</i>	C ₁₈ H ₃₉ N	270
61788-46-3*	<i>Amines, coco alkyl</i>		200
61790-33-8*	<i>Amines, tallow alkyl</i>		262
61790-18-9	Amines, soya alkyl		264
112-90-3*	<i>Cis-9-Octadecenylamine</i>	C ₁₈ H ₃₇ N	267
61791-55-7	Amines, N-tallow alkyltrimethylenedi-		320
7173-62-8	1,3-Propanediamine, N-(9Z)-octadecenyl-	C ₂₁ H ₄₄ N ₂	325
3151-59-5	<i>Hexadecylamine hydrofluoride (Hetaflur)</i>	C ₁₆ H ₃₅ N.H-F	241 ^b
+36505-83-6	<i>9-Octadecen-1-amine hydrofluoride</i>	C ₁₈ H ₃₇ N.H-F	267 ^b

Text Table B: Molecular Formula and Molecular Weight of Chemicals with Defined or Representative Structures

CAS RN	Name	Molecular Formula	Molecular Weight ^a
Subcategory II: Dimethylalkylamines			
<i>112-18-5</i>	<i>1-Dodecanamine, N,N-dimethyl</i>	<i>C₁₄H₃₁N</i>	<i>213</i>
112-75-4	1-Tetradecanamine, N,N-dimethyl	C ₁₆ H ₃₅ N	241
112-69-6	1-Hexadecanamine, N,N-dimethyl	C ₁₈ H ₃₉ N	270
124-28-7	1-Octadecanamine, N,N-dimethyl	C ₂₀ H ₄₃ N	298
<i>61788-93-0</i>	<i>Amines, coco alkyl dimethyl</i>		<i>228</i>
61788-95-2	Amines, (hydrogenated tallow alkyl)dimethyl		291
61788-91-8	Amines, dimethyl soya alkyl		292
<i>28061-69-0</i>	<i>Octadecen-1-amine, N,N-dimethyl</i>	<i>C₂₀H₄₁N</i>	<i>296</i>
Subcategory III: Dialkylmethylamines and Dialkylamines			
7396-58-9	1-Decanamine, N-decyl-N-methyl	C ₂₁ H ₄₅ N	312
4088-22-6	1-Octadecanamine, N-methyl-N-octadecyl	C ₃₇ H ₇₇ N	536
<i>61788-62-3</i>	<i>Amines, dicoco alkylmethyl</i>		<i>397</i>
61788-63-4	Dihydrogenated tallow methylamine		523
<i>61789-79-5</i>	<i>Amines, bis(hydrogenated tallow alkyl)</i>		<i>509</i>
<i>61789-76-2</i>	<i>Amines, dicoco alkyl</i>		<i>383</i>
68783-24-4	Amines, ditallow alkyl		507
Subcategory IV: Trialkylamines			
68814-95-9	Amines, tri-C ₈₋₁₀ -alkyl-	C ₂₇ H ₅₇ N	396
61790-42-9	Amines, tris (hydrogenated tallow alkyl)		752
61791-31-9	Ethanol, 2,2'-iminobis-, N-coco alkyl derivs.		302
61791-44-4	Ethanol, 2,2'-iminobis-,N-tallow alkyl derivs.		364

Shaded cells with italic font indicate supporting chemicals.

* These chemicals were removed from the original FND Amines Category because they are sponsored by APAG under the ICCA program.

^a Average chain length or estimated chain length is used where appropriate; where no formula is provided, the molecular weight is that generally used by the industry to define the chemical.

^b Molecular weight of the alkyl chain (excludes the hydrofluoride salt).

Rationale for the FND Amines Structure-Based Chemical Category

The members of the FND Amines category are large surfactant molecules. As such, they fall into a family of surfactants, all of which have similar physical/chemical properties. The FND surfactants (amines, cationics, amides) are comprised of either defined long-chain alkyl substituents or use natural oils and fats. The following table summarizes the long-chain alkyl substituents found in the FND Amines Category chemicals:

Text Table C: Chain Length and Degree of Unsaturation for Long-Chain Substituents in the FND Amines Category Chemicals

Identifier	Chain Length(s) or Average	Degree of Unsaturation
C8-C10 alkyl	9	None
Isodecyl	10	None
C9-C11 (C10 rich)	10	None
Dodecyl	12	None
C13 branched	13	None
C11-C14 (C13 rich)	13	None
Tetradecyl	14	None
Hexadecyl	16	None
C14-C18	Not specified	None
C12-C18	Not specified	None
C14-C18 and C16-C18 unsaturated	Not specified	Not specified
C16-C18 and C18-unsaturated	Not specified	Not specified
Octadecyl	18	None
Octadecenyl	18	1
Coco (coconut)	C6: 0-1% C8: 5-9% C10: 5-10% C12: 44-53% C14: 13-19% C16: 8-11% C18: 1-3% C16: 0-1% C18: 5-8% C18: 1-3%	None None None None None None None 1 1 2
Tallow, hydrogenated ¹	C14: 1-6% C16: 23-46% C18: 49-67%	None None None
Tallow	C14: 1-6% C16: 20-37% C18: 14-21% C16: 3-9% C18: 35-46% C18: 4-10% C18: 0-3%	None None None 1 1 2 3
Soya (soy bean)	C16: 7-11% C18: 2-7% C20: 0-2% C18: 20-30% C18: 43-56% C18: 8-14%	None None None 1 2 3

Based on an analysis of data across the FND chemicals (including FND cationics, amides, and nitriles submitted in separate Test Plans), the chain length and degree of unsaturation in the FND

¹ Percentages assume 100% hydrogenation of the unsaturated tallow chains.

surfactants does not appear to have a significant impact on fate and effects. A careful examination of the chemical structures (Table 1) shows the close relationship of all of the chemicals in the category. In addition, the following discussion describes how interrelated the structures of the various FND Amine Category chemicals may be: The nomenclature issue described below is directly pertinent to this Test Plan in that testing is conducted under two chemical names for CAS RN 4088-22-6; specifically, dioctadecane methyl amine and ditallow methyl amine.

Nomenclature for FND Amines: Higher chain length raw materials used within the industry for the manufacture of amines in the C14 to C18 alkyl range typically include commercial stearic acid commonly sourced from tallow; tallow/tallow fatty acid, or hydrogenated tallow/hydrogenated tallow fatty acid. These fatty acid raw materials are commonly referred to in the industry by their source name tallow/hydrogenated tallow fatty acid or stearic acid. Commercial stearic acid comes in three principle grades, single pressed stearic, double pressed stearic, and triple pressed stearic acid. These technical grades are mixtures of palmitic (C16) and stearic (C18) acids, not pure C18 (octadecanoic acid). The higher grade, double and triple pressed stearic, has increasing levels of C18 fatty acid. The general chain length makeup and relative level of unsaturation, as measured by Iodine Value (IV), of the grades is as follows:

Text Table D: Effect of Processing on FND Amine Composition

	I.V. (g/100 g)	%C14	%C15	%C16	%C17	%C18	%C18 (monounsaturated)
Double Pressed	4.0 max	2.5	0.5	50	1	40	6
Triple Pressed	2.0 max	1.5	0.5	50	1	47	<0.2

Commercial "stearic acid" is approximately a 50/50 mixture of C16/C18 saturated chain lengths indicative of the historical commercial separation process limitations and tallow composition from which it is commonly made. Most of the C18 monounsaturate and higher C18 unsaturated fatty acids have been separated away. It is an example of a Class 2 chemical substance that is known commercially by a Class 1 name. At the inception of the TSCA Inventory, the Class I IUPAC name "octadecanoic acid"--indicative of only C18 saturated fatty acid--was assigned to the trivial name, "stearic acid". As a result, many commercial "stearic acid" derivatives are named according to "octadecyl" nomenclature implying only C18 alkyl chain when the actual commercial product is an alkyl range derivative material that principally includes C16 and C18 chain lengths. An example is the class of amines referred to as ditallow methyl amines. Commercially, only a relatively few stearic acid derivatives are composed of the single, pure C18 alkyl chain.

Thus, not only are the FND Amines Category chemicals similar structurally, but also in many cases may be produced from the same starting materials. The following discussion highlights the structural similarities within and among the Subcategories of the FND Amines Category.

Subcategory I - Primary Alkylamines and Alkyldiamines: A number of the chemicals in the category are essentially identical or only differ in one or two carbons on the long-chain substituent. The alkane-substituted amines in Subcategory I have carbon chain distributions ranging from C12 to C18. Empirical data and the commonality of microbial degradation

processes indicate that degradation of these molecules would clearly result in similar by-products and metabolites. Other than unsaturation of the alkyl chain, the unsaturated substituents including tallow (primarily C16 and C18 saturated and unsaturated) and soya (primarily C18 unsaturated) are identical to the saturated chain molecules. The two alkyldiamines in this Subcategory have corresponding alkylamines. Degradation of these molecules, other than generation of an additional ammonia, would be identical to those of the corresponding monoamine.

Subcategory II - Dimethylalkylamines: Each of the Subcategory II chemicals has an identical or very similar corresponding primary alkylamine in Subcategory I. As shown by the data presented herein, the addition of the dimethyl substituents does not result in recognizable differences in environmental fate or hazard assessments.

Subcategory III - Dialkylmethylamines and Dialkylamines: The chemicals in this Subcategory are similar to those in Subcategory II with the substitution of a longer chain length for one of the methyl groups (dialkylmethylamines) or with substitution of two longer chain alkyl groups (dialkylamines). These substitutions would not be expected to result in recognizable differences in environmental fate or hazard assessments since these substituents impart no structural alerts or unusual properties different from the chemicals in the other subcategories.

Subcategory IV - Trialkylamines: The two long-chain tri-substituted members of this category (CAS RN 68814-95-9 and 61790-42-9) are essentially equivalent to the dimethyl alkyl and dialkyl amines in Subcategory II or III. As shown by the data presented herein, replacing two of the long-chain substituents with ethanol would not result in structural alerts or potential degradation products of concern.

SUMMARY: The diversity of chemical structures for the FND Amines Category results from manufacturing processes, including the use of natural oils, and the need for different application properties. This structural diversity does not result in chemicals with different structural alerts. To the contrary, based on the chemical structures and supported by the available ecotoxicity and mammalian toxicity data, these chemicals show consistent toxicity.

The goal of subcategorizing is to aid in the description and evaluation of the Category as a whole. It is considered appropriate to read-across from other Subcategories when the data are consistent. As noted above, each of the chemicals within the Subcategories is structurally similar to chemicals in one or more other Subcategories. The approach to the Test Plan for the FND Amine Category chemicals is, therefore, to provide the available information that shows that each of the Subcategories fits the overall pattern of fate and toxicity for the FND Amines Category and the FND surfactants in general. It is not necessary or appropriate to consider the Category or the Subcategories as having “ends” that, when tested, represent a continuum of structure. That is, there is no pattern of increasing or decreasing environmental fate or toxicity among these chemicals. Rather, there is a consistency of response across the entire Category.

Available Data to Fulfill HPV Screening Information Data Set (SIDS) Endpoints

Approach to Evaluate the Database for the FND Amines Category

The following approach was used to obtain and analyze data relevant to the assessment of the FND Amines Category.

1. The chemical names and CAS RN of 28 HPV FND Amines Category chemicals supported by the American Chemistry Council Fatty Nitrogen Derivatives Panel, Amines Task Group (Task Group) were provided.
2. Five Primary Alkylamines (CAS RN 61788-45-2*, 124-30-1*, 61788-46-3*, 61790-33-8* and 112-90-3*) were removed from the original list since they were sponsored by the European Chemical Industry in the ICCA Program. As discussed above, these and seven other chemicals of similar structure and function to the FND Amines Category chemicals were included as supporting chemicals. Therefore, there are a total of 23 HPV Sponsored chemicals in the category.
3. Published and unpublished reports were obtained as available from the members of the FND Amines Task Group and other chemical industry companies; they were organized and reviewed to identify studies that could fulfill SIDS endpoints.
4. Pertinent databases² were searched and all reports considered relevant by the Panel were obtained to help establish the full extent and nature of the published literature for the 23 FND Amines Category and 12 supporting chemicals.
5. Each of the reports obtained was reviewed to determine adequacy according to EPA criteria and reliability according to Klimisch *et al.* (1997).
6. Robust summaries were prepared for each report with Klimisch scores of 1 or 2, according to the guidelines proposed by the EPA (U. S. EPA, 1999a) for each study type.
7. Robust summaries for the studies sponsored in the ICCA program included herein were accepted *a priori* from the European industry and were not generated from the original reports.
8. Where possible, estimates for physical/chemical properties, environmental fate and ecotoxicity values were developed for the HPV and supporting chemicals by using recommended approaches for developing Structure Activity Relationships (SAR).
9. Where possible, fugacity modeling was performed to estimate transport and distribution into environmental compartments for the HPV and supporting chemicals.
10. Robust summaries were generated for the SAR data.

Use of Structure Activity Relationships for the FND Amines Category

Approaches recommended in the EPA document on the use of SAR in the HPV Chemicals Challenge Program were employed in the assessment of the FND Amines Category (U. S. EPA, 1999b). Several models were employed to support the review and assessment of the FND Amines Category chemicals. The models included several based on SAR, as well as Mackay-type fugacity-based modeling. The SAR models for physical properties were used to estimate boiling points, melting points, aqueous solubility, octanol-water partition coefficients and vapor

² Databases include ChemIDplus HSDB (Hazardous Substances Data Bank), IRIS (Integrated Risk Information System), CCRIS (Chemical Carcinogenesis Research Information System), GENE-TOX, EMIC (Environmental Mutagen Information Center), DART/ETIC (Developmental and Reproductive Toxicology and Environmental Teratology Information Center), MEDLINE, TOXLINE, RTECS (Registry of Toxic Effects of Chemical Substances), TSCATS (Toxic Substances Control Act Test Submissions), IUCLID, 1996 (International Uniform Chemical Information Database).

pressures. Other SAR models were used to estimate hydroxyl radical mediated atmospheric photo-oxidation and biodegradation potential. SAR models also were used to obtain estimates of acute toxicity to aquatic organisms.

Common Features of the Models

All of the models (except the Mackay-type models) require the input of a molecular structure to perform the calculations. The structure must be entered into the model in the form of a SMILES (Simplified Molecular Input Line Entry System) notation or string. SMILES is a chemical notation system used to represent a molecular structure by a linear string of symbols. The SMILES string allows the program to identify the presence or absence of structural features used by the submodels to determine the specific endpoint. The models contain files of structures and SMILES strings for approximately 100,000 compounds, accessible via CAS RN. SMILES strings cannot be developed for mixtures or chemicals without a single, definable structure.

Estimation of Physical/Chemical Properties

The SAR models for estimating physical properties and abiotic degradation were obtained from Syracuse Research Corporation 2000 (Estimation Programs Interface for Windows, Version 3.05 or EPIWIN v. 3.05). The models were used to calculate melting point, boiling point, vapor pressure (submodel MPBPVP), octanol-water partition coefficient (K_{ow}) (submodel KOWWIN), and aqueous solubility (submodel WSKOWWIN). The calculation procedures are described in the program guidance and are adapted from standard procedures based on analysis of key structural features (Meylan and Howard, 1999a, b, and c).

Estimation of Environmental Fate Properties

Atmospheric photo-oxidation potential was estimated using the submodel AOPWIN (Meylan and Howard, 2000a). The estimation methods employed by AOPWIN are based on the SAR methods developed by Dr. Roger Atkinson and co-workers (Meylan and Howard, 2000a). The SAR methods rely on structural features of the subject chemical. The model calculates a second-order rate constant with units of $\text{cm}^3/\text{molecules}\cdot\text{sec}$. Photodegradation based on atmospheric photo-oxidation is in turn based on the rate of reaction ($\text{cm}^3/\text{molecules}\cdot\text{sec}$) with hydroxyl radicals ($\text{HO}\bullet$), assuming first-order kinetics and an $\text{HO}\bullet$ concentration of $1.5 \text{ E}+6 \text{ molecules}/\text{cm}^3$ and 12 hours of daylight. Pseudo first-order half-lives ($t_{1/2}$) were then calculated as follows: $t_{1/2} = 0.693/[(k_{\text{phot}} \times \text{HO}\bullet) \times (12\text{-hr}/24\text{-hr})]$.

The database that supports the modeling of water stability provides only for neutral organic compounds that have structures that can be hydrolyzed. Therefore, no model estimates for hydrolytic stability are available since the FND Amines Category chemicals do not have the necessary characteristics.

Estimation of Environmental Distribution

The Level III Mackay-type, fugacity-based models were obtained from the Trent University's Modeling Center. The specific model used was the generic Equilibrium Concentration model (EQC) Level 3, version 1.01. These models are described in Mackay *et al.* (1996a and b). Fugacity-based modeling is based on the "escaping" tendencies of chemicals from one phase to another. For instance, a Henry's Law constant calculated from aqueous solubility and vapor

pressure is used to describe the "escape" of a chemical from water to air or vice versa as equilibrium between the phases is attained. The key physical properties required as input parameters into the model are melting point, vapor pressure, K_{ow} and aqueous solubility. The model also requires estimates of first-order half-lives in the air, water, soil and sediment. An additional key input parameter is loading of the chemical into the environment.

Estimation of Acute Aquatic Toxicity

Models developed by the U. S. Environmental Protection Agency (EPA) were employed to make estimates of acute toxicity to aquatic organisms, specifically a commonly tested fish, the fathead minnow (*Pimephales promelas*), a water column dwelling invertebrate (*Daphnia magna*) and a commonly tested green alga, *Selenastrum capricornutum*. The models are incorporated in a modeling package called ECOSAR, version 0.99f (U. S. EPA, 2000). ECOSAR may be obtained from the EPA website for the Office of Pollution Prevention and Toxics, Risk Assessment Division. The models calculate toxicity based on structural features and physical properties, mainly the K_{ow} (Meylan and Howard, 1998).

Modeling Information Specific to the FND Amines Category

When CAS RNs were included in the files of structures, the models described above were used for the FND Amines Category chemicals and the 12 supporting chemicals. Estimations of physical properties, environmental fate and distribution, and ecotoxicity were not possible for 16 of the 23 HPV chemicals in the FND Amines Category because they do not have single definable structures and/or were not available in the files of structures of the models. Model predictions were available for five of the supporting chemicals. The model did not provide estimates of stability in water for this class of chemicals because the model cannot calculate this parameter for chemicals that do not meet the criteria of neutral organic compounds with structures that can be hydrolyzed. Since the FND Amines Category chemicals are considered to be released into wastewater treatment systems consistent with their use patterns, release to soil and air were considered to be minor avenues of entry for FND Amines Category chemicals into the environment. Therefore, for fugacity modeling, all input was assumed to be into surface water using the chemical specific parameters to attain estimates of the chemical distributions between environmental compartments. The submodel for Cationic Surfactants was initially used for the ECOSAR model output (data included on Table 3). Subsequently, the model for Aliphatic Amines was examined. In a number of cases, the Aliphatic Amines calculations are more similar to experimental values. Therefore, these values, where different, are included in Table 3 as well. In many cases the ECOSAR model indicated the chemicals were not toxic to aquatic organisms at predicted solubility. These are indicated on appropriate tables but are not discussed in this text.

Physical/Chemical Properties Data

The available reliable data and SAR estimates for physical/chemical properties of the FND Amines Category chemicals are presented in Table 2. Robust summaries for the reliable studies are provided in Appendix A and Robust Summaries for all of the SAR data are included in Appendix B. The Test Plan for Physical/Chemical Properties is outlined in Table 5.

Measurement of physical/chemical properties for surfactants is complicated by their behavior in test systems and the environment. For example, measurement of the octanol/water partition

coefficient ($\log K_{ow}$) is confounded by the ability of the chemicals to emulsify octanol/water solutions. The resulting values are inaccurate and of limited utility for determining environmental fate and effects. Similarly, measurements such as melting points and boiling points provide minimal information since they do not identify key characteristics of the molecules. The large size of the molecules makes these chemicals non-volatile and the determination of a precise value for vapor pressure is difficult and of little practical use.

As described above, where possible, the physical/chemical property estimation program EPIWIN version 3.05 was used to derive estimates. As with actual measurement, prediction of physical/chemical properties for surfactants is complicated. As explained above, the $\log K_{ow}$, a key determinant in the models, is not an appropriate hydrophobicity parameter for reliably predicting environmental behavior of surfactants. The data are, therefore, of limited value in estimating environmental fate and toxicity. The SAR estimates are based on structure and can be made only for substances for which a structure can be defined. Thus, model data were generated for seven of the 23 HPV chemicals and five supporting chemicals that have discrete structures.

The available data for physical/chemical properties are summarized below:

Subcategory I – Primary Alkylamines and Alkyldiamines: EPIWIN predicted melting points ranging from approximately 28 to 142°C. Three reported values, for CAS RN 124-22-1, 61788-45-2* and 124-30-1*, were the same as the model values suggesting that these reported values were also calculated. The reported value for CAS RN 112-90-3* of 21°C was lower than the model value of 93°C. Reported values for the supporting chemical CAS RN 61790-33-8* were 34 to 40°C and 25 to 30°C. Model estimates made for boiling points ranged from 259 to 402°C. Reported boiling points were identical (CAS RN 124-22-1, 61788-45-2* and 124-30-1*) or similar (CAS RN 112-90-3*) to the model values. Boiling point for CAS RN 61790-33-8* was 200 to 230°C. Decomposition at 348°C was reported for CAS RN 61788-45-2*.

As expected, based on extensive practical experience with these and similar large organic molecules, the reported and EPIWIN estimated vapor pressures were extremely low across the FND Amines Subcategory, i.e. more than two orders of magnitude lower than water. The FND Amines Category chemicals are essentially nonvolatile, as is generally the case for molecules of this size and complexity.

Predicted or measured $\log K_{ow}$ values are of limited practical use for the FND Amines Category chemicals. An inherent property of surfactants is that they accumulate at the interface between hydrophobic and hydrophilic phases rather than equilibrating between the two phases. Therefore, the accurate measurement of the $\log K_{ow}$ of any surfactant is notoriously difficult. Even if such measurements were made accurately, the $\log K_{ow}$ is not an appropriate value by which to predict the partitioning behavior of the FND Amines Category chemicals in the environment because of the tendency of surfactants to partition at lipid/aqueous interfaces. The EPIWIN estimated values for the octanol/water partition coefficient ($\log K_{ow}$) ranged from approximately 5 to 8. No reported values were identified for the HPV chemicals. For supporting chemicals, a measured value for CAS RN 61790-33-8* was reported to be 7.5 and a range of values from >3.11 to 8.1 was reported for CAS RN 112-90-3*.

Reported water solubility for the primary alkylamines and alkyldiamines varied from insoluble to slightly soluble. Reported values for CAS RN 124-22-1 and 124-30-1* were 2000 and 1000 mg/L, respectively although a separate report for CAS RN 124-30-1* indicated it was “not soluble”. Other reported information indicated the chemicals were “insoluble” or “very insoluble” in water. Model predictions for water solubility also ranged from virtually insoluble (< 0.1 mg/L) to slightly soluble (approximately 45 mg/L).

Subcategory II – Dimethylalkylamines: EPIWIN predicted melting points for the five chemicals that could be modeled ranged from 22 to 80°C. There is a reported value for CAS RN 112-18-5 of -15 to -20°C compared to the model value of 22°C and two reported values for CAS RN 124-28-7 of approximately 20 to 23°C similar to the model value (23°C). Model estimates for boiling point ranged from 260 to 346°C. There are no reported boiling point values available for HPV or supporting chemicals.

EPIWIN estimated vapor pressures were very low across this FND Amines Subcategory and ranged from 0.000052 to 0.0159 hPa. There are no reported values available for HPV or supporting chemicals. As noted above, the FND Amines Category chemicals are non-volatile.

No reported values for the octanol/water partition coefficient (log K_{ow}) were identified for HPV or supporting chemicals. EPIWIN predicted values for log K_{ow} ranged from 5.44 to 8.39. As noted above, the partition coefficient for these types of molecules is not appropriate for predicting partitioning in the environment.

Model predictions for water solubility ranged from 0.0089 to 8.58 mg/L. HPV chemical CAS RN 124-28-7 was reported as “not soluble.”

Subcategory III – Dialkylmethylamines and Dialkylamines: EPIWIN predicted data were available for one HPV chemical that could be modeled (CAS RN 4088-22-6). The predicted melting point was 216°C and the predicted boiling point was 543°C. The estimated vapor pressure was 2.0×10^{-11} hPa and estimated partition coefficient (log K_{ow}) was 17. This chemical had a predicted water solubility of 2×10^{-11} mg/L. A reported partition coefficient and associated water solubility of 3.15 and 0.288 mg/L, respectively were identified for CAS RN 61788-63-4. In the partition coefficient determination, an apparent concentration-related difference in log K_{ow} was indicated (see Robust Summary) again suggesting that this measurement is not appropriate for these types of chemicals.

Subcategory IV – Trialkylamines: No measured or model data were available for these chemicals.

Summary – Physical/Chemical Properties

Melting points and boiling points are of very limited value in determining the fate and toxicity of surfactant molecules. The available data and model predictions are considered adequate to define the typical ranges for these endpoints. In addition, these types of molecules tend to degrade rather than boil. Consistent with the size and nature of these molecules, measured and modeled vapor pressures are very low, and the FND Amines Category chemicals are considered to be essentially nonvolatile. Measurement and prediction of physical/chemical properties for surfactants are complicated by their behavior in test systems and the environment, and the log

K_{ow} is not an appropriate hydrophobicity parameter for reliably predicting environmental behavior. The available values and estimates are considered of very minimal use and additional testing is not warranted. Water solubility estimates varied from slightly soluble to very insoluble. The majority of these chemicals are clearly insoluble in water and the chemicals in Subcategories I – III are adequately represented as insoluble. In addition, as noted below, water solubility is not related to the toxicity of these surfactant molecules to aquatic species. The trialkyl substituted amines in Subcategory IV would be expected to be insoluble based on similarity of structure with other members of the Category containing shorter-chain substituents. While the water solubility of the fatty acid diethanolamines (CAS RN 61791-31-9 and 61791-44-4) has not been evaluated, in testing for biodegradation (see Robust Summary for Biodegradation), it is clearly stated that CAS RN 61791-31-9 was not water soluble while CAS RN 61797-44-4 was soluble to 1 g/liter. Due to the insoluble nature of the chemical, surfactants were required to generate emulsions necessary to complete the test for CAS RN 61791-31-9. Therefore, the chemicals in Subcategory IV are also insoluble or poorly soluble. Overall, it is noted that measurement and prediction of physical/chemical properties for surfactants are complicated by their behavior in test systems and the environment, including strong adsorption and absorption properties and surface tension activity. Although predictions vary, the data and knowledge of the chemicals support the conclusion that the FND Amines Category chemicals behave similarly from the perspective of physical/chemical properties.

Additional Testing – Physical/Chemical Properties

No additional testing (Table 5) is proposed for the Category based either on the inappropriateness of the endpoint (melting point, boiling point, partition coefficient) for these surfactant molecules or adequate information (vapor pressure, water solubility) to establish the characteristics across the category.

Environmental Fate and Ecotoxicity Data

The available reliable data and SAR estimates for the environmental fate and effects of the FND Amines Category chemicals are presented in Table 3. Robust summaries for the reliable studies are provided in Appendix A and Robust Summaries for all of the SAR data are included in Appendix B. The Test Plan for the Environmental Fate and Ecotoxicity Endpoints is summarized in Table 6.

Subcategory I – Primary Alkylamines and Alkyldiamines: Models for atmospheric photodegradation were used according to EPA guidelines. However, the fugacity models predict virtually no occurrence of the FND Amines Category chemicals in air, which is consistent with the very low vapor pressures. Nonetheless, modeling of the HPV and supporting chemicals indicates that they would be expected to degrade relatively rapidly upon exposure to light ($t_{1/2}$ values ranging from approximately 0.7 to 2.8 hours).

The HYDROWIN model did not provide estimates of stability in water for this class of chemicals because the model cannot calculate this parameter for chemicals that do not meet the criteria of neutral organic compounds with structures that can be hydrolyzed. These types of chemicals generally do not have hydrolysable groups.

An estimation of the transport and distribution of the FND Amines Category chemicals in environmental media (percent in air, water, soil and sediment) following entry into the environment via water is presented in Table 3. Distribution to air and soil were < 1% for all of the chemicals that could be modeled while distribution to the water compartment varied from 10 to 75% with the remainder in the sediment.

For biodegradation, guideline studies and studies similar to guidelines were available for seven of the 14 HPV and supporting chemicals in this FND Amines Subcategory. For one of the two HPV chemicals for which data are available (CAS RN 124-22-1) the 28-day biodegradation was >60% ThOD. For the HPV chemical (CAS RN 61791-55-7), 87% of the chemical was adsorbed in the sludge and 90% DOC elimination occurred in 3 hours. For the supporting chemicals, the 28-day degradation ranged from 44 to 91.1%. Overall, the Subcategory I chemicals are either readily biodegradable or attain degradation close to meeting the “readily biodegradable” criteria.

One HPV (CAS RN 124-22-1) and four supporting chemicals (CAS RN 61788-45-2*, 61788-46-3*, 61790-33-8*, and 112-90-3*) were tested for acute toxicity to fish. The LC₅₀ values ranged from 0.11 to 9.3 mg/L. The only value >1 mg/L was for CAS RN 61790-33-8* that also had a reported LC₅₀ value between 0.18 and 0.25 mg/L. Acute toxicity to aquatic invertebrates was determined for five of the supporting chemicals (CAS RN 61788-45-2*, 124-30-1*, 61788-46-3*, 61790-33-8*, and 112-90-3*). The EC₅₀ values were all less than 1 mg/L with the lowest actually determined value being 0.011 mg/L (CAS RN 112-90-3*). In addition, a study evaluating the toxicity of CAS RN 61788-46-3* to the larvae and pupae of four mosquito species indicated that the chemical is moderately toxic with EC₅₀ values ranging between 2.0 and 13.0 mg/L. Toxicity to aquatic plants was determined for these same five supporting chemicals and indicated that these amine surfactants are highly toxic to algae (E_bC₅₀ and E_rC₅₀ values ranging from < 0.00075 to 0.17 mg/L). The ECOSAR model for cationic surfactants and for some of the aliphatic amines does not predict toxicity to aquatic organisms accurately when the chemicals are poorly soluble or insoluble in water. However, the prediction for acute fish toxicity for one of the chemicals in this Subcategory as an aliphatic amine, rather than as cationic surfactant, is similar to the experimental value (0.87 mg/L predicted vs. 0.42 mg/L measured for CAS RN 124-22-1). Estimates for the toxicity to daphnia and algae similarly indicated a high order of toxicity for this chemical. While these model values are useful in support of the conclusion that the FND Amine Category chemicals are toxic to aquatic species, overall the model estimates are of minimal reliability because of the low solubility of the chemicals.

Subcategory II – Dimethylalkylamines: Modeling of three HPV and two supporting chemicals indicated they would be expected to degrade relatively rapidly upon exposure to light (t_{1/2} values ranging from approximately 1.0 to 1.4 hours). The model did not provide estimates of stability in water for this subclass of chemicals.

An estimation of the transport and distribution of the FND Amines Category chemicals in environmental media (percent in air, water, soil and sediment) following entry into the environment via water is presented in Table 3. Distribution to air and soil were < 1% for all of the chemicals that could be modeled while distribution to the water compartment varied from 5 to 42% with the remainder in the sediment.

Measured data for biodegradation were available for the five HPV and three supporting chemicals in this Subcategory. Four of the five HPV chemicals (CAS RN 112-69-6, 124-28-7, 61788-95-2, and 61788-91-8) were considered to be readily biodegradable. The fifth HPV chemical (CAS RN 112-75-4) had a value of 2% degradation after 28 days. This value does not appear scientifically justifiable based on all other tests of similar chemicals, and the assay is considered invalid by the FND Amines Task Group. For the supporting chemicals, the 28-day ThOD ranged from 50 to 81%. Overall, the chemicals in this Subcategory are either readily biodegradable or closely approach ready biodegradability.

Toxicity to fish was measured for six of the eight HPV and supporting chemicals with LC₅₀ values all less than 1.0 mg/L. For toxicity to aquatic invertebrates, one HPV chemical (CAS RN 124-28-7) and one supporting chemical (CAS RN 112-18-5) had LC₅₀/EC₅₀ values of 0.074 and 0.083 mg/L, respectively. CAS RN 112-18-5 was shown to be highly toxic to algae in three assays each yielding E_bC₅₀ and E_rC₅₀ values < 0.1 mg/L. In addition, a study with CAS RN 124-28-7 to establish algistatic and algicidal concentrations to two species of algae confirmed the high toxicity of this chemical to aquatic species (0.029 and 0.11 mg/L algistatic concentrations and >0.032 and 0.16 algicidal concentrations). Model values for toxicity to aquatic invertebrates (CAS RN 112-18-5 and 112-75-4) and algae (CAS RN 112-18-5) for aliphatic amines appeared to be relatively accurate with predicted EC₅₀ values of 0.04 and 0.01 mg/L for daphnia and 0.26 mg/L for algae. Overall, however, as for the other Subcategories, the model predictions (Table 3) were considered of little value due to the low water solubility of the chemicals.

Subcategory III – Dialkylmethylamines and Dialkylamines: Modeled data were available for one HPV chemical (CAS RN 4088-22-6). The model predicted rapid photodegradation (t_{1/2} was 1.0 hour). Stability in water was not calculable by the model. The Level III fugacity model estimated that 5% of the chemical would be distributed to the water compartment and 95% distributed to sediment.

One HPV (CAS RN 61788-63-4) and one supporting chemical (CAS RN 61788-62-3) were shown to be readily biodegradable in high quality tests. In both of these assays, a surfactant was used in the assay to suspend the test chemical providing for adequate bioavailability. The range of values for CAS RN 61788-63-4 in six different biodegradation assays, however, shows the complexity of evaluating the degradation of these types of chemicals. The toxicity of the chemicals to the organisms, binding to organic matter, and method of introduction of the test material to the system can all have a significant impact on the ultimate biodegradation observed. These confounding factors are shown in biodegradation studies for two supporting chemicals (CAS RN 61789-79-5 and 61789-76-2) with only 16% and 20% degradation observed respectively after 28 days. In the first test, no effort was made to suspend the test chemical in the solution and the second assay employed binding of the chemical to silica gel as a means of suspension. Due to the low water solubility and the ability of these types of chemicals to tenaciously bind to solids, the FND Amines Task Group considers the results of these studies were likely significantly impacted by lack of bioavailability.

A measured LC₅₀ value for fish toxicity was 6.15 mg/L for the supporting chemical with CAS RN 61788-62-3. Three assays for CAS RN 61788-63-4 indicated substantial differences in the measured toxicity ranging from 23 to > 1000 mg/L. Again, this range shows the complexity of testing of these types of chemicals. In the assay that provided no LC₅₀ value (i.e. > 1000 mg/L),

the test chemical was observed to be insoluble in the test water. It is likely that the range of values represents bioavailability or physical availability (important because many surfactant-like chemicals are known to kill aquatic organisms via a physical rather than chemical mechanism) of the test chemical to the fish. Tests conducted for two other chemicals in the Subcategory (CAS RN 4088-22-6 and 61789-79-5) indicated much higher LC₅₀ values between 100 and 500 mg/L. In each of these latter studies, however, there was evidence that the test material was not soluble in the test solutions and no remedial action was taken to emulsify the test chemicals. Similarly, tests for acute toxicity to daphnia for CAS RN 61788-63-4 were confounded by solubility problems and yielded higher EC₅₀ values (35.2 and 790 mg/L) than expected. Further studies with this HPV chemical indicated EC₅₀ values ranging from 3.1 to 21 mg/L. In addition, a study examining a mixture of the active ingredient (83.5% or 63% of the HPV chemical) with inert materials (e.g. as used in soap) and using two water sources indicated that river water reduced the toxicity compared to well water (EC₅₀ = 60 vs. 22 mg/L, respectively) and that the inert ingredients tended to reduce toxicity (EC₅₀ = 6.5 mg/L for the 83.5% material vs. 22 for the 63% material). These studies reflect the impact of adsorption/absorption of the FND Amines Category chemicals to organic material. For CAS RN 61788-63-4, the E_bC₅₀ and E_rC₅₀ in a standard algae test were 0.05 and 0.12 mg/L, respectively. A series of studies evaluating the algistatic properties of this chemical provided 5-day algistatic concentrations of 0.052 to 4.6 mg/L in four different algae species. Careful examination of the large numbers of acute toxicity to fish and aquatic invertebrate studies available for the FND Amines Category chemicals overall, indicates that when studies are carried out at low concentrations (generally less than 10 mg/L) or emulsions are made using additives, the toxicity to aquatic organisms is high with LC₅₀/EC₅₀ values frequently less than 1 mg/L.

Subcategory IV – Trialkylamines: No modeled data were available for chemicals in this Subcategory.

Measured biodegradation data were available for the two alkyl diethanolamines (CAS RN 61791-31-9 and 61791-44-4). In 28 days, there was 61% COD and 52% ThOD, respectively indicating these, like the other FND Amines in the category are readily or nearly readily biodegradable.

Acute and chronic fish LC₅₀ values for CAS RN 61791-31-9 were 0.47 mg/L (48-hour) and 0.0179 mg/L (30-day). For the same chemical, the acute (48-hour) EC₅₀ for daphnia was 0.38 mg/L and the 21-day EC₅₀ values for growth in two separate experiments were 0.14 and 0.15 mg/L. These data indicate that the FND Amine Category chemicals in Subcategory IV have similar toxicity profiles in aquatic species as the other chemicals in the Category as well as other FND chemicals (cationics, amides) in other HPV Categories.

Summary – Environmental Fate and Ecotoxicity

As anticipated in the EPA guidance for HPV chemicals, only model estimates were available for photodegradation and fugacity. The other exclusively modeled value, stability in water, could not be calculated for this category of chemicals. Atmospheric photodegradation was predicted to be rapid although fugacity models suggested very minimal distribution of these chemicals to the air. Predicted distribution of the chemicals in the environment was to water and sediment compartments based on the assumption that release of the chemicals to the environment is all via water. Extensive biodegradation testing across the Category indicated that the FND Amines

Category chemicals are biodegradable, often meeting the “readily biodegradable” criteria. No additional biodegradation studies are proposed since there is no observable pattern or structural properties of the chemicals within the Category and Subcategories to suggest that non-tested chemicals would behave differently. The substantial numbers of studies evaluating the aquatic toxicity of the FND Amine Category chemicals clearly indicate that these surfactants are highly toxic (LC_{50}/EC_{50} values generally < 1 mg/L) to aquatic organisms when bioavailable. Furthermore, this high toxicity is consistent with the large numbers of tests conducted for other FND surfactants (amides, cationics) and for surfactants in general. Therefore, further testing of these chemicals for aquatic toxicity is considered of little or no value in a screening program such as the HPV Chemical Challenge. For the purpose of the program, all of the FND Amine Category chemicals can be considered highly toxic to aquatic species. Overall, the available data support the conclusion that the FND Amines Category chemicals possess similar environmental fate and ecotoxicity across the category.

Additional Testing – Environmental Fate and Ecotoxicity

No additional testing (Table 6) is proposed for the Category. The available model data are adequate for photodegradation, particularly in light of the very limited potential volatility of the FND Amines Category chemicals, as well as for fugacity. These chemicals are not expected to exhibit hydrolysis under normal conditions. Adequate biodegradation data are available to indicate the chemicals in the Category are readily or nearly readily biodegradable. As noted above, additional testing for aquatic toxicity is unwarranted since all of the FND Amine Category chemicals, similar to other surfactants, can be considered highly toxic to aquatic organisms. The available data are considered adequate for the screening purposes of the HPV Chemical Challenge Program.

Human Health-Related Data

The human health effects data for SIDS endpoints of the 23 FND Amines Category chemicals and 12 supporting chemicals are presented in Table 4. Robust summaries for the reliable studies are provided in Appendix A. The Test Plan for human health related studies is presented in Table 7.

Subcategory I – Primary Alkylamines and Alkyldiamines: The rat acute oral LD_{50} value for the HPV chemical, CAS RN 124-22-1, in two separate studies was 1020 and >2000 mg/kg indicating that the chemical possesses slight acute toxicity by the oral route. The value for mice was similar (1160 mg/kg). The LD_{50} value for the alkyldiamine HPV chemical (CAS RN 61791-55-7) in this Subcategory was >5000 mg/kg. Results were similar for six supporting chemicals with LD_{50} values ranging from approximately 1000 to >6000 mg/kg. Three studies evaluating rabbit acute dermal toxicity for CAS RN 61788-46-3* gave LD_{50} values >2000 mg/kg. One acute inhalation study (CAS RN 61788-46-3*) indicated this chemical caused irritation but no lethality at 0.099 mg/L from a one-hour exposure.

Repeated dose toxicity studies were available for four supporting chemicals. In two chronic two-year dietary studies in rats for CAS RN 124-30-1*, the NOAEL was approximately 25 mg/kg/day. In a one-year chronic dietary study in dogs for this chemical, the reported NOAEL was 3.0 mg/kg/day. In this latter study, the occurrence of “foamy” histiocytes in the mesenteric lymph nodes and abnormal appearance of the intestines was recorded. For CAS RN

61790-33-8*, a 4-week gavage study had an NOAEL of 12.5 mg/kg/day. A 14-day repeated dose skin study in rats with minimal observations was reported with CAS RN 112-90-3*. The chemical was irritating at all doses after several days of dosing with the lowest dose of 0.5% showing minimal irritation. No necropsies were performed so this study is considered of supplemental value to establishing the irritant properties of the test chemical. For the mixture of hydrofluoride salts of hexadecylamine and octadecenamine (CAS RN 3151-59-5 + 36505-83-6), a 24-month rat study and a 2-year dog study were available. The NOAEL for both studies was 6.0 mg/kg/day. Non-specific effects on body weight, food consumption, clinical chemistry measurements and organ weights were observed at 30 mg/kg/day in the rat study. Enlarged intestinal lymph nodes with histological evidence of sinusoidal dilation with congestion and fibroplasia were observed at the high dose. Dogs could not tolerate a dose of 30 mg/kg/day and the high dose was reduced to 12 mg/kg/day after five weeks. Effects at the high dose were minimal, primarily related to decreased serum protein throughout the study.

Adequate Salmonella Reverse Mutation (Ames) assays for one of the FND Amines Category chemicals (CAS RN 143-27-1) and four of the supporting chemicals (CAS RN 124-30-1*, 61788-46-3*, 61790-33-8*, and 112-90-3*) were identified. All of the assays were negative. In two cases (CAS RN 124-30-1* and 61788-46-3*), toxicity was observed for the higher concentrations used in these studies thus limiting the number of concentrations available for evaluation. However, since the criteria for a positive test includes dose response and the concentrations that could be evaluated were as high as could have been tested, these studies are considered adequate. An *in vivo* rat micronucleus assay for CAS RN 61790-33-8* was negative. A CHO/HGPRT gene mutation assay, a mouse lymphoma assay, a chromosome aberration assay and an *in vivo* cytogenetics assay were negative for CAS RN 112-90-3*.

Evaluations of potential reproductive effects were available for three supporting chemicals. For CAS RN 124-30-1*, reproductive organs were examined in both two-year toxicity studies with rats and the one-year toxicity study with dogs. No effects were seen in the reproductive organs at the highest doses tested (approximately 25 mg/kg/day for rats and 15 mg/kg/day for dogs). Reproductive and developmental screening for CAS RN 61790-33-8* was conducted in a study that followed OECD 421 guidelines. The parental and offspring NOAEL was 12.5 mg/kg based on body weight effects at the mid dose of 50 mg/kg/day. The high dose of 120 mg/kg/day was lethal. No effects on reproduction or developmental toxicity were observed. For the mixture of hydrofluoride salts of hexadecylamine and octadecenamine (CAS RN 3151-59-5 + 36505-83-6), in a Segment I, reproductive screening assay, male body weights were decreased at the highest dose (30 mg/kg/day) while no effects on offspring were noted. Results for two developmental toxicity studies were available for the supporting chemical, CAS RN 112-90-3*. The NOAEL for maternal toxicity in rats was 10 mg/kg/day and the corresponding value for rabbits was 3.0 mg/kg/day. No teratogenic or developmental toxicity was observed in either study at the highest doses tested. For the mixture (CAS RN 3151-59-5 + 36505-83-6), Segment II (teratology) studies in rats and rabbits and a Segment III (perinatal) study in rats were identified. Maternal body weights were decreased in the Segment II study for rats (NOAEL = 6.0 mg/kg/day) and rabbits (NOAEL not established). No developmental toxicity was observed in these studies and no effects on offspring or mothers were observed in the Segment III study (NOAELs = 30 mg/kg/day).

Subcategory II – Dimethylalkylamines: Rat acute oral toxicity LD₅₀ data were available for the five HPV chemicals and two of three supporting chemicals in this Subcategory. Values ranged from approximately 800 to >2000 mg/kg indicating that the chemicals possess slight acute toxicity by the oral route. Acute dermal studies for the HPV chemicals (CAS RN 112-69-6, 124-28-7, and 61788-91-8) and supporting chemicals (CAS RN 112-18-5 and 61788-93-0) yielded LD₅₀ values ranging from approximately 3000 to 5000 mg/kg. These values indicate that these chemicals possess slight toxicity via the dermal route with doses of 3000 to 8000 mg/kg being lethal to some animals for the tested chemicals.

Salmonella Reverse Mutation (Ames) assays were conducted on three HPV chemicals (CAS RN 112-75-4, 112-69-6 and 124-28-7). These studies were conducted using only two strains of bacteria and do not adequately fulfill the HPV Chemical Challenge Program requirements. However, the results were negative adding support to the large weight of evidence that the FND Amines Category chemicals are unlikely to be mutagenic. An *in vivo* mouse micronucleus assay for supporting chemical, CAS RN 112-18-5, was negative.

No reproductive or developmental toxicity studies were identified for the chemicals in this Subcategory.

Subcategory III – Dialkylmethylamines and Dialkylamines: Two HPV (CAS RN 4088-22-6 and 61788-63-4) and two supporting (CAS RN 61788-62-3 and 61789-79-5) chemicals had reported acute oral LD₅₀ values of >2000, >5000, > 10000 or > 15000 mg/kg. An acute dermal study with CAS RN 4088-22-6 indicated the dermal LD₅₀ is greater than 2000 mg/kg.

A series of repeated dose toxicity studies was reported for CAS RN 4088-22-6. In a limited gavage range finding study in rabbits at doses of 100 to 1000 mg/kg/day, the LOAEL was determined to be 100 mg/kg/day based on altered body weights and reduced food consumption. In a 13-week dietary toxicity study in rats at concentrations of 0.15, 0.5, and 1.5% (approximately 130, 375 and 1000 mg/kg/day), the LOAEL was 130 mg/kg/day. This study reported extensive findings of ‘foamy macrophages’ in the intestinal mucosa and other organs including ovaries. This finding was dose-related and occurred at all doses. The lymph nodes in the intestines were enlarged at all doses as well. No NOAEL was, therefore, established. In three studies with repeated dermal exposure of 7 days or 13 weeks duration, no systemic toxicity was observed but skin irritation was prominent at doses of approximately 5 mg/kg/day and above.

An adequate Salmonella Reverse Mutation (Ames) assay for CAS RN 4088-22-6 was negative. A series of genetic toxicity screening studies with CAS RN 61788-63-4, including the Salmonella Reverse Mutation assay, mouse lymphoma, *in vitro* UDS, and *in vivo* cytogenetics, were all negative.

Reproductive organs were examined in the 13-week dietary study with CAS RN 4088-22-6. The identification of ‘foamy macrophages’ in the ovaries of this study precludes a definition of a NOAEL. This finding is not considered related to reproductive toxicity per se and is likely related to clearance of the test material. However, finding these macrophages in the ovaries is not common for chemicals that have this type of lesion due to clearance. No effect on reproductive organs was observed in a 13-week dermal study with rabbits at 5 or 50 mg/kg/day. A developmental toxicity study for CAS RN 4088-22-6 with rabbits at doses of 50, 250 and

1000 mg/kg/day provided a maternal NOAEL of 50 mg/kg/day without showing fetal effects at 250 mg/kg/day. Fetal body weight effects were minimal at in the high dose group. No teratogenicity was observed.

Subcategory IV – Trialkylamines: Rat acute oral toxicity LD₅₀ data were available for the two diethanolamines (CAS RN 61791-31-9 and 61791-44-4) in this Subcategory. Values ranged from 630 to >15,000 mg/kg. The wide range of lethal doses for CAS RN 61791-44-4 is not clearly explainable. However, the lower LD₅₀ values were obtained from studies in which the test chemical was dosed neat while the higher values (> 2000 and > 15,000 mg/kg) were dosed with suspensions of the test chemical. It is possible that the corrosive effects of neat test material in the stomach resulted in the lower doses required to cause toxicity and death. Overall, these chemicals exhibit acute toxicity similar to the other chemicals in the category.

One acute inhalation study for this Subcategory (CAS RN 61791-44-4) was conducted. The study had an unusual design, using heated test material with and without polypropylene aerosol. The study design and untoward results prohibited a clear definition of an LC₅₀ since 100% of the animals with the polypropylene in the aerosol died while none died without the inert polymer. The authors speculate that the actual concentration of the test material may have been much higher than the nominal value in the polypropylene plus test material group. Therefore, the LC₅₀ of > 0.08 mg/L (no deaths) for the group exposed to the test chemical only, is considered to be uncertain (FND Amines Task Group).

Three acute dermal studies produced no deaths at 2000 mg/kg. However, in a fourth study, 4 of 6 animals died following a 2000 mg/kg dose. The reason for the difference in this latter study with three studies showing no mortality at 1500 or 2000 mg/kg or 2000 ml/kg is not clearly explainable.

A number of repeated dose studies have been reported for CAS RN 61791-44-4. The NOAELs for a 90-day dietary study in rats and dogs were approximately 50 mg/kg/day and 13 mg/kg/day, respectively. In the dog study, the higher doses of 40 and 120 mg/kg/day were poorly tolerated with extensive emesis reported. Both of these studies reported the finding of “foamy macrophages” in the intestines of the animals at the higher doses, similar to that reported for the Subcategories I and III chemicals discussed above. In a second 90-day study with rats, the NOAEL was 12 mg/kg/day based on slightly lower body weights and the presence of “foamy macrophages” at the highest dose of 400 mg/kg/day. In dermal studies of approximately three or four weeks duration and limited numbers of doses, no systemic toxicity was observed but skin irritation was prominent at doses as low as 2 mg/kg/day.

In vitro genetic assays for CAS RN 61791-44-4, including three Salmonella Reverse Mutation assays, a mouse lymphoma study, and a UDS assay were negative for mutagenic effects. An *in vitro* chromosomal aberration assay was negative without metabolic activation but was considered positive with metabolic activation. However, *in vivo* mouse micronucleus and cytogenetics studies were negative indicating the finding in the *in vitro* assay was aberrant. Overall these studies are consistent with the lack of mutagenicity for the chemicals in the FND Amines category as well as the other FND Category chemicals (amides, cationics, nitriles).

Evaluations of reproductive organs were made for the animals in the two 90-day rat studies and the 90-day dog study (CAS RN 61791-44-4) meeting the requirements for the HPV screening for

reproductive effects. No effects were observed at the highest doses tested (approximately 450, 400 and 120 mg/kg/day, respectively). No developmental toxicity data were available for chemicals in this Subcategory.

Summary – Human Health-Related Data

Adequate acute oral LD₅₀ studies were available throughout the category. They indicate slight to minimal acute toxicity for the FND Amines Category chemicals. Acute dermal studies indicate these chemicals can be classified as minimally toxic. Acute inhalation studies did not result in deaths under normal exposure conditions for two chemicals. Repeated dose toxicity studies in Subcategories I, III, and IV had similar NOAELs (12.5 to 50 mg/kg/day for rats and 3 or 13 mg/kg/day for dogs). Importantly because the highest exposure potential for some of the FND Amines Category chemicals is via skin contact, a number of repeat dose dermal studies indicate the chemicals are highly irritating. This irritation helps provide added assurance that human exposure will be limited due to avoidance of the irritant effects. No clear organ-specific toxicity occurred in any of the repeat dose studies with the chemicals in the FND Amines Category. Interestingly, one dog study for a chemical in Subcategory I (CAS RN 124-30-1*) and the rat and dog studies from Subcategories III and IV all reported ‘foamy macrophages’ in the intestines, this finding being associated with effects by which the NOAELs were established. These types of findings have been reported following oral consumption of white oils (Firriolo *et al.*, 1995; Shoda *et al.*, 1997). These lesions are thought to be related to clearance of high molecular weight oils but are not associated with long-term effects. Enlargement and lesions in the intestinal lymph nodes in the chronic rat study with the hydrofluoride salt mixture (CAS RN 3151-59-5 + 36505-83-6) in Subcategory I were also observed. The occurrence of these lesions following exposure to the FND Amines Category chemicals suggests that clearance may be similar to that of the high molecular weight oils. Available data indicate that the FND Amines Category chemicals are unlikely to be mutagenic and that they are not reproductive or developmental toxins.

Additional Testing – Human Health-Related Studies

In evaluating potential further testing of the FND Amines Category chemicals, it is useful to review the available data for the related FND Cationic and FND Amides Category chemicals. Acute oral toxicity studies (approximately 80 studies for 40 chemicals in the three categories) provide LD₅₀ values from approximately 400 to 10,000 mg/kg with no apparent organ specific toxicity. Similarly, repeated dose toxicity studies (approximately 35 studies for 15 chemicals) provide NOAELs between 10 and 100 mg/kg/day for rats and slightly lower for dogs. More than 60 genetic toxicity studies (*in vitro* bacterial and mammalian cells as well as *in vivo* studies) indicated only one equivocally positive Salmonella Reverse Mutation assay and one positive chromosomal aberration assay that was ultimately shown to be aberrant, among more than 30 chemicals tested. For reproductive evaluations, 14 studies evaluated reproductive endpoints and/or reproductive organs for 11 chemicals and 15 studies evaluated developmental toxicity for 13 chemicals indicating no reproductive or developmental effects for the FND group as a whole.

These comparisons clearly provide a strong weight of evidence that the FND Amines Category chemicals will not pose significant toxicity to humans. As noted previously, it is not appropriate to consider the FND Amines Category chemicals to represent a continuum of alkyl chain substitution. As outlined in Text Table C, the minimal difference among the alkyl substituents

and the large database for the FND Categories indicates that the structural differences in these large alkyl chains do not result in differences in toxicity or mutagenicity. Thus, there is no current scientifically justifiable expectation that any of the alkylamines in the Category will result in significant toxicity not already established by tests with the HPV and supporting chemicals. The primary alkylamines and alkyldiamines are well represented by the available data. Additional substitutions, as with the chemicals in the other Subcategories, serve to decrease bioavailability while providing no additional structural alerts to warrant selection for additional testing. Based on the consistent pattern of toxicity within and among the FND Categories, no additional testing is proposed for the FND Amines Category chemicals. Table 7 provides the Test Plan for the human health related endpoints.

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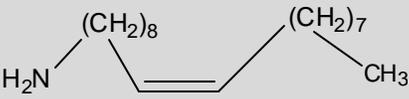
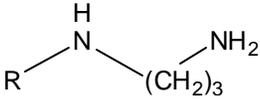
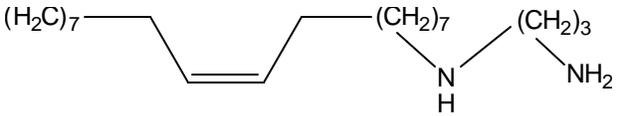
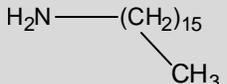
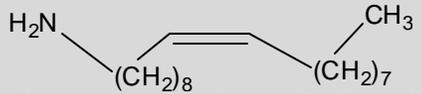
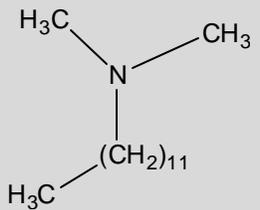
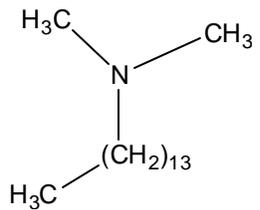
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Table 1
Structures of FND Amines Category Chemicals

Subcategory I: Primary Alkylamines and Alkyldiamines	
$\text{H}_2\text{N}-(\text{CH}_2)_{11}-\text{CH}_3$ <p>Dodecylamine 124-22-1</p>	$\text{H}_2\text{N}-(\text{CH}_2)_{15}-\text{CH}_3$ <p>Hexadecylamine 143-27-1</p>
$\text{H}_2\text{N}-\text{R}$ <p>R = C₁₄ – C₁₈ alkyl</p> <p>Amines, C₁₄₋₁₈-alkyl 68037-91-2</p>	$\text{H}_2\text{N}-\text{R}$ <p>R = hydrogenated tallow alkyl</p> <p><i>Amines, hydrogenated tallow alkyl</i> <i>61788-45-2*</i></p>
$\text{H}_2\text{N}-(\text{CH}_2)_{17}-\text{CH}_3$ <p><i>Octadecylamine</i> <i>124-30-1*</i></p>	$\text{H}_2\text{N}-\text{R}$ <p>R = coco alkyl</p> <p><i>Amines, coco alkyl</i> <i>61788-46-3*</i></p>
$\text{H}_2\text{N}-\text{R}$ <p>R = C₁₄ – C₁₈- and C₁₆ – C₁₈-unsaturated alkyl</p> <p>Amines, C₁₄₋₁₈ and C₁₆₋₁₈-unsatd. alkyl 68155-38-4</p>	$\text{H}_2\text{N}-\text{R}$ <p>R = tallow alkyl</p> <p><i>Amines, tallow alkyl</i> <i>61790-33-8*</i></p>
$\text{H}_2\text{N}-\text{R}$ <p>R = soya alkyl</p> <p>Amines, soya alkyl 61790-18-9</p>	$\text{H}_2\text{N}-\text{R}$ <p>R = C₁₆ – C₁₈- and C₁₈-unsaturated alkyl</p> <p>Amines, C₁₆₋₁₈ and C₁₈-unsaturated alkyl 68037-95-6</p>

Shaded cells with name and CAS RN in italics are for supporting chemicals [non-HPV]

Table 1
Structures of FND Amines Category Chemicals

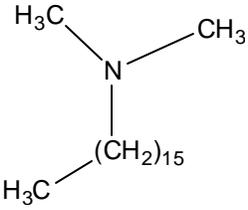
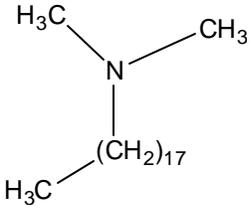
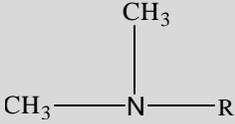
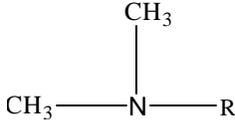
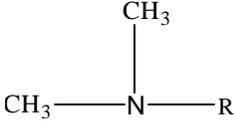
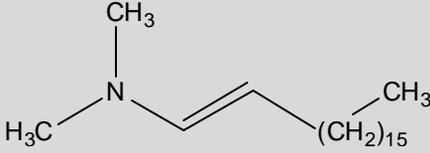
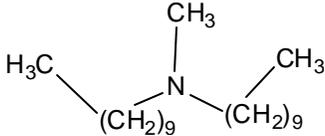
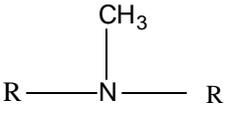
 <p><i>Cis-9-Octadecenylamine</i> 112-90-3*</p>	 <p>R = tallow alkyl</p> <p>Amines, N-tallow alkyltrimethylenedi- 61791-55-7</p>
 <p>1,3-Propanediamine, N-(9Z)-octadecenyl- 7173-62-8</p>	 <p><i>Hexadecylamine hydrofluoride (Hetaflur)</i>³ 3151-59-5</p>  <p><i>9-Octadecen-1-amine hydrofluoride</i>³ 36505-83-6</p>
<p>Subcategory II: Dimethylalkylamines</p>	
 <p><i>1-Dodecanamine, N,N-dimethyl</i> 112-18-5</p>	 <p>1-Tetradecanamine, N,N-dimethyl 112-75-4</p>

Shaded cells with name and CAS RN in italics are for supporting chemicals [non-HPV]

* These chemicals were removed from the original FND Amines Category because they are sponsored by APAG under the ICCA program.

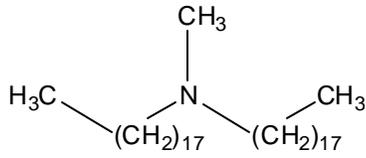
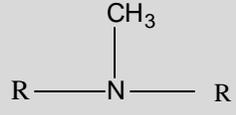
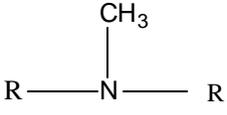
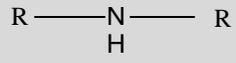
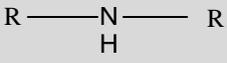
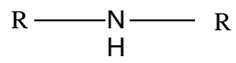
³ Hydrofluoride salt not shown in structure.

Table 1
Structures of FND Amines Category Chemicals

 <p>1-Hexadecanamine, N,N-dimethyl 112-69-6</p>	 <p>1-Octadecanamine, N,N-dimethyl 124-28-7</p>
 <p>R = coco alkyl</p> <p><i>Amines, coco alkyl dimethyl</i> 61788-93-0</p>	 <p>R = hydrogenated tallow alkyl</p> <p><i>Amines, (hydrogenated tallow alkyl)dimethyl</i> 61788-95-2</p>
 <p>R = soya alkyl</p> <p><i>Amines, dimethyl soya alkyl</i> 61788-91-8</p>	 <p><i>Octadecen-1-amine, N,N-dimethyl</i> 28061-69-0</p>
<p>Subcategory III: Dialkylmethylamines and Dialkylamines</p>	
 <p>1-Decanamine, N-decyl-N-methyl 7396-58-9</p>	 <p>R = C₁₄ – C₁₈ alkyl</p> <p><i>Amines, di-C₁₄₋₁₈-alkylmethyl</i> 67700-99-6</p>

Shaded cells with name and CAS RN in italics are for supporting chemicals [non-HPV]

Table 1
Structures of FND Amines Category Chemicals

$\text{R} \text{---} \text{NH} \text{---} \text{R}$ <p>R = C₁₂ – C₁₈ alkyl</p> <p><i>Amines, di-C₁₂₋₁₈-alkyl</i> 68153-95-7</p>	 <p>1-Octadecanamine, N-methyl-N-octadecyl 4088-22-6</p>
 <p>R = coco alkyl</p> <p><i>Amines, dicoco alkylmethyl</i> 61788-62-3</p>	 <p>R = hydrogenated tallow alkyl</p> <p><i>Dihydrogenated tallow methylamine</i> 61788-63-4</p>
 <p>R = hydrogenated tallow alkyl</p> <p><i>Amines, bis(hydrogenated tallow alkyl)</i> 61789-79-5</p>	 <p>R = coco alkyl</p> <p><i>Amines, dicoco alkyl</i> 61789-76-2</p>
 <p>R = tallow alkyl</p> <p><i>Amines, ditallow alkyl</i> 68783-24-4</p>	

Shaded cells with name and CAS RN in italics are for supporting chemicals [non-HPV]

Table 1
Structures of FND Amines Category Chemicals

Subcategory IV: Trialkylamines	
$\begin{array}{c} \text{R} \\ \\ \text{R} - \text{N} - \text{R} \end{array}$ <p>R = C₈ - C₁₀ alkyl</p> <p>Amines, tri-C₈₋₁₀-alkyl- 68814-95-9</p>	$\begin{array}{c} \text{R} \\ \\ \text{R} - \text{N} - \text{R} \end{array}$ <p>R = hydrogenated tallow alkyl</p> <p>Amines, tris (hydrogenated tallow alkyl) 61790-42-9</p>
$\begin{array}{c} \text{R} \\ \\ \text{HO} - \text{CH}_2 - \text{CH}_2 - \text{N} - \text{CH}_2 - \text{CH}_2 - \text{OH} \end{array}$ <p>R = coco alkyl derivs.</p> <p>Ethanol, 2,2'-iminobis-, N-coco alkyl derivs. 61791-31-9</p>	$\begin{array}{c} \text{R} \\ \\ \text{HO} - \text{CH}_2 - \text{CH}_2 - \text{N} - \text{CH}_2 - \text{CH}_2 - \text{OH} \end{array}$ <p>R = tallow alkyl derivs.</p> <p>Ethanol, 2,2'-iminobis-, N-tallow alkyl derivs. 61791-44-4</p>

Table 2
Physical/Chemical Properties Data for FND Amines Category Chemicals

CAS RN	Melting Point (°C)	Boiling Point (°C)	Vapor Pressure (hPa)	Partition Coefficient (log K _{ow})	Water Solubility (mg/L)
Subcategory I: Primary Alkylamines and Alkyldiamines					
124-22-1	28.3	259			2000
	28.3	259	0.0081	4.76	45.1
143-27-1	47	323	0.00013	6.73	0.48
68037-91-2					
61788-45-2*	52.9	348	0.000012		
	52.9	347	0.000087	7.71	0.049
124-30-1*	52.9	347 349	0.000012		1000 not soluble
	52.9	347	0.000087	7.71	0.049
61788-46-3*					
68155-38-4					
61790-33-8*	34 – 40 25 – 30	200 – 230	< 1.3	7.5	insoluble
61790-18-9					
68037-95-6					
112-90-3*	~21 21	275- 344 335	< 1.3 0.00013⁴	7.5⁴ and 8.1⁴ 7.5⁴ >3.11	(0.5 x 10⁻³)⁴ and (0.7 x 10⁻⁵)⁴ insoluble very insoluble
	93	346	0.000037	7.50	0.076
61791-55-7					
7173-62-8	142	402	4.9 x 10 ⁻⁷	7.47	0.037

⁴ Estimated value.

Table 2
Physical/Chemical Properties Data for FND Amines Category Chemicals

CAS RN	Melting Point (°C)	Boiling Point (°C)	Vapor Pressure (hPa)	Partition Coefficient (log K _{ow})	Water Solubility (mg/L)
<i>3151-59-5</i> <i>+ 36505-83-6</i>					
Subcategory II: Dimethylalkylamines					
<i>112-18-5</i>	<i>-15 to -20</i> <i>22</i>	<i>260</i>	<i>0.0159</i>	<i>5.44</i>	<i>8.58</i>
112-75-4	43	292	0.0020	6.42	0.88
112-69-6	63	321	0.00029	7.41	0.089
124-28-7	22.9 19.6 - 22.4 <i>22.9</i>	346	0.00017	8.39	not soluble 0.0089
<i>61788-93-0</i>					
<i>61788-95-2</i>					
<i>61788-91-8</i>					
<i>28061-69-0</i>	<i>80</i>	<i>345</i>	<i>0.000052</i>	<i>8.25</i>	<i>0.012</i>
Subcategory III: Dialkylmethylamines and Dialkylamines					
<i>7396-58-9</i>					
<i>67700-99-6</i>					
<i>68153-95-7</i>					
4088-22-6	216	543	2.0 x 10 ⁻¹¹	17	2 x 10 ⁻¹¹
<i>61788-62-3</i>					
61788-63-4				3.15	0.288
<i>61789-79-5</i>					
<i>61789-76-2</i>					
<i>68783-24-4</i>					

Note: Bold font indicates reliable data for which a Robust Summary is provided in Appendix A
 Regular font indicates data obtained from appropriate models as described in the text and Appendix B.
 Shaded cells with CAS RN and data in italics are for supporting chemicals [non-HPV].
 Empty block denotes data either are not available or are available and judged inadequate.
 * These chemicals were removed from the original FND Amines Category because they are sponsored by APAG under the ICCA program.
 Subcategory IV, Trialkylamines, is not shown; no data available

Table 3
Environmental Fate and Ecotoxicity Data for FND Amines Category Chemicals

CAS RN	Photodegradation (cm ³ /molecule-sec for k _{phot})	Stability in Water	Transport & Distribution ⁵	Biodegradation	Acute/Prolonged Toxicity to Fish 96-hour LC ₅₀ (mg/L)	Acute/Chronic Toxicity to Invertebrates EC ₅₀ (mg/L)	Toxicity to Aquatic Plants 72-hr. EC ₅₀ (mg/L)
Subcategory I: Primary Alkylamines and Alkyldiamines							
124-22-1	46 E-12 t _{1/2} = 2.8 hr	not calculable	Air: <1% Water: 75% Soil: <1% Sediment: 25%	> 60% ThOD in 28 d	0.42 9.77 (0.87) ⁶	3.2 (0.09) ⁶	not calculable (0.45) ⁶
143-27-1	51 E-12 t _{1/2} = 2.5 hr	not calculable	Air: <1% Water: 13% Soil: <1% Sediment: 87%		not toxic at solubility	not toxic at solubility (0.008) ⁶	not calculable (not toxic at solubility) ⁶
68037-91-2							
61788-45-2*	54 E-12 t _{1/2} = 2.4 hr	not calculable	Air: <1% Water: 10% Soil: <1% Sediment: 90%	75% ThOD in 28 d 64% CO ₂ in 28 d	0.88 not toxic at solubility	0.16 <1.0 not toxic at solubility	96-hour: E_bC₅₀⁷ = 0.012 E_rC₅₀⁷ ~ 0.016 not calculable (not toxic at solubility) ⁶
124-30-1*	54 E-12 t _{1/2} = 2.4 hr	not calculable	Air: <1% Water: 10% Soil: <1% Sediment: 90%	>60% ThOD in 12 d 70% ThOD in 28 d	not toxic at solubility	0.13 not toxic at solubility	E_bC₅₀ = 0.062 E_rC₅₀ = 0.12 not calculable (not toxic at solubility) ⁶

⁵ Water was assumed to be the exclusive route of entry into the environment.

⁶ Original model calculations were made specifying the chemicals as "Cationic Surfactants"; a second calculation was made assuming the chemicals are Aliphatic Amines—the values for this second calculation are included in () if different than for Cationic Surfactants.

⁷ E_bC₅₀ is the EC₅₀ based on growth (biomass); E_rC₅₀ is the EC₅₀ based on growth rate.

Table 3
Environmental Fate and Ecotoxicity Data for FND Amines Category Chemicals

CAS RN	Photodegradation (cm ³ /molecule-sec for k _{phot})	Stability in Water	Transport & Distribution ⁵	Biodegradation	Acute/Prolonged Toxicity to Fish 96-hour LC ₅₀ (mg/L)	Acute/Chronic Toxicity to Invertebrates EC ₅₀ (mg/L)	Toxicity to Aquatic Plants 72-hr. EC ₅₀ (mg/L)
61788-46-3*				56% ThOD in 28 d (74% in 42 d) 58% ThCO ₂ in 28 d 91.1% ThCO ₂ in 28 d	0.16 0.24	0.045 0.09 Larvae = 2.0 – 3.0 ⁸ Pupae = 3.5 – 13.0 ⁸	E _b C ₅₀ = 0.14 E _r C ₅₀ = 0.17 96-hour: E _b C ₅₀ = 0.00075 E _r C ₅₀ = 0.0011
68155-38-4							
61790-33-8*				56% TCO ₂ in 28 d >51% BOD in 28 d (~70% in 42 d) 73% in 28 d	9.3 >0.18 and <0.25	0.093 0.09 <0.25	E _b C ₅₀ = 0.052 E _r C ₅₀ = 0.059 E _b C ₅₀ = 0.068 E _r C ₅₀ = 0.083
61790-18-9							
68037-95-6							
112-90-3*	110 E-12 t _{1/2} = 1.2 hr	not calculable	Air: <1% Water: 11% Soil: <1% Sediment: 89%	> 60% ThOD in 12 d 44% ThOD in 28 d (72% in 42 d) 66% ThCO ₂ in 28 d 69% ThOD in 28 d	0.11 not toxic at solubility	0.011 not toxic at solubility	96-hour: E _b C ₅₀ = 0.03 E _r C ₅₀ = 0.04 not toxic at solubility
61791-55-7				90% DOC elimination in 3 hrs; 87% adsorption in sludge			

⁸ Values are ppm. Test performed on 4 strains of mosquito larvae and pupae; *C. p. quinquefasciatus*, *A. albimanus*, *A. aegypti*, and *A. nigromaculis*.

Table 3
Environmental Fate and Ecotoxicity Data for FND Amines Category Chemicals

CAS RN	Photodegradation (cm ³ /molecule-sec for k _{phot})	Stability in Water	Transport & Distribution ⁵	Biodegradation	Acute/Prolonged Toxicity to Fish 96-hour LC ₅₀ (mg/L)	Acute/Chronic Toxicity to Invertebrates EC ₅₀ (mg/L)	Toxicity to Aquatic Plants 72-hr. EC ₅₀ (mg/L)
7173-62-8	193 E-12 t _{1/2} = 0.7 hr	not calculable	Air: <1% Water: 11% Soil: <1% Sediment: 89%		not toxic at solubility	not toxic at solubility	not calculable (not toxic at solubility) ⁹
3151-59-5 + 36505-83-6							
Subcategory II: Dimethylalkylamines							
112-18-5	93 E-12 t _{1/2} = 1.4 hr	not calculable	Air: <1% Water: 42% Soil: <1% Sediment: 58%	67% ThOD in 28 d 72% TCO ₂ in 29 d 67% ThN-BOD in 28 d	0.57 not toxic at solubility	0.083 3.24 (0.04) ¹⁰	E _b C ₅₀ = 0.056 ¹¹ E _r C ₅₀ = 0.092 E _b C ₅₀ = 0.034 E _r C ₅₀ = 0.056 E _b C ₅₀ 0.0133 E _r C ₅₀ 0.0235 not calculable (0.26) ¹⁰
112-75-4	96 E-12 t _{1/2} = 1.3 hr	not calculable	Air: <1% Water: 7% Soil: <1% Sediment: 93%	≤ 2% COD in 28 d ¹²	0.18 > 0.01 and < 1.0 > 0.01 and < 0.1 0.35 not toxic at solubility	not toxic at solubility (0.01) ¹⁰	not calculable (not toxic at solubility) ¹⁰

⁹ Original model calculations were made specifying the chemicals as “Cationic Surfactants”; a second calculation was made assuming the chemicals are Aliphatic Amines—the values for this second calculation are included in () if different than for Cationic Surfactants.

¹⁰ Original model calculations were made specifying the chemicals as “Cationic Surfactants”; a second calculation was made assuming the chemicals are Aliphatic Amines—the values for this second calculation are included in () if different than for Cationic Surfactants.

¹¹ First four values are from a single study using two natural water sources.

¹² The scientific validity of this value is unjustifiable based on all other tests of similar chemicals. The assay is presumed to be invalid.

Table 3
Environmental Fate and Ecotoxicity Data for FND Amines Category Chemicals

CAS RN	Photodegradation (cm ³ /molecule-sec for k _{phot})	Stability in Water	Transport & Distribution ⁵	Biodegradation	Acute/Prolonged Toxicity to Fish 96-hour LC ₅₀ (mg/L)	Acute/Chronic Toxicity to Invertebrates EC ₅₀ (mg/L)	Toxicity to Aquatic Plants 72-hr. EC ₅₀ (mg/L)
112-69-6	99 E-12 t _{1/2} = 1.3 hr	not calculable	Air: <1% Water: 5% Soil: <1% Sediment: 95%	59% ThOD in 28 d (70% in 42 d) 107% TCO ₂ in 29 d	0.18 >0.1 and <1.0 not toxic at solubility	not toxic at solubility	not calculable (not toxic at solubility) ¹⁰
124-28-7	102 E-12 t _{1/2} = 1.3 hr	not calculable	Air: <1% Water: 5% Soil: <1% Sediment: 95%	91% TCO ₂ at 0.2 mg/L in 7 d (79% at 2.0 mg/L in 7 d); 118% TCO ₂ at 10 mg/L in 40 d; and 51% TCO ₂ at 20 mg/L in 40 d 49% TCO ₂ in 28 d	0.18 > 0.1 and <1.0 not toxic at solubility	LC ₅₀ = 0.074 ¹³ not toxic at solubility	0.029; 0.11 > 0.032; 0.16 ¹⁴ not calculable (not toxic at solubility) ¹⁵
61788-93-0				81% ThOD in 28 d 69% ThOD in 28 d	>0.1 and <1.0		
61788-95-2				58% ThOD in 28d (66% in 42 d)			
61788-91-8				98% ThOD in 28 d	> 0.1 and < 1.0		
28061-69-0	126 E-12 t _{1/2} = 1.0 hr	not calculable	Air: <1% Water: 5% Soil: <1% Sediment: 95%	50% ThOD in 28 d (59% in 70 d)	not toxic at solubility	not toxic at solubility	not calculable (not toxic at solubility) ¹⁵

¹³ 96-hour LC₅₀ value for *Mysidopsis bahia*

¹⁴ The study was conducted on *Selenastrum capricornutum* and *Microcystis aeruginosa* with a 5-day exposure and a 9-day recovery period. First two values are the algistatic concentrations for each species, respectively. Second two values are the algicidal concentrations for each species. An EC₅₀ was not determined.

¹⁵ Original model calculations were made specifying the chemicals as "Cationic Surfactants"; a second calculation was made assuming the chemicals are Aliphatic Amines – the values for this second calculation are included in () if different than for Cationic Surfactants.

Table 3
Environmental Fate and Ecotoxicity Data for FND Amines Category Chemicals

CAS RN	Photodegradation (cm ³ /molecule -sec for k _{phot})	Stability in Water	Transport & Distribution ⁵	Biodegradation	Acute/Prolonged Toxicity to Fish 96-hour LC ₅₀ (mg/L)	Acute/Chronic Toxicity to Invertebrates EC ₅₀ (mg/L)	Toxicity to Aquatic Plants 72-hr. EC ₅₀ (mg/L)
Subcategory III: Dialkylmethylamines and Dialkylamines							
7396-58-9							
67700-99-6							
68153-95-7							
4088-22-6	134 E-12 t _{1/2} = 1.0 hr	not calculable	Air: <1% Water: 5% Soil: <1% Sediment: 95%		>100 and <500 ¹⁶ not toxic at solubility	not toxic at solubility	not calculable (not toxic at solubility) ¹⁷
61788-62-3				82% ThOD in 28 d	6.15		
61788-63-4				75% ThOD in 28 d (85% in 40 d); 100% COD in 28 d; 48.3 or 63.5% in 53 d; 78.5 or 73.0% in 55 d; 70.47% in 28 d (acclimated sludge); 91.2% SCAS Removal	>1000 ¹⁶ 23 180	35.2 (48-hr acute) ¹⁶ 790 (48-hr acute) ¹⁶ 3.1 (48-hr acute) 21 (48-hr acute) 2.0 (48-hr acute) 6.5; 22; 60 (48- hour acute) ¹⁸	E _b C ₅₀ = 0.05 E _r C ₅₀ =0.12 AC _{d5} = 0.052 AC _{d5} = 0.96 AC _{d5} = 4.6 AC _{d5} = 1.14 ¹⁹

¹⁶ The value(s) is(are) questionable due to the bioavailability of the test substance in this study.

¹⁷ Original model calculations were made specifying the chemicals as "Cationic Surfactants"; a second calculation was made assuming the chemicals are Aliphatic Amines – the values for this second calculation are included in () if different than for Cationic Surfactants.

¹⁸ Three studies with a mixture or a prill containing the test substance were conducted in different source waters – EC₅₀ values are as the mixture/prill concentration; well water with mixture EC₅₀ = 6.5 mg/L (83.5% ditallowmethylamine); well water with prill EC₅₀ = 22 mg/L (63% ditallowmethylamine); river water with prill EC₅₀ = 60 mg/L (63% ditallowmethylamine);

¹⁹ AC_{d5} = Algistatic concentration after 5 days exposure. Four separate studies were conducted on four strains of algae; *Selenastrum capricornutum*, *Microcystis aeruginosa*, *Navicula seminulum*, and *Navicula pelliculosa*.

Table 3
Environmental Fate and Ecotoxicity Data for FND Amines Category Chemicals

CAS RN	Photodegradation (cm ³ /molecule-sec for k _{phot})	Stability in Water	Transport & Distribution ⁵	Biodegradation	Acute/Prolonged Toxicity to Fish 96-hour LC ₅₀ (mg/L)	Acute/Chronic Toxicity to Invertebrates EC ₅₀ (mg/L)	Toxicity to Aquatic Plants 72-hr. EC ₅₀ (mg/L)
61789-79-5				<i>16% O₂ in 28 d¹⁶</i>	<i>220 and 500¹⁶</i>		
61789-76-2				<i>20% ThOD in 28 d²⁰</i> <i>(18% in 42 d)²⁰</i>			
68783-24-4							
Subcategory IV: Trialkylamines							
68814-95-9							
61790-42-9							
61791-31-9				61% COD in 28 d (62% in 42 d); Up to 85% TCO₂ in 28 d – Activated Sludge; >97% SCAS Removal; 100% (River Die Away)	0.47 (48-hour) 0.0179 (30-day)	0.38 (48-hour) 0.15 (21-day growth) 0.14 (21-day growth)	
61791-44-4				52% ThOD in 28 d (62% in 35 d)			

Note: Bold font indicates reliable data for which a Robust Summary is provided in Appendix A

Regular font indicates data obtained from appropriate models as described in the text and Appendix B.

Shaded cells with CAS RN and data in italics are for supporting chemicals [non-HPV].

Empty block denotes data either are not available or are available and judged inadequate.

* These chemicals were removed from the original FND Amines Category because they are sponsored by APAG under the ICCA program.

²⁰ The value(s) is(are) questionable due to the bioavailability of the test substance in this study.

Table 4
Human Health-Related Data for FND Amines Category Chemicals

CAS RN	Acute Oral Toxicity (g/kg)	Acute Inhalation Toxicity (mg/L)	Acute Dermal Toxicity (g/kg)	Repeated Dose Toxicity NOAEL (mg/kg/day)	Genetic Toxicity <i>In vitro/ In vivo</i>	Toxicity to Reproduction NOAEL (mg/kg/day)	Developmental Toxicity NOAEL (mg/kg/day)
Subcategory I: Primary Alkylamines and Alkyldiamines							
124-22-1	1.02 1.16 (mouse) >2.0						
143-27-1					Negative (Ames) Negative (Ames)		
68037-91-2							
61788-45-2*	>5.0 4.8 >2.0						
124-30-1*	~1.0 (rat and mouse) >2.0 >2.0			~25 ²¹ ~25 ²² 3.0 ²³	Negative (Ames) Negative (Ames) Negative (Ames)	~25 ²¹ ~25 ²² 15 ²³	
61788-46-3*	1.24 (male) 1.39 (female) >2.0 (male) 2.82 (female) 2.04 >6.0	>0.099 ²⁴	>2.0 >2.0 ml/kg >2.0 ml/kg		Negative (Ames)		
68155-38-4							

²¹ Chronic (two-year) dietary toxicity study in rats. The NOAEL was 500 ppm (highest dose tested) estimated to be approximately 25 mg/kg/day. Reproductive organs were examined, meeting the requirements for SIDS/HPV reproductive screening.

²² Chronic (two-year) dietary toxicity study in rats. Reproductive organs were examined, meeting the requirements for SIDS/HPV reproductive screening.

²³ Chronic (one-year) oral (capsule) toxicity study in dogs. Reproductive organs were examined, meeting the requirements for SIDS/HPV reproductive screening.

²⁴ Exposure period = 1 hour

Table 4
Human Health-Related Data for FND Amines Category Chemicals

CAS RN	Acute Oral Toxicity (g/kg)	Acute Inhalation Toxicity (mg/L)	Acute Dermal Toxicity (g/kg)	Repeated Dose Toxicity NOAEL (mg/kg/day)	Genetic Toxicity <i>In vitro/ In vivo</i>	Toxicity to Reproduction NOAEL (mg/kg/day)	Developmental Toxicity NOAEL (mg/kg/day)
61790-33-8*	>2.50 (male) >2.00 (female); 2.23 ml/kg (male) 2.61 ml/kg (female)			12.5 ²⁵	Negative (Ames) Negative (In vivo rat micronucleus)	Parents = 12.5 Offspring = 12.5 ²⁶	Parents = 12.5 Offspring = 12.5 ²⁶
61790-18-9							
68037-95-6							
112-90-3*	~2.0 (females) ~1.18 (males)			See Robust Summary ²⁷	Negative (Ames) Negative (gene mutation) Negative (mouse lymphoma) Negative (chrom. aberration) Negative (In vivo cytogenetic)		Maternal = 10; Developmental = 80 ²⁸ Maternal = 3.0 ; Developmental = 30 ²⁹
61791-55-7	>5.0						
7173-62-8							
3151-59-5 + 36505-83-6				6.0 ³⁰ 6.0 ³¹		Parents = 6.0 Offspring = 30.0 ³²	Maternal = 6.0 Developmental = 30.0 ³³ Maternal LOAEL = 1.2 Developmental = 30.0 ³⁴ Maternal and Offspring = 30.0 ³⁵

²⁵ Four-week oral (gavage) toxicity study in rats.

²⁶ OECD 421 oral gavage study in rats.

²⁷ A 14-day dermal toxicity study in rats with limited evaluations; not adequate for SIDS/HPV testing but provides data on the irritation of the chemical following repeated exposure.

²⁸ Developmental toxicity study in rats dosed via oral gavage at doses of 0, 10, 40 and 80 mg/kg.

²⁹ Developmental toxicity study in rabbits dosed via oral gavage at doses of 0, 3, 10 and 30 mg/kg/day.

³⁰ 24-Month feeding study in rats at doses of 1.2, 6.0 and 30.0 mg/kg/day.

³¹ Two-year study in dogs via oral gavage at doses of 1.2, 6.0 and 12.0 mg/kg/day.

³² Segment I (Fertility and General Reproductive Performance) study in rats via oral gavage at doses of 1.2, 6.0 and 30.0 mg/kg/day.

³³ Two Segment II (Teratology) studies in rats were conducted at doses of 1.2, 6.0 and 30.0 mg/kg/day. Decreases in maternal body weight gains at 30.0 mg/kg/day in the confirmatory study.

³⁴ Segment II (Teratology) study in rabbits at doses of 1.2, 6.0 and 30.0 mg/kg/day. Maternal body weight decreased at the low dose.

³⁵ Segment III (Perinatal and Postnatal) study in rats at doses of 1.2, 6.0 and 30.0 mg/kg/day.

Table 4
Human Health-Related Data for FND Amines Category Chemicals

CAS RN	Acute Oral Toxicity (g/kg)	Acute Inhalation Toxicity (mg/L)	Acute Dermal Toxicity (g/kg)	Repeated Dose Toxicity NOAEL (mg/kg/day)	Genetic Toxicity <i>In vitro/ In vivo</i>	Toxicity to Reproduction NOAEL (mg/kg/day)	Developmental Toxicity NOAEL (mg/kg/day)
Subcategory II: Dimethylalkylamines							
112-18-5	1.22 0.79 >1.26 and <2.52		~5.0		Negative (<i>In vivo</i> mouse micronucleus)		
112-75-4	2.116 1.32				Negative (Ames) ³⁶		
112-69-6	0.80 ³⁷ >2.0 1.015		4.29 ³⁷		Negative (Ames) ³⁶		
124-28-7	0.78 ³⁷ 2.116		4.29 ³⁷		Negative (Ames) ³⁶		
61788-93-0	1.50 (male) 1.30 (female); >1.0 and <1.25 1.58 ³⁷		4.29 ³⁷				
61788-95-2	>2.0						
61788-91-8	0.835 ³⁷		3.0 ³⁷				
28061-69-0							
4088-22-6	>2.0 >5.0		>2.0	LOAEL = 130 ³⁸ LOAEL = 100 ³⁹ LOAEL = 50 ⁴⁰ LOAEL = 50 ⁴¹	Negative (Ames)	LOAEL = 130 ³⁸ LOAEL = 50 ⁴¹	Maternal = 50 Developmental = 250
61788-62-3	>2.0						

³⁶ Evaluation with only two tester strains.

³⁷ Value is ml/kg.

³⁸ 13-week dietary toxicity study in rats. Reproductive organs were examined, meeting the requirements for SIDS/HPV reproductive screening.

³⁹ 4-week gavage range-finding study (developmental toxicity) in rabbits

⁴⁰ 7-day dermal range finding study in rabbits; LOAEL determined by skin irritation

⁴¹ 13-week dermal study in rabbits (5 and 50 mg/kg/day). LOAEL for repeated dose toxicity determined by skin irritation Reproductive organs were examined, meeting the requirements for SIDS/HPV reproductive screening.

Table 4

Human Health-Related Data for FND Amines Category Chemicals

CAS RN	Acute Oral Toxicity (g/kg)	Acute Inhalation Toxicity (mg/L)	Acute Dermal Toxicity (g/kg)	Repeated Dose Toxicity NOAEL (mg/kg/day)	Genetic Toxicity <i>In vitro/ In vivo</i>	Toxicity to Reproduction NOAEL (mg/kg/day)	Developmental Toxicity NOAEL (mg/kg/day)
Subcategory III: Dialkylmethylamines and Dialkylamines							
7396-58-9							
67700-99-6							
68153-95-7							
61788-63-4	>5.0 >15.0				Negative (Ames) Negative (Mouse Lymphoma) Negative (<i>in vitro</i> UDS) Negative (<i>in vivo</i> Cytogenetics)		
61789-79-5	>10.0 (<i>males</i>)						
61789-76-2							
68783-24-4							

Table 4
Human Health-Related Data for FND Amines Category Chemicals

Subcategory IV: Trialkylamines							
68814-95-9							
61790-42-9							
61791-31-9	>5.0						
61791-44-4	1.50 (male) 1.20 (female) >2.0 0.89 0.63 1.15 >15.0	See Robust Summary ⁴²	>2.0 ml/kg >2.0 <2.0 ml/kg ⁴³ >1.5	~50 ⁴⁴ 13 ⁴⁵ 12 ⁴⁶ 40 ⁴⁷ 10 ⁴⁸ 10 ⁴⁹ 40/200 ⁵⁰	Negative (Ames) – 3 tests; Negative (Mouse Lymphoma) Negative without metabolic activation, Positive with metabolic activation (<i>in vitro</i> Chromosomal Aberration); Negative (<i>in vitro</i> UDS); Negative (<i>in vivo</i> Mouse Micronucleus); Negative (<i>in vivo</i> Cytogenetics)	~450 ⁴⁴ 120 ⁴⁵ 400 ⁴⁶	

⁴² A 4-hour exposure study was conducted that does not adequately define the LC₅₀ for the chemical. The study provides additional data on the potential inhalation hazard.

⁴³ Four of 6 animals died following a 24-hour exposure to 2.0 ml/kg

⁴⁴ 90-day dietary toxicity study in rats. NOAEL for repeated dose toxicity was 500 ppm in the diet estimated to be approximately 50 mg/kg/day. Reproductive organs were examined, meeting the requirements for SIDS/HPV reproductive screening. NOEL for reproductive toxicity was 4500 ppm in the diet estimated to be approximately 450 mg/kg/day.

⁴⁵ 90-day dietary toxicity study in dogs. Doses of 40 and 120 mg/kg/day were poorly tolerated with extensive emesis. Reproductive organs were examined, meeting the requirements for SIDS/HPV reproductive screening.

⁴⁶ 13-week dietary study in rats. Reproductive organs were examined, meeting the requirements for SIDS/HPV reproductive screening.

⁴⁷ 28-day dermal study in rabbits (only one dose tested; no systemic toxicity; skin irritation observed)

⁴⁸ 4-week dermal study in rabbits (two doses tested; no systemic toxicity; skin irritation observed for both the 2 and 10 mg/kg/day groups)

⁴⁹ 17-day dermal exposure followed by approximately 10 weeks of examination (study terminated due to irritation of the 2 and 10 mg/kg/day doses)

⁵⁰ 28-day dermal study in rabbits (200 mg/kg/day for two days reduced to 40 mg/kg/day). Only skin irritation considered to be treatment related.

Note: Shaded cells with CAS RN and data in italics are for supporting chemicals [non-HPV]. Empty block denotes data either are not available or are available and judged inadequate.

* These chemicals were removed from the original FND Amines Category because they are sponsored by APAG under the ICCA program.

Table 5
Proposed Test Plan for American Chemistry Council FND Amines Category
Physical/Chemical Properties

CAS RN	Melting Point (°C)	Boiling Point (°C)	Vapor Pressure (hPa)	Partition Coefficient (log K_{ow})	Water Solubility (mg/L)
Subcategory I: Primary Alkylamines and Alkyldiamines					
124-22-1	A (M)	A (M)	M	M	A (M)
143-27-1	M	M	M	M	M
68037-91-2	R	R	R	R	R
61788-45-2*	A (M)	A (M)	A (M)	M	M
124-30-1*	A (M)	A (M)	A (M)	M	A (M)
61788-46-3*	R	R	R	R	R
68155-38-4	R	R	R	R	R
61790-33-8*	A	A	A	A	A
61790-18-9	R	R	R	R	R
68037-95-6	R	R	R	R	R
112-90-3*	A (M)	A (M)	A (M)	A (M)	A (M)
61791-55-7	R	R	R	R	R
7173-62-8	M	M	M	M	M
3151-59-5 + 36505-83-6	R	R	R	R	R
Subcategory II: Dimethylalkylamines					
112-18-5	A (M)	M	M	M	M
112-75-4	M	M	M	M	M
112-69-6	M	M	M	M	M
124-28-7	A (M)	M	M	M	A (M)
61788-93-0	R	R	R	R	R
61788-95-2	R	R	R	R	R
61788-91-8	R	R	R	R	R
28061-69-0	M	M	M	M	M

Table 5
Proposed Test Plan for American Chemistry Council FND Amines Category
Physical/Chemical Properties

CAS RN	Melting Point (°C)	Boiling Point (°C)	Vapor Pressure (hPa)	Partition Coefficient (log K _{ow})	Water Solubility (mg/L)
Subcategory III: Dialkylmethylamines and Dialkylamines					
7396-58-9	R	R	R	R	R
67700-99-6	R	R	R	R	R
<i>68153-95-7</i>	R	R	R	R	R
4088-22-6	M	M	M	M	M
<i>61788-62-3</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>
61788-63-4	R	R	R	A	A
<i>61789-79-5</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>
<i>61789-76-2</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>
68783-24-4	R	R	R	R	R
Subcategory IV: Trialkylamines					
68814-95-9	R	R	R	R	R
61790-42-9	R	R	R	R	R
61791-31-9	R	R	R	R	R
61791-44-4	R	R	R	R	R

Note: Shaded cells with CAS RN and data in italics are for supporting chemicals [non-HPV].

A = Adequate reported values

M = Adequate model data available

R = Read across from available data and/or experimental determination is considered inappropriate.

* These chemicals were removed from the original FND Amines Category because they are sponsored by APAG under the ICCA program.

Table 6
Proposed Test Plan for American Chemistry Council FND Amines Category
Environmental Fate and Ecotoxicity

CAS RN	Photodegradation (cm ³ /molecule-sec for k _{phot})	Stability in Water	Transport & Distribution	Biodegradation	Acute/Prolonged Toxicity to Fish 96-hour LC ₅₀ (mg/L)	Acute/Chronic Toxicity to Invertebrates EC ₅₀ (mg/L)	Toxicity to Aquatic Plants 72-hr. EC ₅₀ (mg/L)
Subcategory I: Primary Alkylamines and Alkyldiamines							
124-22-1	M	NC	M	A	A (M)	M	M
143-27-1	M	NC	M	R	M	M	M
68037-91-2	R	R	R	R	R	R	R
61788-45-2*	M	NC	M	A	A (M)	A (M)	A (M)
124-30-1*	M	NC	M	A	M	A (M)	A (M)
61788-46-3*	R	R	R	A	A	A	A
68155-38-4	R	R	R	R	R	R	R
61790-33-8*	R	R	R	A	A	A	A
61790-18-9	R	R	R	R	R	R	R
68037-95-6	R	R	R	R	R	R	R
112-90-3*	M	NC	M	A	A (M)	A (M)	A (M)
61791-55-7	R	R	R	A	R	R	R
7173-62-8	M	NC	M	R	M	M	M
3151-59-5 + 36505-83-6	R	R	R	R	R	R	R
Subcategory II: Dimethylalkylamines							
112-18-5	M	NC	M	A	A (M)	A (M)	A (M)
112-75-4	M	NC	M	A	A (M)	M	M
112-69-6	M	NC	M	A	A (M)	M	M
124-28-7	M	NC	M	A	A (M)	A (M)	A (M)
61788-93-0	R	R	R	A	A	R	R
61788-95-2	R	R	R	A	R	R	R
61788-91-8	R	R	R	A	A	R	R
28061-69-0	M	NC	M	A	M	M	M

Table 6
Proposed Test Plan for American Chemistry Council FND Amines Category
Environmental Fate and Ecotoxicity

CAS RN	Photodegradation (cm ³ /molecule-sec for k _{phot})	Stability in Water	Transport & Distribution	Biodegradation	Acute/Prolonged Toxicity to Fish 96-hour LC ₅₀ (mg/L)	Acute/Chronic Toxicity to Invertebrates EC ₅₀ (mg/L)	Toxicity to Aquatic Plants 72-hr. EC ₅₀ (mg/L)
Subcategory III: Dialkylmethylamines and Dialkylamines							
7396-58-9	R	R	R	R	R	R	R
67700-99-6	R	R	R	R	R	R	R
68153-95-7	R	R	R	R	R	R	R
4088-22-6	M	NC	M	R	A (M)	M	M
<i>61788-62-3</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>A</i>	<i>A</i>	<i>R</i>	<i>R</i>
61788-63-4	R	R	R	A	A	A	A
<i>61789-79-5</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>A</i>	<i>A</i>	<i>R</i>	<i>R</i>
<i>61789-76-2</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>A</i>	<i>R</i>	<i>R</i>	<i>R</i>
68783-24-4	R	R	R	R	R	R	R
Subcategory IV: Trialkylamines							
68814-95-9	R	R	R	R	R	R	R
61790-42-9	R	R	R	R	R	R	R
61791-31-9	R	R	R	A	A	A	R
61791-44-4	R	R	R	A	R	R	R

Note: Shaded cells with CAS RN and data in italics are for supporting chemicals [non-HPV].

A = Adequate reported values

M = Adequate model data available

R = Read across from available data and/or experimental determination is considered inappropriate.

NC = Model could not calculate a value.

* These chemicals were removed from the original FND Amines Category because they are sponsored by APAG under the ICCA program.

Table 7
Proposed Test Plan for American Chemistry Council FND Amines Category
Human Health-Related Data

CAS RN	Acute Oral Toxicity (g/kg)	Acute Inhalation Toxicity (mg/L)	Acute Dermal Toxicity (g/kg)	Repeated Dose Toxicity NOAEL (mg/kg/day)	Genetic Toxicity <i>In vitro/ In vivo</i>	Toxicity to Reproduction NOAEL (mg/kg/day)	Developmental Toxicity NOAEL (mg/kg/day)
Subcategory I: Primary Alkylamines and Alkyldiamines							
124-22-1	A	R	R	R	R	R	R
143-27-1	R	R	R	R	A (Ames)	R	R
68037-91-2	R	R	R	R	R	R	R
61788-45-2*	A	R	R	R	R	R	R
124-30-1*	A	R	R	A	A (Ames)	A	R
61788-46-3*	A	A	A	R	A (Ames)	R	R
68155-38-4	R	R	R	R	R	R	R
61790-33-8*	A	R	R	A	A (Both)	A	A
61790-18-9	R	R	R	R	R	R	R
68037-95-6	R	R	R	R	R	R	R
112-90-3*	A	R	R	R	A (Both)	R	A
61791-55-7	A	R	R	R	R	R	R
7173-62-8	R	R	R	R	R	R	R
3151-59-5 + 36505-83-6	R	R	R	A	R	A	A
Subcategory II: Dimethylalkylamines							
112-18-5	A	R	A	R	A (Cyto)	R	R
112-75-4	A	R	R	R	A ⁵¹	R	R
112-69-6	A	R	A	R	A ⁵¹	R	R
124-28-7	A	R	A	R	A ⁵¹	R	R
61788-93-0	A	R	A	R	R	R	R
61788-95-2	A	R	R	R	R	R	R
61788-91-8	A	R	A	R	R	R	R
28061-69-0	R	R	R	R	R	R	R

⁵¹ Salmonella Reverse Mutation Assay in two esters strains was negative.

Table 7
Proposed Test Plan for American Chemistry Council FND Amines Category
Human Health-Related Data

CAS RN	Acute Oral Toxicity (g/kg)	Acute Inhalation Toxicity (mg/L)	Acute Dermal Toxicity (g/kg)	Repeated Dose Toxicity NOAEL (mg/kg/day)	Genetic Toxicity <i>In vitro/ In vivo</i>	Toxicity to Reproduction NOAEL (mg/kg/day)	Developmental Toxicity NOAEL (mg/kg/day)
Subcategory III: Dialkylmethylamines and Dialkylamines							
7396-58-9	R	R	R	R	R	R	R
67700-99-6	R	R	R	R	R	R	R
68153-95-7	R	R	R	R	R	R	R
4088-22-6	A	R	A	A	A (Ames)	A	A
<i>61788-62-3</i>	<i>A</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>
61788-63-4	A	R	R	R	A (Both)	R	R
<i>61789-79-5</i>	<i>A</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>
<i>61789-76-2</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>
68783-24-4	R	R	R	R	R	R	R
Subcategory IV: Trialkylamines							
68814-95-9	R	R	R	R	R	R	R
61790-42-9	R	R	R	R	R	R	R
61791-31-9	A	R	R	R	R	R	R
61791-44-4	A	R	A	A	A	A	R

Note: Shaded cells with CAS RN and data in italics are for supporting chemicals [non-HPV].

Reliable data for acute toxicity by any of the three routes of exposure are considered adequate under the EPA HPV Challenge Program.

A = Adequate reliable data

R = Endpoint fulfilled by category read-across from existing or proposed test data.

* These chemicals were removed from the original FND Amines Category because they are sponsored by APAG under the ICCA program.