Supporting Documents for Initial Risk-Based Prioritization of High Production Volume Chemicals

Carboxylic Food Acids and Salts Category

Acetic acid **(CASRN 64-19-7)**

Acetic acid, ammonium salt **(CASRN 631-61-8)**
(CA Index Name: Acetic acid, ammonium salt (1:1))

Acetic acid, potassium salt **(CASRN 127-08-2)**
(CA Index Name: Acetic acid, potassium salt (1:1))

Acetic acid, sodium salt **(CASRN 127-09-3)**
(CA Index Name: Acetic acid, sodium salt (1:1))

Acetic acid, calcium salt **(CASRN 62-54-4)**
(CA Index Name: Acetic acid, calcium salt (2:1))

Acetic acid, magnesium salt **(CASRN 142-72-3)**
(CA Index Name: Acetic acid, magnesium salt (2:1))

Acetic acid, manganese salt **(CASRN 638-38-0)**
(CA Index Name: Acetic acid, manganese(2+) salt (2:1)

Fumaric Acid **(CASRN 110-17-8)**
(CA Index Name: 2-Butenedioic acid (2E)-)

Malic Acid **(CASRN 6915-15-7)**
(CA Index Name: Butanedioic acid, 2-hydroxy-)

Citric Acid **(CASRN 77-92-9)**
(CA Index Name: 1,2,3-Propanetricarboxylic acid, 2-hydroxy-)

Citric acid, sodium salt (unspecified number of sodium atoms) **(CASRN 994-36-5)**
(CA Index Name: 1,2,3-Propanetricarboxylic acid, 2-hydroxy-, sodium salt (1:?))

Citric acid, trisodium salt **(CASRN 68-04-2)**
(CA Index Name: 1,2,3-Propanetricarboxylic acid, 2-hydroxy-, sodium salt (1:3))

Citric acid, tripotassium salt **(CASRN 866-84-2)**
(CA Index Name: 1,2,3-Propanetricarboxylic acid, 2-hydroxy-, potassium salt (1:3))

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BACKGROUND

Screening-level hazard, exposure and risk characterizations for high production volume chemicals (HPV) are important contributions to the chemicals cooperation work being done in North America[1] through the EPA Chemical Assessment and Management Program (ChAMP)[2]. These screening-level characterizations are developed by EPA for individual chemicals or chemical categories to support initial Risk-Based Prioritizations (RBPs) for HPV chemicals. These screening-level characterizations are technical documents intended primarily to inform the Agency's internal decision-making process. Accordingly, they are written for assessment professionals and assume a degree of technical understanding. Each of the support documents is described below.

The Risk-Based Prioritizations are found in an accompanying document and are written for a general audience. They present EPA's initial thinking regarding the potential risks presented by these chemicals and future possible actions that may be needed.

Hazard Characterizations for HPV Chemicals

EPA's screening-level hazard characterizations are based primarily on the review of the summaries of studies and other information submitted by the chemical sponsor(s) under the HPV Challenge Program[3]. These studies included in the scope of the HPV Challenge comprise the Screening Information Data Set (SIDS) of the Organization for Economic Cooperation and Development (OECD)[4], an internationally recognized battery of tests that provides the basic data necessary to make an initial evaluation of a chemical's hazards and fate. In preparing the initial hazard characterizations, EPA also consulted a variety of reliable sources[5] for additional relevant information and considered its own comments and public comments on the original submission as well as the sponsor's responses to comments and revisions made to the submission. In order to determine whether any new hazard information was developed since the time of an HPV submission, EPA also searched publicly available databases[6] for information entered from one year prior to the HPV submission through May 2008. The screening-level hazard characterization is performed according to established EPA guidance[7]. A more detailed description of the hazard characterization process is available on the EPA website[8].

With respect to chemicals for which internationally-accepted OECD SIDS Initial Assessment Profiles (SIAP) and Initial Assessment Reports (SIAR) were available, EPA did not generate its own screening-level hazard characterization, but did check for and incorporate updated information in the risk characterization.

Exposure Characterizations for HPV Chemicals

EPA recently received exposure-related data on chemicals submitted in accordance with the requirements of Inventory Update Reporting (IUR)[9]. The 2006 IUR submissions pertain to chemicals manufactured in

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[1] U.S. EPA – U.S. Commitments to North American Chemicals Cooperation: http://www.epa.gov/hpv/pubs/general/sppframework.htm.
[2] U.S. EPA – ChAMP information: http://www.epa.gov/champ/.
[3] U.S. EPA – HPV Challenge Program information: http://www.epa.gov/hpv.
[4] U.S. EPA – Technical Guidance Document, OECD SIDS Manual Sections 3.4 and 3.5: http://www.epa.gov/chemrtk/pubs/general/sidsappb.htm.
[5] U.S. EPA – Public Database Hazard Information: http://www.epa.gov/hpvis/hazardinfo.htm.
[6] U.S. EPA – Public Database Update Information: http://www.epa.gov/chemrtk/hpvis/updateinfo.htm.
[7] U.S. EPA – Risk Assessment Guidelines: http://cfpub.epa.gov/ncea/raf/rafguid.cfm.
[8] U.S. EPA – About HPV Chemical Hazard Characterizations: http://www.epa.gov/hpvis/abouthc.htm.
[9] U.S. EPA – Basic IUR Information: http://www.epa.gov/opptintr/iur/pubs/guidance/basic-information.htm.

(including imported into) the U.S. during calendar year 2005 in quantities of 25,000 pounds or more at a single site. The reports include the identity, the quantity, and the physical form of the chemical manufactured or imported, and the number of workers reasonably likely to be exposed during manufacture of the chemical. For chemicals manufactured or imported in quantities of 300,000 pounds or more at a single site, additional reported information includes: the industrial processing and uses of the chemical; the number of industrial processing sites and workers reasonably likely to be exposed to the chemical at those sites; the consumer and commercial uses of the chemical; and an indication whether the chemical was used in products intended for use by children under 14 years of age.

EPA's screening-level exposure characterizations are based largely on the information submitted under the IUR reporting, although other exposure information submitted to the Agency (for example, in HPV submissions) or readily available through a limited set of publicly accessible databases[10] was also considered. The screening-level Exposure Characterizations identify a potential (high, medium, or low) that each of five populations – the environment, the general population, workers, consumers, and children – might be exposed to the chemical. In most cases, this potential doesn't address the quantity, frequency, or duration of exposure, but refers only to the likelihood that an exposure could occur.

In many instances EPA is not able to fully disclose to the public all the IUR exposure-related data reviewed or relied upon in the development of the screening-level documents because some of the material was claimed as confidential business information (CBI) when it was submitted to the Agency. These CBI claims do limit the Agency's ability to be completely transparent in presenting some underlying exposure and use data for chemicals in public documents. EPA does consider all data, including data considered to be CBI, in the screening-level exposure and risk characterization process, and endeavors whenever possible to broadly characterize supporting materials claimed as confidential in ways that do not disclose actual CBI.

Risk Characterizations for HPV Chemicals

EPA combines the information from the screening-level exposure characterization with the screening-level hazard characterization to develop a qualitative screening-level risk characterization, as described in the Agency's guidance on drafting risk characterizations[11]. These screening-level risk characterizations are technical documents intended to support subsequent priority-setting decisions and actions by OPPT. The purpose of the qualitative screening-level risk characterization is two-fold: to support initial risk-based decisions to prioritize chemicals, identify potential concerns, and inform risk management options; and to identify data needs for individual chemicals or chemical categories.

These initial characterization and prioritization documents do not constitute a final Agency determination as to risk, nor do they determine whether sufficient data are available to characterize risk. Recommended actions reflect EPA's relative judgment regarding this chemical or chemical category in comparison with others evaluated under this program, as well as the uncertainties presented by gaps that may exist in the available data.

[10] U.S. EPA – Summary of Public Databases Routinely Searched: http://www.epa.gov/chemrtk/hpvis/pubdtsum.htm.
[11] U.S. EPA – Risk Characterization Program: http://www.epa.gov/osa/spc/2riskchr.htm.

QUALITATIVE SCREENING-LEVEL RISK CHARACTERIZATION OF HIGH PRODUCTION VOLUME CHEMICALS

SPONSORED CHEMICAL

CHEMICAL CATEGORY NAME:
Carboxylic Food Acids and Salts Category

Acetic acid	**CAS No. 64-19-7**
Acetic acid, ammonium salt	**CAS No. 631-61-8**
Acetic acid, potassium salt	**CAS No. 127-08-2**
Acetic acid, sodium salt	**CAS No. 127-09-3**
Acetic acid, calcium salt	**CAS No. 62-54-4**
Acetic acid, magnesium salt	**CAS No. 142-72-3**
Acetic acid, manganese salt	**CAS No. 638-38-0**
Fumaric acid	**CAS No. 110-17-8**
Malic acid	**CAS No. 6915-15-7**
Citric acid	**CAS No. 77-92-9**
Citric acid, sodium salt (unspecified number of sodium atoms)	**CAS No. 994-36-5**
Citric acid, trisodium salt	**CAS No. 68-04-2**
Citric acid, tripotassium salt	**CAS No. 866-84-2**

August 2008

Prepared by

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QUALITATIVE SCREENING-LEVEL RISK CHARACTERIZATION FOR Carboxylic Food Acids and Salts Category

1. Category Justification

In this category, the chemicals are grouped together because of their close structural relationships, their natural occurrence in plants and animals, and their role in cell metabolism, particularly in the tricarboxylic acid cycle (also known as the citric acid or Kreb's cycle). The compounds in this category are either carboxylic acids or their respective salts. Acetic acid has one, fumaric acid and malic acid have two, and citric acid has three carboxylic acid functional groups. Malic acid and citric acid also have an additional alcohol group. These compounds are naturally occurring in many fruits and vegetables, and are critical for basic metabolic processes.

EPA, in its test plan comments, suggested that the 13 compounds that are included under the umbrella of a single carboxylic food acids and salts category, should be subdivided as follows: 1) citric acid and salts; 2) malic acid; 3) fumaric acid; and 4) acetic acid and salts. Further details on this are provided in the accompanying Hazard Characterization.

3. Physical-Chemical Properties and Environmental Fate

The substances in the carboxylic food acids and salts category are solids, with the exception of acetic acid, which exists as a liquid at room temperature. The salts of acetic acid and citric acid have negligible vapor pressure and high water solubilities. Acetic acid has a high vapor pressure, while fumaric, malic, and citric acid have either low or negligible vapor pressure. All of the compounds contained within this category dissociate in water; therefore, volatilization is negligible since ionic substances do not volatilize. All of the substances in this category are expected to possess high mobility in soil. If released to air, acetic acid, malic acid, citric acid, and fumaric acid may exist in the vapor-phase and the rate of atmospheric photooxidation for these substances is considered moderate to negligible. In the atmosphere, the salts would exist in the particulate phase and atmospheric photooxidation would be negligible. Acetic acid, citric acid, and fumaric acid are all readily biodegradable, therefore the potential to persist in the environment for the compounds in this category is judged to be low (P1). Based upon estimated bioconcentration factors, the potential for bioaccumulation for members of this category is also judged to be low (B1).

4. Hazard Characterization

Aquatic Organism Toxicity. The evaluation of available data on aquatic organisms indicates the potential hazard of the carboxylic food acids and salts category for fish, aquatic invertebrates, and aquatic plants is low.

Human Health Toxicity. Acetic Acid and its Salts Subcategory: The acute oral and inhalation toxicity for acetic acid and its salts is low, and the dermal toxicity for acetic acid and its salts is moderate. A repeated oral exposure to acetic acid in rats induced irritation at point of contact. Other repeated-dose studies for the subcategory showed either no signs of toxicity or the toxic

effects were seen at high doses; in one study, exceeding the limit dose. No reproductive toxicity data are available for this subcategory. No maternal or developmental toxicity was seen in mice, rats or rabbits exposed to high doses. The subcategory members, acetic acid and acetic acid sodium salt did not show potential to induce genetic mutations; data on potential to induce chromosomal aberrations was insufficient; however, acetic acid was not shown to be clastogenic in one assay.

Fumaric Acid Subcategory: The acute oral and dermal toxicity for fumaric acid is low. Repeated exposures to this chemical via the oral route showed signs of toxicity at high doses. No functional reproductive toxicity data are available for fumaric acid; however, a repeated dose toxicity study showed testicular effects at high doses. No developmental toxicity data are available. Fumaric acid did not show potential to induce genetic mutations; data on potential to induce chromosomal aberrations was insufficient.

Malic Acid Subcategory: The acute oral toxicity for malic acid is low. Repeated exposures to this chemical via the oral route showed transient effects in a 2-year study in rats; however, the study was poorly documented and did not provide sufficient details in order to adequately evaluate the toxicity and therefore, the reported effects were not considered to be treatment-related or clearly adverse. No reproductive toxicity data are available for malic acid. No adverse signs of maternal or developmental toxicity were observed in rats or mice exposed to high doses of malic acid. Malic acid did not show potential to induce genetic mutations; data on potential to induce chromosomal aberrations was insufficient.

Citric Acid and Salts Subcategory: The acute oral toxicity for citric acid and its salts is low. An acute skin irritation study in rabbits exposed to a solution containing citric acid caused erythema and edema. Repeated exposures to high doses in this subcategory via the oral route did not result in any adverse effects. Reproductive and developmental toxicity studies with high doses did not result in any adverse effects. Citric acid and its salts did not show potential to induce genetic mutations; no data are available for chromosomal aberrations.

5. Exposure Characterization

The 13 carboxylic food acids and salts category chemicals have an aggregated production and import volume in the range of 86 million to 311 million pounds. The aggregated production volume range excludes one of the thirteen chemicals, acetic acid (CAS# 64-19-7), which has a production volume of over 1 billion pounds. Non-confidential information in the Inventory Update Reporting (IUR) for many of the chemicals in the carboxylic food acids and salts category indicates that these chemicals are used as intermediates, solvents, coloring agents, pH-regulating agents and functional fluids in a variety of industries. All chemicals in this category have IUR submissions that indicate uses in commercial settings or consumer uses. Information in the Hazardous Substance Data Bank (HSDB) indicates that carboxylic food acids and salts are used in food preservation, pharmaceuticals, textile dyeing, anticoagulant for blood, buffer for photography and the manufacturing of other chemicals.

Potential Exposures to the General Population and the Environment: Based on the totality of the information considered, including chemical presence in monitoring data and known uses,

EPA identifies, for the purposes of risk-based prioritization, a high potential that the general population and the environment might be exposed. Public data sources indicate that some of the chemicals in the carboxylic food acids and salts category are naturally occurring in plants and organisms, and can be potentially released through waste streams from various industrial applications.

Persistence and bioaccumulation ratings for this chemical are P1 and B1. Based upon estimated bioconcentration factors, the potential for bioaccumulation for each member of this category is expected to be low (B1). Acetic acid, citric acid, and fumaric acid are all readily biodegradable, therefore the persistence potential for the compounds of this category is expected to be low (P1).

Potential Exposures to Workers: Based on the information considered, including the HSDB and IUR data (both confidential and non-confidential business information), and in combination with the Agency's professional judgment, EPA identifies, for the purposes of risk-based prioritization, a high relative ranking for the potential worker exposure. This relative ranking is based on the large number of industrial processing and uses, potential for dermal and inhalation exposure to liquids and solids, substantially high production volume, and a high number of potentially exposed workers (>1,000 workers for most members of category). Only one chemical in this category, acetic acid (CAS# 64-19-7), has an OSHA Permissible Exposure Limit (PEL) of 10 ppm 8-hour time weighted average (TWA).

Potential Exposures to Consumers: EPA identifies, for the purposes of risk-based prioritization, a high potential that consumers might be exposed based on the use of products containing this chemical. All chemicals in this category have IUR submissions that indicate uses in commercial settings or consumer uses. Some non-confidential IUR commercial and consumer uses are in rubber and plastic products, soaps and detergents, photographic supplies, paints and coatings, as well as paper products.

Potential Exposures to Children: EPA identifies, for the purposes of risk-based prioritization, a high potential that children might be exposed based on the use of products containing this chemical. Seven of the IUR submissions reported uses in products intended to be used by children, six submissions reported that such information was Not Readily Obtainable. HSDB also indicates that carboxylic food acids and salts are added in foods and beverages which may be consumed by children.

6. Risk Characterization

The statements and rationale provided below are intended solely for the purpose of this qualitative screening-level risk characterization and will be used for prioritizing substances for future work in the Chemical Assessment and Management Program (ChAMP). Chemicals in the carboxylic food acids and salts category are naturally occurring in many fruits and vegetables, and are critical for basic metabolic processes.

Risk Statement and Rationale

Potential Risk to Aquatic Organisms from Environmental Releases (LOW CONCERN). EPA identifies a high potential that aquatic organisms might be exposed from environmental releases. Chemicals in the carboxylic food acids and salts category have low persistence and low bioaccumulation. These characteristics in combination with the low toxicity to aquatic organisms for chemicals in the category indicate a low concern for potential risk to fish, aquatic invertebrates, and aquatic plants.

Potential Risk to the General Population from Environmental Releases (LOW CONCERN). EPA identifies a high potential that the general population might be exposed from environmental releases. The potential human health hazard is expected to be low due to the lack of specific toxicity to animals following exposure to high doses. Some members of the category have the potential for irritation at point of contact following prolonged exposures; however, EPA assumes it is unlikely that concentrations released to the environment would be high enough to warrant concern. The low hazard and the environmental fate characteristics of low persistence and low bioaccumulation together suggest a low concern for potential risk to the general population from environmental releases.

Potential Risk to Workers (LOW CONCERN). EPA identifies a high relative ranking for potential worker exposure. The potential human health hazard is expected to be low due to the lack of specific toxicity to animals following exposure to high doses. However, there is potential for irritation at point of contact following prolonged exposures. Adherence to standard good industrial hygiene practices (gloves, respirators, goggles, and other protective clothing) to prevent irritation will limit the exposure of workers. There is an OSHA PEL for one category member (acetic acid). Therefore, taken together, the available information suggests a low concern for potential risk to workers.

Potential Risk to Consumers from Known Uses (LOW CONCERN). EPA identifies a high potential that consumers might be exposed. The potential human health hazard is expected to be low due to the lack of specific toxicity to animals following exposure to high doses. Some members of the category have the potential for irritation at point of contact following prolonged exposures; however, EPA assumes it is unlikely that concentrations in consumer products would be high enough to warrant concern. Taken together, the available information suggests a low concern for potential risk to consumers.

Potential Risk to Children (LOW CONCERN). Products specifically intended to be used by children were reported in the IUR and other data sources. Exposures to children may also be expected to occur through the household use of some consumer products. Data that specifically addresses toxicity to children do not exist; however, the overall toxicity profile is low. Some members of the category have the potential for irritation at point of contact following prolonged exposures; however, EPA assumes it is unlikely that concentrations to which children may be exposed would be high enough to warrant concern. Taken together, the available information suggests a low concern for potential risks to children.

SCREENING-LEVEL HAZARD CHARACTERIZATION OF HIGH PRODUCTION VOLUME CHEMICALS

CHEMICAL CATEGORY NAME:
Carboxylic Food Acids and Salts Category

Acetic acid	**CAS No. 64-19-7**
Acetic acid, ammonium salt	**CAS No. 631-61-8**
Acetic acid, potassium salt	**CAS No. 127-08-2**
Acetic acid, sodium salt	**CAS No. 127-09-3**
Acetic acid, calcium salt	**CAS No. 62-54-4**
Acetic acid, magnesium salt	**CAS No. 142-72-3**
Acetic acid, manganese salt	**CAS No. 638-38-0**
Fumaric acid	**CAS No. 110-17-8**
Malic acid	**CAS No. 6915-15-7**
Citric acid	**CAS No. 77-92-9**
Citric acid, sodium salt (unspecified number of sodium atoms)	**CAS No. 994-36-5**
Citric acid, trisodium salt	**CAS No. 68-04-2**
Citric acid, tripotassium salt	**CAS No. 866-84-2**

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SCREENING-LEVEL HAZARD CHARACTERIZATION OF HIGH PRODUCTION VOLUME CHEMICALS

SCREENING-LEVEL HAZARD CHARACTERIZATION
Carboxylic Food Acids and Salts Category

Introduction

The sponsor, The American Chemistry Council's Acetic Acid and Salts Panel submitted a Test Plan and Robust Summaries to EPA for the Carboxylic Food Acids and Salts Category on June 5, 2001. EPA posted the submission on the ChemRTK HPV Challenge website on October 2, 2001 (http://www.epa.gov/chemrtk/pubs/summaries/acetisalt/c13102tc.htm). EPA comments on the original submission were posted to the website on April 26, 2002. Public comments were also received and posted to the website. The sponsor submitted revised documents September 9, 2002 and May 9, 2003, which were posted to the ChemRTK website on September 23, 2002 and June 6, 2003, respectively. The Carboxylic Food Acids and Salts Category consists of the following 13 chemicals:

Acetic acid	CAS No. 64-19-7
Acetic acid, ammonium salt	CAS No. 631-61-8
Acetic acid, potassium salt	CAS No. 127-08-2
Acetic acid, sodium salt	CAS No. 127-09-3
Acetic acid, calcium salt	CAS No. 62-54-4
Acetic acid, magnesium salt	CAS No. 142-72-3
Acetic acid, manganese salt	CAS No. 638-38-0
Fumaric acid	CAS No. 110-17-8
Malic acid	CAS No. 6915-15-7
Citric acid	CAS No. 77-92-9
Citric acid, sodium salt (unspecified number of sodium atoms)	CAS No. 994-36-5
Citric acid, trisodium salt	CAS No. 68-04-2
Citric acid, tripotassium salt	CAS No. 866-84-2

This screening-level hazard characterization is based primarily on the review of the test plan and robust summaries of studies submitted by the sponsor(s) under the HPV Challenge Program. In preparing the hazard characterization, EPA considered its own comments and public comments on the original submission as well as the sponsor's responses to comments and revisions made to the submission. In order to determine whether any new hazard information was developed since the time of the HPV submission, a search of the following databases was made from 2002 to June 2008: the NLM databases (ChemID to locate available data sources including Medline/PubMed, Toxline, HSDB, ATSDR, EPA SRS, etc.), STN/CAS online databases (Registry file for locators, ChemAbs for toxicology data, RTECS, Merck, etc.) and Science Direct. Structure(s) of the sponsored chemical(s) is included in the appendix. The screening-level hazard characterization for environmental and human health toxicity is based largely on SIDS endpoints and is described according to established EPA or OECD effect level definitions and hazard assessment practices.

Category Justification

This category was previously referred to as the Acetic Acid and Salts category, and has been renamed the Carboxylic Food Acids and Salts category to more clearly represent the relationship of the chemicals being sponsored. In this category, the chemicals are grouped together because of their close structural relationships, their natural occurrence in plants and animals, and their role in cell metabolism, particularly in the tricarboxylic acid cycle (also known as the citric acid or Kreb's cycle). The compounds in this category are either carboxylic acids or their respective salts. Acetic acid has one, fumaric acid and malic acid have two, and citric acid has three carboxylic

acid functional groups. Malic acid and citric acid also have an additional alcohol group. These compounds are naturally occurring in many fruits and vegetables, and are critical for basic metabolic processes.

For the purpose of this screening-level hazard characterization, EPA has subdivided the category members based on structural, functional and toxicological properties as follows: 1) citric acid and salts; 2) malic acid; 3) fumaric acid; and 4) acetic acid and salts. In the revised test plan, the sponsors note that acetic acid and its salts undergo dissociation in aqueous media into the acetate anion ($H_3C_2O_2^-$) and the respective cations (H^+, NH_4^+, Ca^{2+}, Mg^{2+}, Mn^{2+}, K+, Na^+) and that the toxicity of each compound is driven by acetate, with the cations in most cases playing a minor role. EPA generally agrees with this conclusion, but also with the sponsor's point that manganese cation may be a special case (due to toxicity in aquatic organisms and potential neurotoxicity) and so should be treated differently than the other cations in this category. Thus, given that assessments for manganese have been published in well recognized and peer reviewed compendia, its toxicity is not addressed in this screening-level hazard characterization. Detailed information on the hazards of manganese can be found in: U.S. EPA IRIS Profiles (http://www.epa.gov/ncea/iris/subst/0373.htm) ATSDR Toxicological Profiles (http://www.atsdr.cdc.gov/toxprofiles/tp151.html), Concise International Chemical Assessment Document 63, 2004 (CICADS; http://www.inchem.org/documents/cicads/cicads/cicad63.htm#7.2), and WHO Environmental Health Criteria (http://www.inchem.org/documents/ehc/ehc/ehc017.htm). In addition, Citric acid (CAS No. 77-92-9) has been assessed under the OECD SIDS program and the assessment has been published on the UNEP website (http://www.chem.unep.ch/irptc/sids/OECDSIDS/77929.pdf).

Hazard Characterization

The substances in the carboxylic food acids and salts category are solids, with the exception of acetic acid, which exists as a liquid at room temperature. The salts of acetic acid and citric acid have negligible vapor pressure and high water solubilities. Acetic acid has a high vapor pressure, while fumaric, malic, and citric acid have either low or negligible vapor pressure. All of the compounds contained within this category dissociate in water; therefore, volatilization is negligible since ionic substances do not volatilize. All of the substances in this category are expected to possess high mobility in soil. If released to air, acetic acid, malic acid, citric acid, and fumaric acid may exist in the vapor-phase and the rate of atmospheric photooxidation for these substances is considered moderate to negligible. In the atmosphere, the salts would exist in the particulate phase and atmospheric photooxidation would be negligible. Acetic acid, citric acid, and fumaric acid are all readily biodegradable, therefore the persistence potential for the compounds of this category is judged to be low (P1). Based upon estimated bioconcentration factors, the potential for bioaccumulation for each member of this category is judged to be low (B1).

The evaluation of available data on aquatic organisms indicates the potential hazard of the carboxylic food acids and subcategories for fish, aquatic invertebrates, and aquatic plants is low.

Acetic Acid and Salts Subcategory: The acute oral and inhalation toxicity for acetic acid and its salts is low, the oral toxicity for the manganese salt is low, and the dermal toxicity for acetic acid and its salts is moderate. A repeated oral exposure to acetic acid in rats induced irritation at point of contact. Other repeated-dose studies for the subcategory showed either no signs of toxicity or the toxic effects were seen at high doses; in one study, exceeding the limit dose. No reproductive toxicity data are available for this subcategory. No maternal or developmental toxicity was seen in mice, rats or rabbits exposed to high doses. The subcategory members, acetic acid and acetic acid sodium salt did not show potential to induce genetic mutations; data on potential to induce chromosomal aberrations was insufficient; however, acetic acid was not shown to be clastogenic in one assay.

Fumaric Acid Subcategory: The acute oral and dermal toxicity for fumaric acid is low. Repeated exposures to this chemical via the oral route showed signs of toxicity at high doses. No functional reproductive toxicity data are available for fumaric acid; however, a repeated dose toxicity study showed testicular effects at high doses. No developmental toxicity data are available. Fumaric acid did not show potential to induce genetic mutations; data on potential to induce chromosomal aberrations was insufficient.

Malic Acid Subcategory: The acute oral toxicity for malic acid is low. Repeated exposures to this chemical via the oral route showed transient effects in a 2-year study in rats; however, the study was poorly documented and did not provide sufficient details in order to adequately evaluate the toxicity and therefore, the reported effects were not

considered to be treatment-related or clearly adverse. No reproductive toxicity data are available for malic acid. No adverse signs of maternal or developmental toxicity were observed in rats or mice exposed to high doses of malic acid. Malic acid did not show potential to induce genetic mutations; data on potential to induce chromosomal aberrations was insufficient.

Citric Acid and Salts Subcategory: The acute oral toxicity for citric acid and its salts is low. An acute skin irritation study in rabbits exposed to a solution containing citric acid caused erythema and edema. Repeated exposures to high doses in this subcategory via the oral route did not result in any adverse effects. Reproductive and developmental toxicity studies with high doses did not result in any adverse effects. Citric acid and its salts did not show potential to induce genetic mutations; no data are available for chromosomal aberrations.

No data gaps were identified under the HPV Challenge Program.

1. Physical-Chemical Properties and Environmental Fate

Physical-Chemical Properties Characterization

The substances in the carboxylic food acids and salts category are solids, with the exception of acetic acid, which exists as a liquid at room temperature. The salts of acetic acid and citric acid have negligible vapor pressure and high water solubilities. Acetic acid has high vapor pressure, while fumaric, malic, and citric acid have either low or negligible vapor pressure.

Environmental Fate Characterization

All of the compounds in the carboxylic food acids and salts category dissociate in water; therefore, volatilization is negligible since ionic substances do not volatilize. All of the substances in this category are expected to possess high mobility in soil. If released to air, acetic acid, malic acid, citric acid, and fumaric acid may exist in the vapor-phase and the rate of atmospheric photooxidation for these substances is considered moderate to negligible. In the atmosphere, the salts would exist in the particulate phase and atmospheric photooxidation would be negligible. Based upon estimated bioconcentration factors, the potential for bioaccumulation for each member of this category is judged to be low (B1). Acetic acid, citric acid, and fumaric acid are all readily biodegradable, therefore the persistence potential for the carboxylic food acids and salts category is judged to be low (P1).

Table 1a. Physical-Chemical Properties of Carboxylic Food Acids Category[1]

Property	Acetic acid	Acetic acid, ammonium salt	Acetic acid, calcium salt	Acetic acid, magnesium salt	Acetic acid, manganese salt	Acetic acid, potassium salt	Acetic acid, sodium salt	Fumaric acid	Malic acid	Citric acid	Citric acid, sodium salt	Citric acid, tripotassium salt	Citric acid, trisodium salt
CAS No.	64-19-7	631-61-8	62-54-4	142-72-3	638-38-0	127-08-2	127-09-3	110-17-8	6915-15-7	77-92-9	994-36-5	866-84-2	68-04-2
Molecular Weight	60.0	77.1	158.7	142.4	173	98.1	82	116.1	134.1	192.1	214.1	306.4	258.1
Physical State	Liquid	Solid	Solid	Solid	Solid	Solid	Solid	Solid	Solid	Solid	Solid	Solid	Solid
Melting Point	16.7°C (measured)	114°C (measured)	Decomposes above 160°C	80°C (measured)	No data	292°C (measured)	58°C (measured)	290°C (sublimes)	128°C (measured)	153°C (measured)	No data	211°C (estimated)	150°C (measured)
Boiling Point	118.1°C (measured)	No data	Decomposes above 160°C	No data	No data	No data	Decomposes above 400°C	290°C (sublimes)	Decomposes above 140°C	Decomposes	No data	Decomposes at 230°C	Decomposes upon heating
Vapor Pressure	11.4 mm Hg at 20°C (measured)	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	1.5×10^{-4} mm Hg at 25°C (measured)	2.9×10^{-6} mm Hg (estimated)	5.6×10^{-9} mm Hg (estimated)	Negligible	Negligible	Negligible
Dissociation Constant (pK_a)	4.76	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	3.01; 4.46	3.4; 5.5	3.1; 4.8; 6.4	Not applicable	Not applicable	Not applicable
Henry's Law Constant	5.5×10^{-7} atm-m^3/mol (estimated)[2]	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	1×10^{-12} atm-m^3/mol (estimated)[2]	8×10^{-13} atm-m^3/mol (estimated)[2]	8×10^{-18} atm-m^3/mol (estimated)[2]	Negligible	Negligible	Negligible
Water Solubility	50 g/L (measured)	1,480 g/L (measured)	430 g/L (measured)	Very soluble	Soluble	2,530 g/L (measured)	365 g/L (measured)	7 g/L (measured)	592 g/L (measured)	1,330 g/L (measured)	1,000 g/L[2]	63 g/L (estimated)	425 g/L (measured)
Log K_{ow}	-0.17 (measured)	-2.79 (estimated)	-1.38 (estimated)	-1.38 (estimated)	-0.58 (estimated)	-3.72 (estimated)	-3.72 (estimated)	0.33 (measured)	-1.26 (measured)	-1.72 (measured)	-0.28 (estimated)	-0.28 (estimated)	-0.28 (estimated)

[1]American Chemistry Council Acetic Acid and Salts Panel. 2003. Revised Robust Summary and Test Plan for Carboxylic Food Acids and Salts Category. http://www.epa.gov/chemrtk/pubs/summaries/acetisalt/c13102tc.htm.

[2]US EPA. 2008. Estimation Programs Interface Suite™ for Microsoft® Windows, v3.20. United States Environmental Protection Agency, Washington, DC, USA. http://www.epa.gov/opptintr/exposure/pubs/episuite.htm.

Table 1b. Environmental Fate Characteristics of Carboxylic Food Acids Category[1]

Property	Acetic acid	Acetic acid, ammonium salt	Acetic acid, calcium salt	Acetic acid, magnesium salt	Acetic acid, manganese salt	Acetic acid, potassium salt	Acetic acid, sodium salt	Fumaric acid	Malic acid	Citric acid	Citric acid, sodium salt	Citric acid, tripotassium salt	Citric acid, trisodium salt
CAS Reg. No.	64-19-7	631-61-8	62-54-4	142-72-3	638-38-0	127-08-2	127-09-3	110-17-8	6915-15-7	77-92-9	994-36-5	866-84-2	68-04-2
Photodegradation Half-life	**21 days (measured)**	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	**7.3 hours**	**2 days**	2 days[2] (estimated)	Not applicable	Not applicable	Not applicable
Biodegradation	**74% at 14 days[3]** (readily biodegradable)	No Data 74% (RA)	No Data 74% (RA)	No Data 74% (RA)	No Data 74% (RA)	No Data 74% (RA)	**52.6% at 5 days** 100% at 5 days (inherently biodegradable)	**70% at 14 days[3]** (readily biodegradable) **98% at 21 days** (readily biodegradable)	No Data 70 – 77% (RA)	**77% at 14 days[3]** (readily biodegradable) 98% st 2 days (inherently biodegradable)	No Data 77-98% (RA)	No Data 77-98% (RA)	**90% at 30 days** (readily biodegradable)
Hydrolysis	Dissociates, otherwise stable	Dissociates, otherwise stable	Dissociates, otherwise stable	Dissociates, otherwise stable	Dissociates, otherwise stable	Dissociates, otherwise stable	Dissociates otherwise stable	Dissociates, otherwise stable	Dissociates, otherwise stable	Dissociates, otherwise stable	Dissociates, otherwise stable	Dissociates, otherwise stable	Dissociates, otherwise stable
Log K_{oc}	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]	0.8[2]	0[2]	1[2]	1[2]	1[2]	1[2]
Bioconcentration	3.2[2]	3.2[2]	3.2[2]	3.2[2]	3.2[2]	3.2[2]	3.2[2]	3.2[2]	3.2[2]	3.2[2]	3.2[2]	3.2[2]	3.2[2]
Fugacity (Level III Model)		Not applicable to salts	Not applicable to salts	Not applicable to salts	Not applicable to salts	Not applicable to salts	Not applicable to salts				Not applicable to salts	Not applicable to salts	Not applicable to salts
Air	55.1%							1.2%	<0.1%	<0.1%			
Water	23.1%							38.2%	37.6%	37.6%			
Soil	21.8%							60.6%	62.4%	62.4%			
Sediment	<0.1%							<0.1%	<0.1%	<0.1%			
Persistence[5]	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1
Bioaccumulation[5]	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1	B1

[1]American Chemistry Council Acetic Acid and Salts Panel. 2003. Revised Robust Summary and Test Plan for Carboxylic Food Acids and Salts Category. http://www.epa.gov/chemrtk/pubs/summaries/acetisalt/c13102tc.htm.
[2]US EPA. 2008. Estimation Programs Interface Suite™ for Microsoft® Windows, v[3.20 or insert version used]. United States Environmental Protection Agency, Washington, DC, USA. http://www.epa.gov/opptintr/exposure/pubs/episuite.htm.
[3]Chemicals Inspection Testing Institute of Japan. 2002. Biodegradation and Bioconcentration of the Existing Chemical Substances under the Chemical Substances Control Law. http://www.safe.nite.go.jp/data/hazkizon/pk_e_kizon_input_second.home_object.
[4]FR. 1999. Category for Persistent, Bioaccumulative, and Toxic New Chemical Substances. *Federal Register* 64, Number 213 (November 4, 1999) Page 60194–60204.

Conclusion: The substances in the carboxylic food acids and salts category are solids, with the exception of acetic acid, which exists as a liquid at room temperature. The salts of acetic acid and citric acid have negligible vapor pressure and high water solubilities. Acetic acid has a high vapor pressure, while fumaric, malic, and citric acid have either low or negligible vapor pressure. All of the compounds contained within this category dissociate in water; therefore, volatilization is negligible since ionic substances do not volatilize. All of the substances in this category are expected to possess high mobility in soil. If released to air, acetic acid, malic acid, citric acid, and fumaric acid may exist in the vapor-phase and the rate of atmospheric photooxidation for these substances is considered moderate to negligible. In the atmosphere, the salts would exist in the particulate phase and atmospheric photooxidation would be negligible. Acetic acid, citric acid, and fumaric acid are all readily biodegradable, therefore the persistence potential for the compounds of this category is judged to be low (P1). Based upon estimated bioconcentration factors, the potential for bioaccumulation for each member of this category is judged to be low (B1).

2. Environmental Effects – Aquatic Toxicity

A summary of aquatic toxicity data submitted for SIDS endpoints is provided in Table 2. The table also indicates where data for tested category members are read-across (RA) to untested members of the category.

Acute Toxicity to Fish

Acetic Acid and Salts Subcategory

Acetic acid (CAS No. 64-17-9)
Mosquito fish (*Gambusia affinis*) were exposed to acetic acid at 100, 180, 320, 560 and 1000 mg/L (nominal) under static conditions for 96 hours..
96-h LC_{50} = 251 mg/L

Acetic acid, ammonium salt (CAS No. 631-61-8)
Fathead minnows (*Pimephales promelas*) were exposed to acetic acid, ammonium salt (nominal concentrations; not provided in robust summary) under static conditions for 96 hours.
96-h LC_{50} = 79 – 88 mg/L

Acetic acid, sodium salt (CAS No.127-09-3)
Zebrafish (*Brachydanio rerio*) were exposed to acetic acid, sodium salt at up to 100 mg/L (measured concentrations; not provided in robust summary) under semi-static conditions for 96 hours. No mortality wad observed at the highest concentration tested.
96-h LC_{50} > 100 mg/L

Acetic acid, potassium salt (CAS No. 127-08-2)
Rainbow trout (*Salmo gairdneri*) were exposed to acetic acid, potassium salt (as a commercial formulation) at unspecified nominal concentrations under semi-static conditions for 96 hours.
96-h LC_{50} = 6100 mg/L

Toxicity to Aquatic Invertebrates

Acetic Acid and Salts Subcategory

Acetic acid (CAS No. 64-17-9)
Daphnia magna were exposed to acetic acid (nominal concentrations; not provided in robust summary) under static conditions for 48 hours. The test solutions were apparently un-neutralized.
48-h EC_{50} = 65 mg/L

Acetic acid, Sodium Salt (CAS No.127-09-3)
D. magna were exposed to acetic acid, sodium salt (nominal concentrations; not provided in robust summary) under static conditions for 48 hours.
48-h EC_{50} > 1000 mg/L

Fumaric Acid Subcategory

Fumaric acid (CAS No. 110-17-8)
D. magna were exposed to fumaric acid (nominal concentrations; not provided in robust summary) under static conditions for 48 hours.
48-h EC_{50} = 212 mg/L

Malic Acid Subcategory

Malic acid (CAS No. 6915-15-7)
D. magna were exposed to malic acid at 100, 180, 320, 560, and 1000 mg/L under static conditions for 48 hours.
48-h EC_{50} = 240 mg/L

Toxicity to Aquatic Plants

Fumaric acid subcategory

Fumaric acid (CAS No. 110-17-8)
Green algae (*Scenedesmus subcapitata*) were exposed to fumaric acid (nominal concentrations; not provided in robust summary) under static conditions for 72 hours.
72-h E_rC_{50} (growth) = 41 mg/L

Citric Acid and Salts Subcategory

Citric acid, trisodium salt (CAS No. 68-04-2)
Green algae (*Chlorella vulgaris*) were exposed to citric acid, trisodium salt (nominal concentrations; not provided in robust summary) under static conditions for 96 hours.
96-h E_bC_{50} (biomass) > 18000 – 32000 mg/L

Conclusion: The evaluation of available data on aquatic organisms indicates the potential hazard of the carboxylic food acids and subcategories for fish, aquatic invertebrates, and aquatic plants is low.

Table 2. Summary of Environmental Effects – Aquatic Toxicity Data

Chemical	Fish 96-h LC_{50} (mg/L)	Aquatic Invertebrates 48-h EC_{50} (mg/L)	Aquatic Plants 72-h EC_{50} (mg/L)
Acetic acid (64-19-7)	**251 (m)**	**65 (m)**	No Data 41 (RA)
Acetic acid, ammonium salt (631-61-8)	**79 – 88 (m)**	No Data 65 (RA)	No Data 41 (RA)
Acetic acid, calcium salt (62-54-4)	No Data 251 (RA)	No Data 65 (RA)	No Data 41 (RA)
Acetic acid magnesium salt (142-72-3)	No Data 251 (RA)	No Data 65 (RA)	No Data 41 (RA)
Acetic acid, sodium salt (127-09-3)	**> 100 (m)**	**>1000 (m)**	No Data 41 (RA)
Acetic acid, potassium salt (127-08-2)	**6100 (m)**	No Data 65 (RA)	No Data 41 (RA)
Fumaric acid (110-17-8)	No Data 1516 (RA)	**212 (m)**	**41 (m)**
Malic acid (6915-15-7)	No Data 1516 (RA)	**240 (m)**	No Data 640 (RA)
Citric acid[1] (77-92-9)	**1516 (m)**	**1535 (m)**	**640 (m)**
Citric acid, sodium salt (99-36-5)	No Data 1516 (RA)	No Data 1535 (RA)	No Data >18,000 – 32,000 (RA)
Citric acid, tripotassium salt (866-84-2)	No Data 1516 (RA)	No Data 1535 (RA)	No Data >18,000 – 32,000 (RA)
Citric acid, trisodium salt (68-04-2)	No Data 1516 (RA)	No Data 1535 (RA)	**>18,000 – 32,000 (96-h, m)**

(m) = measured data (i.e. derived from testing); (e) = estimated data (i.e. derived from modeling); (RA) = read across

[1]No citric acid data were submitted; data were located by EPA from the OECD HPV Programme SIAR at: http://www.chem.unep.ch/irptc/sids/OECD SIDS/77929.pdf.

3. Human Health Effects

A summary of health effects data submitted for SIDS endpoints is provided in Table 3. The table also indicates where data for tested category members are read-across (RA) to untested members of the category.

Acute Oral Toxicity

Acetic Acid and Salts Subcategory
The oral LD_{50} values for the members of this category range between 3250-8610 mg/kg-bw (rats) and 4960 mg/kg-bw (mouse), indicating low acute toxicity via the oral route of exposure.

Fumaric Acid Subcategory (CAS No. 110-17-8)

The oral LD_{50} values for fumaric acid range from 9300 to 10700 mg/kg-bw (rats) indicating low acute toxicity via the oral route of exposure.

Malic Acid Subcategory (CAS No. 6915-15-7)

The oral LD_{50} values for malic acid range from 1600 to 3200 mg/kg-bw (mice, rats) indicating low acute toxicity via the oral route of exposure.

Citric Acid and Salts Subcategory

The oral LD_{50} values for the members of this category range from 5790 to 7100 mg/kg-bw (mice) and 11700 mg/kg-bw (rats) indicating low acute toxicity via the oral route of exposure.

Acute Dermal Toxicity

Acetic Acid and Salts Subcategory

The dermal LD_{50} value in rabbits for the members of this category is 1060 mg/kg-bw indicating moderate acute toxicity via the dermal route of exposure.
LD_{50} = 1060 mg/kg-bw

Fumaric Acid Subcategory (CAS No. 110-17-8)

The dermal LD_{50} value in rabbits for the members of this category is >20000 mg/kg-bw indicating low acute toxicity via the dermal route of exposure.
LD_{50} >20000 mg/kg-bw

Citric Acid and Salts Subcategory

A 4-hour skin irritation study in rabbits exposed to a solution containing 60% citric acid caused erythema and edema. This study did not assess a lethal dose value.
LD_{50} is not provided.

Acute Inhalation Toxicity

Acetic Acid and Salts Subcategory

Acetic acid (CAS No. 64-19-7)
4-h LC_{50} =11.4 mg/L
1-h LC_{50} = 5620 ppm (~ 4960 mg/kg-bw)

Repeated-Dose Toxicity

Acetic Acid and Salts Subcategory

Acetic acid (CAS No. 64-17-9)
1) Nine male rats were exposed to single dose of 0.5 ml of a 3% aqueous solution of acetic acid (within the range of vinegar), or approximately 60 mg/kg-bw via gavage 3 times per week for 8 months. All rats showed hyperplasia of the esophagus and forestomach, indicative of irritation at point of contact. Prolonged administration of acetic acid alone did not induce tumors.
LOAEL = 60 mg/kg-bw/day (based on hyperplasia of the esophagus and forestomach, indicative of irritation at point of contact, only dose tested)
NOAEL= Not established (only one dose tested)

2) In a repeated-dose toxicity study, groups of 10 rats (species and sex not stated) and 10 mice (species and sex not stated) were exposed to 11-35 ppm (~0.03 – 0.09 mg/L/day) acetic acid via inhalation continuously for up to 35 days. At 15 ppm (~0.04 mg/L/day) for 22 days or more, decreased activity, behavioral changes, and reductions in work capacity were reported. At 23-31 ppm (~0.060 – 0.08 mg /L/day) for 17-35 days, decreased growth, increased spleen weight, increased iron storage in the spleen, signs of kidney damage and increased kidney weights were reported. No other effects were reported and no further details were provided as to whether the effects were observed in a dose-response manner, whether they were statistically significant, or whether the organ weight changes were relative or absolute. Since this study was poorly documented and did not provide sufficient detail to evaluate the toxicity of acetic acid following repeated-exposure, the reported effects cannot be considered as being clearly adverse.
NOAEL ~ 0.09 mg/L/day (based on no evidence of adverse effects at any dose tested)

Acetic acid, sodium salt (CAS No.127-09-3)
(1) Two groups of six Long-Evans rats/group were administered sodium acetate via drinking water (50 and 500 ppm ~0.005 and 0.05 mg/kg-bw/day) in an 8-month repeated-dose toxicity drinking water study of lead acetate. No marked effects on survival, reinforcement behavior or body weight gain was observed. No separate untreated controls are available for comparison.
NOAEL ~0.05 mg/kg-bw/day (based on no effects observed at the highest dose tested)

(2) In a 4 week repeated-dose toxicity study, Wistar rats (13 males/dose) were exposed to 3.58% (approximately 3.6 g/kg-bw/day) acetic acid, sodium salt ad libitum in the diet (a 25% protein, vitamin B_{12}-deficient ration). The growth and survival of these rats was normal. There were no data on control group use.
NOAEL = 3.6 g/kg-bw/day (based on no effects observed at the only dose tested)

(3) In a 157-day repeated-dose toxicity study, 8 Wistar male rats/dose were exposed to 100 ppm (~0.01 mg/kg-bw/day) acetic acid, sodium salt in their drinking water continuously beginning at 31 days of age for 112 days. This group of rats served as a control group in a lead exposure study. Training in mazes began on day 112 and lasted until day 157. No mortality or cognitive impairment was observed. No separate untreated controls are available for comparison.
NOAEL = ~0.01mg/kg-bw/day (based on no effects observed at the only dose tested)

(4) In a 3-month repeated-dose toxicity study, rats (species and sex not stated) were exposed to 21 mg/kg-bw/day acetic acid, sodium salt orally in their daily diet. There were no data on control group use. Indications of altered thyroid function and decreased growth were reported. No other effects were reported and no more details were provided. Therefore, this study was considered to be of limited use in evaluating the toxicity of acetic acid, sodium salt and the reported effects cannot be considered as being clearly adverse.
NOAEL = 21 mg/kg-bw/day (based on no evidence of clearly adverse effects at only dose tested)

Fumaric Acid Subcategory

Fumaric acid (CAS No. 110-17-8)
In a 2-year oral repeated-dose toxicity study, groups of 12 male and 12 female rats were fed diets containing 0, 0.1, 0.5, 0.8 or 1.2% of fumaric acid (approximately 50, 250, 400 or 600 mg kg-bw/day). A second set of animals consisting of 12 male rats were fed diets containing 0, 0.5, 1 or 1.5% of fumaric acid (approximately 250, 500 or 750 mg kg-bw/day) for 2 years. The only effects reported were seen in male rats at the high dose in the second set of treated animals, consisting of slight increases in mortality and increased incidence of testes degeneration at 1.5% fumaric acid (approx. 750 mg/kg-bw/day). Two rats receiving 1 or 0.5% had stomach inflammation. Statistical significance was not reported.
LOAEL = 750 mg/kg-bw/day (based on slight increases in mortality and increased incidence of testes degeneration at the highest dose tested)
NOAEL = 600 mg/kg-bw/day

Malic Acid Subcategory

Malic acid (CAS No. 6915-15-7)
In a 2-year repeated-dose toxicity study, rats (species, number of animals or number /sex/dose not stated) were treated with 0, 0.05, 0.5 or 5% (equivalent to 2-200 mg/kg-bw/day*) malic acid daily in the diet. No tissue abnormalities or changes in the blood or urine were observed. The only effects reported were transient changes in organ weights, decreases in body weight, and hunched appearance in rats receiving 200 mg/kg-bw/day observed during the first year of treatment only. None of these effects were reported as having occurred in the second year of exposure. The apparent organ weight changes were observed in the absence of tissue histopatholgy or any reported changes in clinical chemistry parameters. No further details were provided as to which organs were affected, whether the changes in organ weights were increases or decreases, relative or absolute, or whether any of the effects were observed in a dose-response manner or statistically significant. Therefore, the reported effects are not considered to be treatment-related or clearly adverse.
*The British Industrial Biological Research Association (BIBRA) cites a dose range of 25 – 2,500 mg/kg-bw/day instead.
NOAEL = 200 mg/kg-bw/day (the highest dose tested, based on no evidence of clearly adverse effects at any dose level)

Citric Acid and Salts Subcategory

Citric acid (CAS No.77-92-9)
(1) In a 150-day repeated-dose toxicity study, 60 male New Zealand White rabbits/concentration were fed diets containing 7.7% (~5% free acid; approximately 1500 mg/kg-bw/day) citric acid, sodium salt. The control group received ground Rockland Rabbit Diet. The diets and water were provided ad libitum for 150 days. Food intake and body weights were recorded at weekly intervals. No significant gross or histopathological changes or difference in growth or survival were found.
NOAEL ~1500 mg/kg-bw/day (based on no effects observed at the only dose tested)

(2) In a 6-week repeated-dose toxicity study, 10 Sprague-Dawley male rats/concentration were fed diet containing 0, 0.2, 2.4 and 4.8% (approximately 200, 2400 and 4800 mg/kg-bw/day) citric acid. No behavioral abnormalities, effects on body weight gain or mortality were observed. No specific histopathological abnormalities were detected. Some minor biochemical changes were observed at the highest dose, but no other details were provided as to what these changes were; therefore, the biological relevance, if any, is unclear.
NOAEL = 4800 mg/kg-bw/day (based on no effects observed at the highest dose tested)

Citric acid, sodium salt (CAS No.994-36-5)
(1) In a 1-year oral repeated-dose toxicity study, two successive generations of rats were exposed to 0.1% citric acid, sodium salt (approximately 50 mg/kg-bw/day) in the diet. No adverse effects were reported. A limited number of tissues were examined microscopically.
NOAEL ~ 50 mg/kg-bw/day (based on no effects observed at the only dose tested)

(2) In a 32-week oral repeated-dose toxicity study, 20 male rats (species not stated) were treated with 5% citric acid, sodium salt (about 2,500 mg/kg-bw/day) in the diet. No overt signs of toxicity were observed.
NOAEL = 2500 mg/kg-bw/day (based on no effects observed at the only dose tested)

Reproductive Toxicity

Citric Acid and Salts Subcategory

Citric acid (CAS No.77-92-9)
(1) In a fertility study, rats (species, number of animals not stated) were exposed to 1.2% citric acid (approximately 600 mg/kg-bw/day) in their daily diet; no information on the control group was provided. Exposure was reported as beginning 29 weeks prior to mating, and continuing for a few months after mating. No information is provided other than a statement that no reproductive toxic effects were detected.
NOAEL (reproductive toxicity) = 600 mg/kg-bw/day (based on no effects observed at the only dose tested)

(2) In a one-generation oral reproductive toxicity study, female rats (species and number not specified) and mice (species and number not stated) were treated with 5% citric acid (about 2500 mg/kg-bw/day) in their daily diet before, during, and after mating. Limited information on study results was provided and it was unclear if results reported were in adults/offspring, rats/mice. Decreases in body weight gain and reduced survival time (statistical significance unknown) in mice was reported. No other effects in mice were noted. Numbers of pregnancies, litter size and postnatal survival were reported as unaffected (species not specified). Effects, if any, in rats were not specifically stated.
LOAEL (mice) = 2500 mg/kg-bw/day (based on decreased body weight gain and reduced survival times in mice)
NOAEL (mice) = Not established (only one dose tested)

Citric acid, sodium salt (CAS No. 994-36-5)
In a fertility study, rats (species and number of animals not specified) were exposed to 0.1% citric acid, sodium salt (approximately 50 mg/kg-bw/day) in their daily diet; no information on the control group was provided. Exposure was reported as beginning 29 weeks prior to mating, and continuing for a few months after mating. No information is provided other than a statement that no reproductive toxic effects were detected.
NOAEL ~50 mg/kg-bw/day (based on no effects observed at the only dose tested)

Developmental Toxicity

Acetic Acid and Salts Subcategory

Acetic acid (CAS No. 64-17-9)
A series of developmental toxicity studies were conducted in CD-1 mice, Wistar rats, and Dutch-belted rabbits. Pregnant females (number unspecified) were administered 0, 16, 74, 345 and 1600 mg/kg-bw/day acetic acid (apple cider vinegar, table strength 5%) via oral gavage on gestation day 6 – 16 for rats and mice, and 6 – 19 for rabbits. The numbers of corpora lutea, implantation/resorptions sites, and live/dead fetuses were recorded. Dams were examined internally and externally. None of the parameters were affected by treatment at any dose level.
NOAEL (maternal and developmental toxicity) (rats, mice, and rabbits) = 1600 mg/kg-bw/day (based on no effects observed at the highest dose tested)

Acetic acid, sodium salt (CAS No.127-09-3)
A Chernoff/Kavlock teratology screening assay administered 30 pregnant CD-1 mice a single dose level of 1000 mg/kg-bw/day acetic acid, sodium salt by gavage on gestation days 8 – 12. No effects on the dams or fetuses were reported.
NOAEL (maternal and developmental toxicity) = 1000 mg/kg-bw/day (based on no effects observed at the only dose tested)

Malic Acid Subcategory

Malic acid (CAS No. 6915-15-7)
A developmental toxicity study in pregnant rats and mice (species and number of animals not specified) administered 350 and 266 mg/kg-bw/day DL-malic acid, respectively, via gavage on gestation days 6 – 15. No maternal or fetal effects were reported.
NOAEL (maternal and developmental toxicity) = 350 and 266 mg/kg-bw/day (rats and mice, respectively; based on no observed effects at the only dose tested)

Citric Acid and Salts Subcategory

Citric acid (CAS No.77-92-9)
A developmental toxicity study in pregnant rats (species and number of animals not specified) a single dose level of 241 mg/kg-bw/day citric acid by gavage on gestation days 6 – 15. No effects on implantations, or on maternal or fetal survival were reported.
NOAEL (maternal and developmental toxicity) = 241 mg/kg-bw/day (based on no observed effects at the only dose tested)

Genetic Toxicity – Gene Mutation

In vitro
Acetic Acid and Salts Subcategory

Acetic acid (CAS No. 64-17-9)
In a bacterial reverse mutation assay using *Salmonella typhimurium* (TA98, TA100, TA1535, TA97 and TA1537) in the presence and absence of metabolic activation and up to 10000 µg/plate, acetic acid was not mutagenic. Two other Ames assays also showed negative results.
Acetic acid was not mutagenic in these assays.

Acetic acid, sodium salt (CAS No.127-09-3)
In a bacterial reverse mutation assay using *S. typhimurium* (TA92, TA94, TA98, TA100 and TA1537) in the presence of metabolic activation and up to 40 mg/plate, acetic acid, sodium salt was not mutagenic. One other Ames assay also showed negative results in the presence and absence of metabolic activation.
Acetic acid, sodium salt was not mutagenic in these assays.

Fumaric Acid Subcategory

Fumaric acid (CAS No. 110-17-8)
In a bacterial reverse mutation assay using *S. typhimurium* (TA98, TA100, TA1535, TA97 and TA1537) in the absence of metabolic activation and concentrations up to 1000 µg/plate, fumaric acid was not mutagenic.
Fumaric acid was not mutagenic in this assay.

Malic Acid Subcategory

Malic acid (CAS No. 6915-15-7)
In a bacterial reverse mutation assay using *S. typhimurium* (TA97, TA98, TA100 and TA104) in the presence and absence of metabolic activation and up to 2000 µg/plate, malic acid was not mutagenic.
Malic acid was not mutagenic in this assay.

Citric and Salts Subcategory

Citric acid (CAS No.77-92-9)
In a bacterial reverse mutation assays using *S. typhimurium* (TA97, TA98, TA100 and TA104) in the presence and absence of metabolic activation and up to 2000 µg/plate, citric acid was not mutagenic.
Citric acid was not mutagenic in this assay.

Citric acid, sodium salt (CAS No.994-36-5)
Citric acid, sodium salt was tested in an assay using *Saccharomyces cerevisiae* cells in the presence and absence of metabolic activation; however, insufficient information was provided in the robust summary of this study to adequately evaluate the results.

Genetic Toxicity – Chromosomal Aberrations

In vitro
Acetic Acid and Salts Subcategory

Acetic acid (CAS No. 64-17-9)
The robust summary of this study states that acetic acid was not clastogenic in an *in vitro* assay using Chinese hamster ovary K1 cells at concentrations $\leq$ 16 mM; however, insufficient information was provided in the robust summary of this study to adequately evaluate the results.

Acetic acid, Sodium Salt (CAS No.127-09-3)
The robust summary of this study states that acetic acid, sodium salt was assayed in an *in vitro* assay using Chinese hamster fibroblast cells in the absence of metabolic activation at doses up to 1 mg/mL; however, insufficient information was provided in the robust summary to adequately evaluate this study.

Fumaric Acid Subcategory

Fumaric acid (CAS No. 110-17-8)
The robust summary of this study states that fumaric acid was assayed in an *in vitro* assay using Chinese hamster fibroblast cells in the absence of metabolic activation at doses up to 1 mg/mL; however, insufficient information was provided in the robust summary to adequately evaluate this study.

Malic Acid Subcategory

Malic acid (CAS No. 6915-15-7)
The robust summary of this study states that malic acid was assayed in an *in vitro* assay using Chinese hamster fibroblast cells in the absence of metabolic activation at doses up to 1 mg/mL; however, insufficient information was provided in the robust summary to adequately evaluate the results

Genetic Toxicity – Other (DNA effects)

Acetic Acid and Salts Subcategory

In vivo
Acetic acid, sodium salt (CAS No.127-09-3)
In an *in vivo* testicular DNA-synthesis inhibition test, male mice were exposed to acetic acid, sodium salt via gavage to 200, 500 and 1000 mg/kg. No inhibitory effect on DNA-replication was detected.
Acetic acid, sodium salt did not inhibit DNA replication in this assay.

Citric Acid and Salts Subcategory

Citric acid (CAS No.77-92-9)
In a Dominant Lethal assay using male/female rats dosed at 3 g/kg for 5 days, citric acid did not induced germ cell genotoxicity. No other details on the test protocol or study results were provided.
Citric acid did not induce germ cell genotoxicity in this assay.

Conclusion:

Acetic Acid and Salts Subcategory: The acute oral and inhalation toxicity for acetic acid and its salts is low, the oral toxicity for the manganese salt is low, and the dermal toxicity for acetic acid and its salts is moderate. A repeated

oral exposure to acetic acid in rats induced irritation at point of contact. Other repeated-dose studies for the subcategory showed either no signs of toxicity or the toxic effects were seen at high doses; in one study, exceeding the limit dose. No reproductive toxicity data are available for this subcategory. No maternal or developmental toxicity was seen in mice, rats or rabbits exposed to high doses. The subcategory members, acetic acid and acetic acid sodium salt did not show potential to induce genetic mutations; data on potential to induce chromosomal aberrations was insufficient; however, acetic acid was not shown to be clastogenic in one assay.

Fumaric Acid Subcategory: The acute oral and dermal toxicity for fumaric acid is low. Repeated exposures to this chemical via the oral route showed signs of toxicity at high doses. No functional reproductive toxicity data are available for fumaric acid; however, a repeated dose toxicity study showed testicular effects at high doses. No developmental toxicity data are available. Fumaric acid did not show potential to induce genetic mutations; data on potential to induce chromosomal aberrations was insufficient.

Malic Acid Subcategory: The acute oral toxicity for malic acid is low. Repeated exposures to this chemical via the oral route showed transient effects in a 2-year study in rats; however, the study was poorly documented and did not provide sufficient details in order to adequately evaluate the toxicity and therefore, the reported effects were not considered to be treatment-related or clearly adverse. No reproductive toxicity data are available for malic acid. No adverse signs of maternal or developmental toxicity were observed in rats or mice exposed to high doses of malic acid. Malic acid did not show potential to induce genetic mutations; data on potential to induce chromosomal aberrations was insufficient.

Citric Acid and Salts Subcategory: The acute oral toxicity for citric acid and its salts is low. An acute skin irritation study in rabbits exposed to a solution containing citric acid caused erythema and edema. Repeated exposures to high doses in this subcategory via the oral route did not result in any adverse effects. Reproductive and developmental toxicity studies with high doses did not result in any adverse effects. Citric acid and its salts did not show potential to induce genetic mutations; no data are available for chromosomal aberrations.

Table 3. Summary of Health Effects Data

Chemical	Acute Oral Toxicity LD_{50} (mg/kg-bw)	Acute Dermal Toxicity LD_{50} (mg/kg-bw)	Acute Inhalation Toxicity LC_{50} (mg/L)	Repeated-Dose Toxicity NOAEL/LOAEL (mg/kg-bw/day)	Reproductive Toxicity NOAEL/LOAEL (mg/kg-bw/day)	Developmental Toxicity NOAEL/LOAEL (mg/kg-bw/day)	Genetic Toxicity – Gene Mutation *In vitro*	Genetic Toxicity – Chromosomal Aberrations *In vitro*	Genetic Toxicity – Other (DNA effects *In vivo*)
Acetic acid (64-19-7)	**3250-8610**	**1060**	**11.4 (4 h)**	**LOAEL (oral) = 60 (8 mo.) NOAEL = Not established** **NOAEL(inhalation) =35ppm (35-day) (~0.09mg/L/day)**	No Data NOAEL (systemic & reproductive tox.) = 600 LOAEL (reproductive tox.) = 2500 NOAEL = Not established (RA)	**NOAEL (mat/dev) = 1600**	**Negative**	**Uncertain Negative**	**–***
Acetic acid, ammonium salt (631-61-8)	No Data 3250-8610 (RA)	No Data 1060 (RA)	No Data 11.4 (4 h) (RA)	No data LOAEL (oral) = 60 (8 mo.) NOAEL = Not established NOAEL(inhalation) = 35 ppm (35 day) (~0.09 mg/L/day) (RA)	No Data NOAEL (systemic & reproductive tox.) = 600 LOAEL (reproductive tox.) = 2500 NOAEL = Not established (RA)	No data NOAEL (mat/dev) = 1000 (RA)	No Data Negative (RA)	No Data Negative (RA)	–*
Acetic acid, calcium salt (62-54-4)	**4280**	No Data 1060 (RA)	No Data 11.4 (4 h) (RA)	No data LOAEL (oral) = 60 (8 mo.) NOAEL = Not established NOAEL(inhalation) = 35 ppm (35-day) (~0.09 mg/L/day) (RA)	No Data NOAEL (systemic & reproductive tox.) = 600 LOAEL (reproductive tox.) = 2500 NOAEL = Not established (RA)	No data NOAEL (mat/dev) = 1000 (RA)	No Data Negative (RA)	No Data Negative (RA)	–*

Table 3. Summary of Health Effects Data

Chemical	Acute Oral Toxicity LD_{50} (mg/kg-bw)	Acute Dermal Toxicity LD_{50} (mg/kg-bw)	Acute Inhalation Toxicity LC_{50} (mg/L)	Repeated-Dose Toxicity NOAEL/LOAEL (mg/kg-bw/day)	Reproductive Toxicity NOAEL/LOAEL (mg/kg-bw/day)	Developmental Toxicity NOAEL/LOAEL (mg/kg-bw/day)	Genetic Toxicity – Gene Mutation *In vitro*	Genetic Toxicity – Chromosomal Aberrations *In vitro*	Genetic Toxicity – Other (DNA effects *In vivo*)
Acetic acid magnesium salt (142-72-3)	**8610**	No Data 1060 (RA)	No Data 11.4 (4 h) (RA)	No data LOAEL (oral) = 60 (8 mo) NOAEL = Not established NOAEL(inhalation) = 35 ppm (35-day) (~0.09 mg/L/day) (RA)	No Data NOAEL (systemic & reproductive tox.) = 600 LOAEL (reproductive tox.) = 2500 NOAEL = Not established (RA)	No data NOAEL (mat/dev) = 1000 (RA)	No Data Negative (RA)	No Data Negative (RA)	–*
Acetic acid, sodium salt (127-09-3)	**3530**	No Data 1060 (RA)	No Data 11.4 (4 h) (RA)	**NOAEL = 0.05 (8 mo)** **NOAEL = 3600 (4-wk)** **NOAEL = 0.01 (157-d)**	No Data NOAEL (systemic & reproductive tox.) = 600 LOAEL (reproductivel tox.) = 2500 NOAEL = not established (RA)	**NOAEL (mat/dev) = 1000**	**Negative**	**Uncertain Negative (RA)**	**Negative**
Acetic acid, potassium salt (127-08-2)	**3250**	No Data 1060 (RA)	No Data 11.4 (4 h) (RA)	No data LOAEL (oral) = 60 (8 mo) NOAEL = Not established NOAEL(inhalation) = 35 ppm (35-day) (~0.09 mg/L/day) (RA)	No Data NOAEL (systemic & reproductive tox.) = 600 LOAEL (reproductive tox.) = 2500 NOAEL = not established (RA)	No data NOAEL (mat/dev) = 1000 (RA)	No Data Negative (RA)	No Data Negative (RA)	–*

Table 3. Summary of Health Effects Data

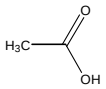
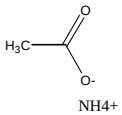
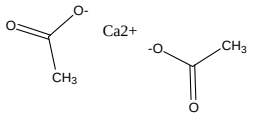
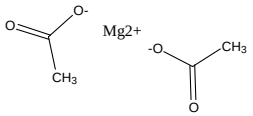
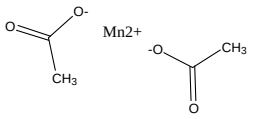
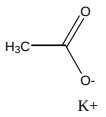
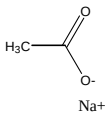
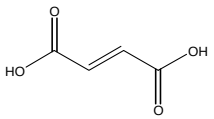
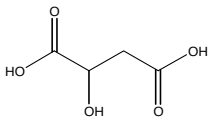
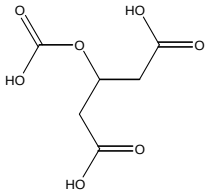
Chemical	Acute Oral Toxicity LD_{50} (mg/kg-bw)	Acute Dermal Toxicity LD_{50} (mg/kg-bw)	Acute Inhalation Toxicity LC_{50} (mg/L)	Repeated-Dose Toxicity NOAEL/LOAEL (mg/kg-bw/day)	Reproductive Toxicity NOAEL/LOAEL (mg/kg-bw/day)	Developmental Toxicity NOAEL/LOAEL (mg/kg-bw/day)	Genetic Toxicity – Gene Mutation *In vitro*	Genetic Toxicity – Chromosomal Aberrations *In vitro*	Genetic Toxicity – Other (DNA effects *In vivo*)
Fumaric acid (110-17-8)	**9300**	**>20,000**	No Data 11.4 (4 h) (RA)	**LOAEL = 750 NOAEL 600 (2-yr)**	No Data NOAEL (systemic & reproductive tox.) = 600 LOAEL (reproductive tox.) = 2500 NOAEL = not established (RA)	No Data (mat/dev) = 350 for rats, 266 for mice (RA)	**Negative**	**Uncertain Negative (RA)**	**–***
Malic acid (6915-15-7)	**1600 – 3200**	No Data >20,000 (RA)	No Data 11.4 (4 h) (RA)	**NOAEL = 200 (2 yr)**	No Data NOAEL (systemic & reproductive tox.) = 600 LOAEL (reproductive tox.) = 2500 NOAEL = not established (RA)	**NOAEL (mat/dev) = 350 for rats, 266 for mice**	**Negative**	**Uncertain Negative (RA)**	**–***
Citric acid (77-92-9)	**5790 - 11,700**	**Erythema and edema** No Data RA >20,000	No Data 11.4 (4 h) (RA)	**NOAEL = 1500 (150-d)** **NOAEL = 4800 (6-wk)**	**NOAEL (systemic & reproductive tox.) = 600** **LOAEL (reproductive tox.) = 2500 NOAEL = not established**	**NOAEL (mat/dev) = 241**	**Negative**	No Data Negative (RA)	**Negative**
Citric acid, sodium salt (994-36-5)	**7100**	No Data >20,000 (RA)	No Data 11.4 (4 h) (RA)	**NOAEL= 0.1% (~50 mg/kg-bw/day) (1-yr)** **NOAEL = 2500 (32-wk)**	**NOAEL (systemic & reproductive tox.) = 0.1% (~50 mg/kg-bw/day)**	No data NOAEL (mat/dev) = 241 (RA)	**Negative**	No Data Negative (RA)	**–***

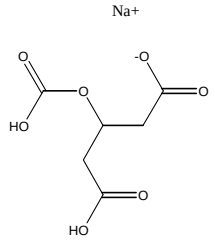
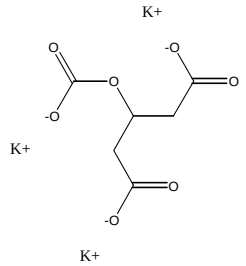
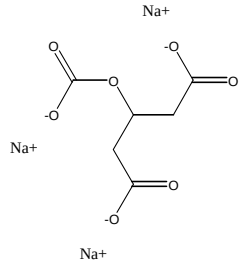
Table 3. Summary of Health Effects Data

Chemical	Acute Oral Toxicity LD_{50} (mg/kg-bw)	Acute Dermal Toxicity LD_{50} (mg/kg-bw)	Acute Inhalation Toxicity LC_{50} (mg/L)	Repeated-Dose Toxicity NOAEL/LOAEL (mg/kg-bw/day)	Reproductive Toxicity NOAEL/LOAEL (mg/kg-bw/day)	Developmental Toxicity NOAEL/LOAEL (mg/kg-bw/day)	Genetic Toxicity – Gene Mutation *In vitro*	Genetic Toxicity – Chromosomal Aberrations *In vitro*	Genetic Toxicity – Other (DNA effects *In vivo*)
Citric acid, tripotassium salt (866-84-2)	No Data 5790 - 11,700 (RA)	No Data >20,000 (RA)	No Data 11.4 (4 h) (RA)	No data NOAEL= 0.1% (~50 mg/kg-bw/day) (1-yr) NOAEL = 2500 (32-wk) (RA)	No data NOAEL (systemic & reproductive tox.) = 0.1% (~50 mg/kg-bw/day) (RA)	No data NOAEL (mat/dev) = 241 (RA)	No Data Negative (RA)	No Data Negative (RA)	–*
Citric acid, trisodium salt (68-04-2)	No Data 5790 - 11,700 (RA)	No Data >20,000 (RA)	No Data 11.4 (4 h) (RA)	No data NOAEL = 0.1% (~50mg/kg-bw/day) (1-yr) NOAEL = 2500 (32-wk) (RA)	No data NOAEL (systemic & reproductive tox.) = 0.1% (~50 mg/kg-bw/day) (RA)	No data NOAEL (mat/dev) = 241 (RA)	No Data Negative (RA)	No Data Negative (RA)	–*

Measured data in bold text; (RA) = read across; — indicates endpoint was not addressed for this chemical; -* indicates endpoint not part of base SIDS; mat/dev = maternal/developmental.

APPENDIX

Carboxylic Food Acids Category		
Chemical Name	**CAS No.**	**Structures**
SPONSORED CHEMICALS		
Acetic acid 9th CI: Acetic acid	64-19-7	
Acetic acid, ammonium salt 9th CI: Acetic acid, ammonium salt	631-61-8	
Acetic acid, calcium salt 9th CI: Acetic acid, calcium salt	62-54-4	
Acetic acid, magnesium salt 9th CI: Acetic acid, magnesium salt	142-72-3	
Acetic acid, manganese salt 9th CI: Acetic acid, manganese(2+) salt	638-38-0	
Acetic acid, potassium salt 9th CI: Acetic acid, potassium salt	127-08-2	
Acetic acid, sodium salt 9th CI: Acetic acid, sodium salt	127-09-3	
Fumaric acid 9th CI: 2-Butenedioic acid (2E)-	110-17-8	
Malic acid 9th CI: Butanedioic acid, hydroxy-	6915-15-7	
Citric acid 9th CI: 1,2,3-Propanetricarboxylic acid, 2-hydroxy-	77-92-9	

Carboxylic Food Acids Category		
Chemical Name	**CAS No.**	**Structures**
SPONSORED CHEMICALS		
Citric acid, sodium salt 9th CI: 1,2,3-Propanetricarboxylic acid, 2-hydroxy-, sodium salt	994-36-5	
Citric acid, tripotassium salt 9th CI: 1,2,3-Propanetricarboxylic acid, 2-hydroxy-, trisodium salt	866-84-2	
Citric acid, trisodium salt	68-04-2	

Screening Level Exposure Characterization for HPV Challenge Chemical

Carboxylic Food Acids and Salts Category

August 2008

Prepared by

Exposure Assessment Branch
Chemical Engineering Branch
Economics, Exposure, and Technology Division
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Screening Level Exposure Characterization
Carboxylic Food Acids and Salts Category

Non-CBI Executive Summary

The 13 carboxylic food acids and salts category chemicals have an aggregated production and import volume in the range of 86 million to 311 million pounds.[12] This aggregated production volume range excludes one of the thirteen chemicals, acetic acid (CAS# 64-19-7), which has a production volume of over 1 billion pounds.[12] Non-confidential information in the Inventory Update Reporting (IUR) for many of the chemicals in the carboxylic food acids and salts category indicates that these chemicals are used as intermediates, solvents, coloring agents, pH-regulating agents and functional fluids in a variety of industries. All chemicals in this category have IUR submissions that indicate uses in commercial settings or consumer uses. Information in the Hazardous Substance Data Bank (HSDB) indicates that carboxylic food acids and salts are used in food preservation, pharmaceuticals, textile dyeing, anticoagulant for blood, buffer for photography and the manufacturing of other chemicals.[13]

Potential Exposures to the General Population and the Environment: Based on the information considered, including chemical presence in monitoring data and known uses, EPA identifies, for purposes of risk-based prioritization, that the potential for exposure to the general population and the environment is high. Public data sources indicate that some of the chemicals in the carboxylic food acids and salts category are naturally occurring in plants and organisms, and can be potentially released through waste streams from various industrial applications.[13]

Persistence and bioaccumulation ratings for this chemical are P1 and B1. Based upon estimated bioconcentration factors, the potential for bioaccumulation for each member of this category is expected to be low (B1). Acetic acid, citric acid, and fumaric acid are all readily biodegradable, therefore the persistence potential for the compounds of this category is expected to be low (P1).[14]

Potential Exposures to Workers: Based on the information considered, including the HSDB and IUR data (both confidential and non-confidential business information), and in combination with Agency's professional judgment, EPA identifies, for the purposes of risk-based prioritization, a high relative ranking for the potential worker exposure. This relative ranking is based on the large number of industrial processing and uses, potential for dermal and inhalation exposure to liquids and solids, substantially high production volume, and a high number of potentially exposed workers (>1,000 workers for most members of category). Only one chemical in this category, acetic acid (CAS# 64-19-7), has an OSHA Permissible Exposure Limit (PEL) [15] of 10 ppm 8-hour time weighted average (TWA).

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[12] USEPA, 2006 Partial Updating of TSCA Chemical Inventory.
[13] HSDB, 2008. Hazardous Substance Data Bank. Accessed, 5/22/08. http://toxnet.nlm.nih.gov/
[14] USEPA, 2008. Screening-Level Hazard Characterization for Carboxylic Food Acid and Salts Category.
[15] NIOSH, 1988. OSHA PEL Project Documentation. http://www.cdc.gov/niosh/pel88/npelcas.html Accessed, 5/22/08.

Potential Exposures to Consumers: EPA identifies, for the purposes of risk-based prioritization, that the potential for exposures to consumers based on the use of products containing this chemical is high. All chemicals in this category have IUR submissions that indicate uses in commercial settings or consumer uses. Some non-confidential IUR commercial and consumer uses are in rubber and plastic products, soaps and detergents, photographic supplies, paints and coatings, as well as paper products.

Potential Exposures to Children: EPA identifies, for the purposes of risk-based prioritization, that the potential for exposures to children based on the use of products containing this chemical is high. Seven of the IUR submissions reported uses in products intended to be used by children, six submissions reported that such information was Not Readily Obtainable. HSDB also indicates that carboxylic food acids and salts are added in foods and beverages which may be consumed by children.[16]

Below are tables summarizing non-confidential information in the IUR for each of the individual chemicals in this category.

This exposure characterization was completed using both public, non-confidential sources, and IUR submissions that were available as of this writing.

[16] HSDB, 2008. Hazardous Substance Data Bank. Accessed, 5/22/08. http://toxnet.nlm.nih.gov/

Non Confidential IUR Data Summary: Fumaric acid - (CAS# 110-17-8)

Manufacturing/Import Information

Production and import volume:	1 million to 10 million pounds
List of non-CBI companies/ sites*:	Chusei U.S.A./Quest Separation Technologies / Pasadena, TX Cook Composites and Polymers Co. / North Kansas City, MO Hercules Incorporated / Hattiesburg, MS Hercules Incorporated / Portland, OR Hercules Incorporated / Savannah, GA ICC Chemical Corporation / New York, NY PMP Fermentation Products, Inc. / Peoria, IL Reichhold Inc. / Jacksonviille, FL Reichhold Inc. / Morris, IL Reichhold Inc. / Valley Park, MO Tate & Lyle Ingredients Americas, Inc. / Duluth, MN TR International, Incorporated / Seattle, WA
Maximum number of exposed workers**:	1,000 or greater (including those of manufacturing, industrial processing &use)
Highest non-CBI maximum concentration*:	up to 100% by weight
Non-CBI physical forms*:	dry powder, pellets or large crystals, liquid

* There may be other companies/ sites, concentrations and physical forms that are claimed confidential.
** There may be additional potentially exposed industrial workers that are not included in this estimate since not all submitters were required to report on industrial processing and use and/or there may be at least one use that contains a "Not Readily Obtainable" (NRO) response among the submissions.

Table 1 Industrial Processing and Use Information Reported in 2006 IUR		
Processing Activity	**Industrial Sector**	**Function in Ind. Sector**
Processing as a reactant	Resin and Synthetic Rubber Manufacturing	Intermediates
Processing--incorporation into formulation, mixture, or reaction product	All Other Chemical Product and Preparation Manufacturing	Solvents (for cleaning or degreasing)
Processing--incorporation into formulation, mixture, or reaction product	Other Basic Organic Chemical Manufacturing	Solvents (which become part of product formulation or mixture)
Processing--incorporation into formulation, mixture, or reaction product	Pharmaceutical and Medicine Manufacturing	Solvents (which become part of product formulation or mixture)
Processing--incorporation into formulation, mixture, or reaction product	Soap and Cleaning Compound Manufacturing	Solvents (which become part of product formulation or mixture)
Additional line item(s) may be claimed as CBI		

Table 2 Commercial/ Consumer Uses Reported in 2006 IUR		
Commercial/ Consumer Product Category Description	**Highest maximum concentration range**	**Use in Children's Products**
Rubber and plastic products	Confidential	No
Soaps and detergents	Confidential	No
Wood and wood furniture	Confidential	No
Additional line item(s) may be claimed as CBI	Confidential	Confidential

Non Confidential IUR Data Summary: Acetic acid, potassium salt (CAS# 127-08-2)

Manufacturing/Import Information

Production and import volume:	10 million to 50 million pounds
List of non-CBI companies/ sites*:	Brenntag Mid-South, Inc. / Henderson, KY Chem One LTD / Houston, TX Cryotech Deicing Technology / Fort Madison, IA Eastman Kodak Company / Rochester, NY Hydrite Chemical Co. / Milwaukee, WI Los Angeles Chemical Company / Huntington Beach, CA Mallinckrodt Baker, Inc. / Phillipsburg, NJ OM Group, Inc. (OMG Americas, Inc.) / Franklin, PA Peiron, Inc. / Lyons, IL Solutia Inc. / Trenton, MI Ticona / Bishop, TX W.R. Grace, Performance Chemicals / Chicago, IL Zaclon, LLC / Cleveland, OH
Maximum number of exposed workers**:	1,000 or greater (including those of manufacturing, industrial processing and use)
Highest non-CBI maximum concentration*:	up to 100% by weight
Non-CBI physical forms*:	dry powder, pellets or large crystals, liquid

* There may be other companies/ sites, concentrations and physical forms that are claimed confidential.
** There may be additional potentially exposed industrial workers that are not included in this estimate since not all submitters were required to report on industrial processing and use and/or there may be at least one use that contains a "Not Readily Obtainable" (NRO) response among the submissions.

Table 1 Industrial Processing and Use Information Reported in 2006 IUR		
Processing Activity	**Industrial Sector**	**Function in Ind. Sector**
Processing as a reactant	Other Basic Organic Chemical Manufacturing	Intermediates
Processing as a reactant	Other Basic Inorganic Chemical Manufacturing	Other
Processing--incorporation into formulation, mixture, or reaction product	All Other Chemical Product and Preparation Manufacturing	Other
Not Readily Obtainable	Not Readily Obtainable	Not Readily Obtainable
Use--nonincorporative activities	All Other Wood Product Manufacturing	Other
Additional line item(s) may be claimed as CBI		

Table 2 Commercial/ Consumer Uses Reported in 2006 IUR		
Commercial/ Consumer Product Category Description	**Highest maximum concentration range**	**Use in Children's Products**
Other	31% - 60%	No
Additional line item(s) may be claimed as CBI	Confidential	Confidential

Non Confidential IUR Data Summary: Acetic acid, sodium salt (CAS# 127-09-3)

Manufacturing/Import Information

Production and import volume:	10 million to 50 million pounds
List of non-CBI companies/ sites*:	Aceto Corporation / Lake Success, NY Alcan International Network U.S.A. Inc. / Stamford, CT Arkema Inc. / Blooming Prairie, MN BASF Catalysts, LLC / Port Allen, LA Burlington Chemical Co., Inc. / Burlington, NC Chem One LTD / Houston, TX ChemQuest, Inc. / Pasadena, TX Ciba Specialty Chemicals Corp. / High Point, NC Compass Chemical International, LLC / Smyrna, GA Cryotech Deicing Technology / Fort Madison, IA Eastman Kodak Company / Rochester, NY Ecolab, Inc. / Garland, TX Fujifilm Hunt Chemical, U.S.A. / Rolling Meadows, IL Piedmont Chemical Industries Inc / High Point, NC Ticona / Bishop, TX The Dow Chemical Company / Midland, MI The Procter & Gamble Company / Cincinnati, OH The Procter & Gamble Company / St. Louis, MO Union Carbide Corporation / Institute, WV
Maximum number of exposed workers**:	1,000 or greater (including those of manufacturing, industrial processing and use)
Highest non-CBI maximum concentration*:	up to 100% by weight
Non-CBI physical forms*:	dry power, pellets or large crystals, wet solid, other solid, liquid

* There may be other companies/ sites, concentrations and physical forms that are claimed confidential.

** There may be additional potentially exposed industrial workers that are not included in this estimate since not all submitters were required to report on industrial processing and use and/or there may be at least one use that contains a "Not Readily Obtainable"

Table 1
Industrial Processing and Use Information
Reported in 2006 IUR

Processing Activity	Industrial Sector	Function in Ind. Sector
Processing as a reactant	All Other Chemical Product and Preparation Manufacturing	pH-regulating agents
Processing as a reactant	Other Basic Inorganic Chemical Manufacturing	Intermediates
Processing--incorporation into formulation, mixture, or reaction product	All Other Chemical Product and Preparation Manufacturing	Functional fluids
Processing--incorporation into formulation, mixture, or reaction product	All Other Chemical Product and Preparation Manufacturing	Other
Processing--incorporation into formulation, mixture, or reaction product	Other Basic Inorganic Chemical Manufacturing	Intermediates
Processing--incorporation into formulation, mixture, or reaction product	Other Basic Organic Chemical Manufacturing	Functional fluids
Processing--repackaging	Other Basic Organic Chemical Manufacturing	Functional fluids
Use--nonincorporative activities	Plastics Materials and Basic Forms and Shapes Merchant Wholesalers	Other
Use--nonincorporative activities	All Other Wood Product Manufacturing	Other
Not Readily Obtainable	Not Readily Obtainable	Not Readily Obtainable
Additional line item(s) may be claimed as CBI		

Table 2
Commercial/ Consumer Uses
Reported in 2006 IUR

Commercial/ Consumer Product Category Description	Highest maximum concentration range	Use in Children's Products
Other	Greater than 90%	No
Paints and coatings	Greater than 90%	No
Photographic supplies	Greater than 90%	No
Not Readily Obtainable	NRO	NRO
Additional line item(s) may be claimed as CBI	Confidential	Confidential

Non Confidential IUR Data Summary: Acetic acid, magnesium salt (CAS# 142-72-3)

Manufacturing/Import Information

Production and import volume:	1 million to 10 million pounds
List of non-CBI companies/ sites*:	Arkema Inc. / Blooming Prairie, MN Cryotech Deicing Technology / Fort Madison, IA Shepherd Chemical / Norwood, OH Toray Plastics (America), Inc. / North Kingstown, RI
Maximum number of exposed workers**:	between 100 and 999 (including those of manufacturing, industrial processing and use)
Highest non-CBI maximum concentration*:	up to 100% by weight
Non-CBI physical forms*:	pellets or large crystals, other solid, liquid

* There may be other companies/ sites, concentrations and physical forms that are claimed confidential.
** There may be additional potentially exposed industrial workers that are not included in this estimate since not all submitters were required to report on industrial processing and use and/or there may be at least one use that contains a "Not Readily Obtainable" (NRO) response among the submissions.

Table 1
Industrial Processing and Use Information
Reported in 2006 IUR

Processing Activity	Industrial Sector	Function in Ind. Sector
Processing--incorporation into formulation, mixture, or reaction product	All Other Wood Product Manufacturing	Other
Additional line item(s) may be claimed as CBI		

Table 2
Commercial/ Consumer Uses
Reported in 2006 IUR

Commercial/ Consumer Product Category Description	Highest maximum concentration range	Use in Children's Products
Other	61% - 90%	No
Additional line item(s) may be claimed as CBI	Confidential	Confidential

Non Confidential IUR Data Summary: Acetic acid, calcium salt (CAS# 62-54-4)

Manufacturing/Import Information

Production and import volume:	1 million to 10 million pounds
List of non-CBI companies/ sites*:	Chevron North America Products / Port Arthur, TX Cryotech Deicing Technology / Fort Madison, IA
Maximum number of exposed workers**:	between 100 and 999 (including those of manufacturing, industrial processing and use)
Highest non-CBI maximum concentration*:	up to 60% by weight
Non-CBI physical forms*:	pellets or large crystals, other solid

* There may be other companies/ sites, concentrations and physical forms that are claimed confidential.
** There may be additional potentially exposed industrial workers that are not included in this estimate since not all submitters were required to report on industrial processing and use and/or there may be at least one use that contains a "Not Readily Obtainable" (NRO) response among the submissions.

Table 1
Industrial Processing and Use Information
Reported in 2006 IUR

Processing Activity	Industrial Sector	Function in Ind. Sector
Processing--incorporation into formulation, mixture, or reaction product	All Other Wood Product Manufacturing	Other
Additional line item(s) may be claimed as CBI		

Table 2
Commercial/ Consumer Uses
Reported in 2006 IUR

Commercial/ Consumer Product Category Description	Highest maximum concentration range	Use in Children's Products
Other	31% - 60%	No
Additional line item(s) may be claimed as CBI	Confidential	Confidential

Non Confidential IUR Data Summary: Acetic acid, ammonium salt (CAS# 631-61-8)

Manufacturing/Import Information

Production and import volume:	1 million to 10 million pounds
List of non-CBI companies/ sites*:	ChemQuest, Inc. / Pasadena, TX Eastman Kodak Company / Rochester, NY Fujifilm Hunt Chemical, U.S.A. / Rolling Meadows, IL Jarchem Industries Inc. / Newark, NJ Lynx Chemical Group, LLC / Dalton, GA Vertellus Health & Specialty Products LLC / Delaware Water Gap, PA
Maximum number of exposed workers**:	1,000 or greater (including those of manufacturing, industrial processing and use)
Highest non-CBI maximum concentration*:	up to 100% by weight
Non-CBI physical forms*:	dry powder, wet solid, liquid

* There may be other companies/ sites, concentrations and physical forms that are claimed confidential.
** There may be additional potentially exposed industrial workers that are not included in this estimate since not all submitters were required to report on industrial processing and use and/or there may be at least one use that contains a "Not Readily Obtainable" (NRO) response among the submissions.

Table 1
Industrial Processing and Use Information
Reported in 2006 IUR

Processing Activity	Industrial Sector	Function in Ind. Sector
Processing--incorporation into formulation, mixture, or reaction product	All Other Chemical Product and Preparation Manufacturing	Other
Processing--incorporation into formulation, mixture, or reaction product	Other Basic Organic Chemical Manufacturing	Other
Use--nonincorporative activities	Other Basic Organic Chemical Manufacturing	Adhesives and binding agents
Use--nonincorporative activities	Other Basic Organic Chemical Manufacturing	Agricultural chemicals (nonpesticidal)
Use--nonincorporative activities	Other Basic Organic Chemical Manufacturing	Other
Additional line item(s) may be claimed as CBI		

Table 2 Commercial/ Consumer Uses Reported in 2006 IUR		
Commercial/ Consumer Product Category Description	**Highest maximum concentration range**	**Use in Children's Products**
Photographic supplies	Greater than 90%	No
Additional line item(s) may be claimed as CBI	Confidential	Confidential

Non Confidential IUR Data Summary: Acetic acid, manganese salt 2+ (CAS# 638-38-0)

Manufacturing/Import Information

Production and import volume:	1 million to 10 million pounds
List of non-CBI companies/ sites*:	OM Group, Inc. (OMG Americas, Inc.) / Franklin, PA Shepherd Chemical / Norwood, OH Umicore USA Inc. / Arab, AL
Maximum number of exposed workers**:	between 100 and 999 (including those of manufacturing, industrial processing and use)
Highest non-CBI maximum concentration*:	up to 90% by weight
Non-CBI physical forms*:	pellets or large crystals, other solid, liquid

* There may be other companies/ sites, concentrations and physical forms that are claimed confidential.
** There may be additional potentially exposed industrial workers that are not included in this estimate since not all submitters were required to report on industrial processing and use and/or there may be at least one use that contains a "Not Readily Obtainable" (NRO) response among the submissions.

Table 1
Industrial Processing and Use Information
Reported in 2006 IUR

Processing Activity	Industrial Sector	Function in Ind. Sector
Processing as a reactant	Other Basic Inorganic Chemical Manufacturing	Coloring agents, pigments
Processing as a reactant	Other Basic Inorganic Chemical Manufacturing	Intermediates
Processing--incorporation into formulation, mixture, or reaction product	All Other Chemical Product and Preparation Manufacturing	Other
Processing--incorporation into formulation, mixture, or reaction product	Other Basic Organic Chemical Manufacturing	Other
Additional line item(s) may be claimed as CBI		

Table 2 Commercial/ Consumer Uses Reported in 2006 IUR		
Commercial/ Consumer Product Category Description	**Highest maximum concentration range**	**Use in Children's Products**
Other	61% - 90%	No
Paints and coatings	Less than 1%	No
Rubber and plastic products	Less than 1%	No
Additional line item(s) may be claimed as CBI	Confidential	Confidential

Non Confidential IUR Data Summary: Acetic acid (CAS# 64-19-7)

Manufacturing/Import Information

Production and import volume:	>1 billion pounds
List of non-CBI companies/ sites*:	3M / Cordova, IL BAE Systems Ordnance systems Inc. / Kingsport, TN BASF Canada, Inc. / Laredo, TX BASF Corporation / Florham Park, NJ BASF Corporation / Bishop, TX Celanese Ltd. / Calvert City, KY Celanese Ltd. / Pampa, TX Celanese Ltd. / Pasadena, TX Ciba Specialty Chemicals Corp. / High Point, NC Compass Chemical International, LLC /Smyrna, GA DAK Americas LLC / Leland, NC Eastman Chemical Company / Kingsport, TN Eastman Chemical Company / Magness, AR EMD Chemicals, Inc. / Cincinnati, OH E. I. du Pont de Nemours and Company / Chattanooga, TN E. I. du Pont de Nemours and Company / La Porte, TX International Flavors & Fragrances Inc / Jacksonville, FL Kanto Corporation / Portland, OR Millennium Inorganic Chemicals / La Porte, TX Mallinckrodt, Inc. / Raleigh, NC Millennium Specialty Chemicals / Jacksonville, FL Rohm and Haas Company / Deer Park, TX Solvay Advanced Polymers, LLC / Augusta, GA Sterling Chemicals, Inc. / Texas City, TX Ticona / Grover, NC Ulrich Chemical, Inc. / Indianapolis, IN Union Carbide Corporation / Hahnville, LA

Maximum number of exposed workers**: 1,000 or greater (including those of manufacturing, industrial processing and use)
Highest non-CBI maximum concentration*: up to 100% by weight
Non-CBI physical forms*: liquid

* There may be other companies/ sites, concentrations and physical forms that are claimed confidential.
** There may be additional potentially exposed industrial workers that are not included in this estimate since not all submitters were required to report on industrial processing and use and/or there may be at least one use that contains a "Not Readily Obtainable" (NRO) response among the submissions.

Table 1
Industrial Processing and Use Information
Reported in 2006 IUR

Processing Activity	Industrial Sector	Function in Ind. Sector
Processing--incorporation into article	Motor Vehicle Body and Trailer Manufacturing	Other
Processing--incorporation into article	Paperboard Container Manufacturing	Coloring agents, dyes
Processing--incorporation into article	Paperboard Mills	Coloring agents, dyes
Processing--incorporation into article	Paper Mills	Coloring agents, dyes
Processing--incorporation into article	Synthetic Dye and Pigment Manufacturing	Coloring agents, dyes
Processing--incorporation into article	NRO	Coloring agents, dyes
Processing as a reactant	Explosives Manufacturing	Other
Processing as a reactant	Other Basic Organic Chemical Manufacturing	Odor agents
Processing as a reactant	Other Basic Organic Chemical Manufacturing	Not Readily Obtainable
Processing as a reactant	NRO	Not Readily Obtainable
Processing as a reactant	Petrochemical Manufacturing	Intermediates
Processing as a reactant	Other Basic Organic Chemical Manufacturing	Intermediates
Processing as a reactant	Other Basic Organic Chemical Manufacturing	Other
Processing--incorporation into formulation, mixture, or reaction product	All Other Textile Product Mills	Processing aid, not otherwise listed
Processing--incorporation into formulation, mixture, or reaction product	Cement Manufacturing	Other
Processing--incorporation into	Other Basic Organic Chemical	Solvents (which become part of

Table 1 Industrial Processing and Use Information Reported in 2006 IUR		
Processing Activity	**Industrial Sector**	**Function in Ind. Sector**
formulation, mixture, or reaction product	Manufacturing	product formulation or mixture)
Processing--incorporation into formulation, mixture, or reaction product	Other Basic Organic Chemical Manufacturing	Not Readily Obtainable
Processing--incorporation into formulation, mixture, or reaction product	Petrochemical Manufacturing	pH-regulating agents
Processing--incorporation into formulation, mixture, or reaction product	Petrochemical Manufacturing	Solvents (which become part of product formulation or mixture)
Processing--repackaging	Other Basic Organic Chemical Manufacturing	Intermediates
Processing--repackaging	Other Basic Organic Chemical Manufacturing	Other
Use--nonincorporative activities	Other Basic Organic Chemical Manufacturing	pH-regulating agents
Use--nonincorporative activities	Other Basic Organic Chemical Manufacturing	Plating agents and metal surface treating agents
Use--nonincorporative activities	Other Basic Organic Chemical Manufacturing	Other
Use--nonincorporative activities	Other Basic Organic Chemical Manufacturing	Solvents (for cleaning or degreasing)
Use--nonincorporative activities	Other Chemical and Allied Products Merchant Wholesalers	Coloring agents, dyes
Not Readily Obtainable	Artificial and Synthetic Fibers and Filaments Manufacturing	Not Readily Obtainable
Not Readily Obtainable	Oil and Gas Extraction	pH-regulating agents
Not Readily Obtainable	Other Basic Organic Chemical Manufacturing	
Not Readily Obtainable	NRO	Not Readily Obtainable
Additional line item(s) may be claimed as CBI		

Table 2 Commercial/ Consumer Uses Reported in 2006 IUR		
Commercial/ Consumer Product Category Description	**Highest maximum concentration range**	**Use in Children's Products**
Adhesives and sealants	NRO	No
Other	NRO	Yes
Other	Greater than 90%	No
Paints and coatings	NRO	No
Paper products	Less than 1%	No
Photographic supplies	NRO	No
Rubber and plastic products	NRO	No
Transportation products	Less than 1%	No
Not Readily Obtainable	NRO	NRO
Additional line item(s) may be claimed as CBI	Confidential	Confidential

Non Confidential IUR Data Summary: Citric acid, trisodium salt - (CAS# 68-04-2)

Manufacturing/Import Information

Production and import volume:	10 million to 50million pounds
List of non-CBI companies/ sites*:	Archer Daniels Midland Company / Southport, NC Ecolab, Inc. / Dallas, TX Ecolab, Inc. / Greensboro, NC Los Angeles Chemical Company / South Gate, CA Tate & Lyle Ingredients Americas, Inc. / Decatur, IL The Clorox Company / Forest Park, GA The Procter & Gamble Company / Barberton, OH
Maximum number of exposed workers**:	1,000 or greater (including those of manufacturing, industrial processing and use)
Highest non-CBI maximum concentration*:	up to 100% by weight
Non-CBI physical forms*:	dry powder, liquid

* There may be other companies/ sites, concentrations and physical forms that are claimed confidential.
** There may be additional potentially exposed industrial workers that are not included in this estimate since not all submitters were required to report on industrial processing and use and/or there may be at least one use that contains a "Not Readily Obtainable" (NRO) response among the submissions.

Table 1
Industrial Processing and Use Information
Reported in 2006 IUR

Processing Activity	Industrial Sector	Function in Ind. Sector
Processing as a reactant	Paper Mills	pH-regulating agents
Processing--incorporation into formulation, mixture, or reaction product	Soap and Cleaning Compound Manufacturing	Solvents (which become part of product formulation or mixture)
Processing--incorporation into formulation, mixture, or reaction product		Solvents (for cleaning or degreasing)
Processing--repackaging	Other Chemical and Allied Products Merchant Wholesalers	Not Readily Obtainable
Additional line item(s) may be claimed as CBI		

Table 2 Commercial/ Consumer Uses Reported in 2006 IUR		
Commercial/ Consumer Product Category Description	**Highest maximum concentration range**	**Use in Children's Products**
Other	1% - 30%	No
Paper products	Less than 1%	Yes
Soaps and detergents	Confidential	No
Additional line item(s) may be claimed as CBI	Confidential	Confidential

Non Confidential IUR Data Summary: Malic acid - (CAS# 6915-15-7)

Manufacturing/Import Information

Production and import volume:	1 million to 10 million pounds
List of non-CBI companies/ sites*:	Ashland Inc. / Dublin, OH Tate & Lyle Ingredients Americas, Inc. / Duluth, MN
Maximum number of exposed workers**:	between 100 and 999 (including those of manufacturing, industrial processing and use)
Highest non-CBI maximum concentration*:	up to 100% by weight
Non-CBI physical forms*:	dry powder, liquid

* There may be other companies/ sites, concentrations and physical forms that are claimed confidential.
** There may be additional potentially exposed industrial workers that are not included in this estimate since not all submitters were required to report on industrial processing and use and/or there may be at least one use that contains a "Not Readily Obtainable" (NRO) response among the submissions.

Table 1
Industrial Processing and Use Information
Reported in 2006 IUR

Processing Activity	Industrial Sector	Function in Ind. Sector
Processing--incorporation into formulation, mixture, or reaction product	All Other Chemical Product and Preparation Manufacturing	pH-regulating agents
Processing--incorporation into formulation, mixture, or reaction product	All Other Chemical Product and Preparation Manufacturing	Solvents (for chemical manufacture and processing and are not part of product at greater than 1% by weight)
Processing--incorporation into formulation, mixture, or reaction product	All Other Chemical Product and Preparation Manufacturing	Stabilizers
Processing--incorporation into formulation, mixture, or reaction product	Fruit and Vegetable Canning, Pickling, and Drying	Solvents (which become part of product formulation or mixture)
Processing--incorporation into formulation, mixture, or reaction product	Other Basic Organic Chemical Manufacturing	Solvents (which become part of product formulation or mixture)
Processing--incorporation into formulation, mixture, or reaction product	Pharmaceutical and Medicine Manufacturing	Other
Additional line item(s) may be claimed as CBI		

Table 2 Commercial/ Consumer Uses Reported in 2006 IUR		
Commercial/ Consumer Product Category Description	**Highest maximum concentration range**	**Use in Children's Products**
Other	Confidential	NRO
Rubber and plastic products	Confidential	No
Soaps and detergents	Confidential	No
NRO	NRO	No
Additional line item(s) may be claimed as CBI	Confidential	Confidential

Non Confidential IUR Data Summary: Citric acid - (CAS# 77-92-9)

Manufacturing/Import Information

Production and import volume:	50 to 100 million pounds
List of non-CBI companies/ sites*:	Albemarle Corporation / Houston, TX Archer Daniels Midland Company / Southport, NC Cargill, Inc. / Eddyville, IA Chem One LTD / Houston, TX Emerald Performance Materials LLC / Charlotte, NC Gehring-Montgomery, Inc. / Warminster, PA JohnsonDiversey, Inc / Sturtevant, WI Los Angeles Chemical Company / Huntington Beach, CA Reckitt Benckiser Inc / Parsippany, NJ Tate & Lyle Ingredients Americas, Inc. / Dayton, OH The Procter & Gamble Company / Cincinnati, OH TR International, Incorporated / Seattle, WA Univar USA Inc. / Redmond, WA Vertellus Performance Materials Inc. (formerly Morflex, Inc.) / Greensboro, NC Vesuvius USA Corporation / Champaign, IL Vitusa Products, Inc. / Berkeley Heights, NJ Wego Chemical & Mineral Corp. / Great Neck, NY
Maximum number of exposed workers**:	1,000 or greater (including those of manufacturing, industrial processing and use)
Highest non-CBI maximum concentration*:	up to 100% by weight
Non-CBI physical forms*:	dry powder, pellets or large crystals, solid, liquid

* There may be other companies/ sites, concentrations and physical forms that are claimed confidential.
** There may be additional potentially exposed industrial workers that are not included in this estimate since not all submitters were required to report on industrial processing and use and/or there may be at least one use that contains a "Not Readily Obtainable" (NRO) response among the submissions.

Table 1
Industrial Processing and Use Information
Reported in 2006 IUR

Processing Activity	Industrial Sector	Function in Ind. Sector
Processing--incorporation into article- Manufacturing	Other Converted Paper Product	pH-regulating agents
Processing--incorporation into article	Soft Drink and Ice Manufacturing	pH-regulating agents
Processing as a reactant	Other Basic Organic Chemical Manufacturing	Intermediates
Processing as a reactant	Other Basic Organic Chemical Manufacturing	Other
Processing as a reactant	Paper Mills	pH regulating agents
Processing--incorporation into formulation, mixture, or reaction product	All Other Chemical Product and Preparation Manufacturing	Other
Processing--incorporation into formulation, mixture, or reaction product	Fertilizer Manufacturing	Stabilizers
Processing--incorporation into formulation, mixture, or reaction product	Frozen Food Manufacturing	Solvents (for cleaning or degreasing)
Processing--incorporation into formulation, mixture, or reaction product	Other Basic Organic Chemical Manufacturing	Other
Processing--incorporation into formulation, mixture, or reaction product	Other Basic Organic Chemical Manufacturing	Solvents (which become part of product formulation or mixture)
Processing--incorporation into formulation, mixture, or reaction product	Resin and Synthetic Rubber Manufacturing	Process regulators, used in vulcanization or polymerization processes
Processing--incorporation into formulation, mixture, or reaction product	Pharmaceutical and Medicine Manufacturing	Solvents (for cleaning or degreasing)
Processing--incorporation into formulation, mixture, or reaction product	Soap and Cleaning Compound Manufacturing	Functional fluids
Processing--incorporation into formulation, mixture, or reaction product	Soap and Cleaning Compound Manufacturing	Process regulators, used in vulcanization or polymerization processes
Processing--incorporation into formulation, mixture, or reaction product-	Soap and Cleaning Compound Manufacturing	Solvents (for cleaning or degreasing)
Processing--incorporation into formulation, mixture, or reaction product-	Soap and Cleaning Compound Manufacturing	Solvents (which become part of product formulation or mixture)
Processing--incorporation into formulation, mixture, or reaction product-	Soft Drink and Ice Manufacturing	Odor agents
Processing--incorporation into formulation, mixture, or reaction product-	Soft Drink and Ice Manufacturing	pH-regulating agents
Processing--incorporation into	Soft Drink and Ice	Reducing agents

Table 1 Industrial Processing and Use Information Reported in 2006 IUR		
Processing Activity	**Industrial Sector**	**Function in Ind. Sector**
formulation, mixture, or reaction product	Manufacturing	
Processing--incorporation into formulation, mixture, or reaction product	Soft Drink and Ice Manufacturing	Solvents (for cleaning or degreasing)
Processing--incorporation into formulation, mixture, or reaction product	Support Activities for Mining	Stabilizers
Processing--repackaging	Other Basic Organic Chemical Manufacturing	Other
Processing--repackaging	Other Chemical and Allied Products Merchant Wholesalers	Not Readily Obtainable
Processing--repackaging	Other Chemical and Allied Products Merchant Wholesalers	Other
Use--nonincorporative activities-Millwork-Other		
Use--nonincorporative activities	Oil and Gas Extraction	Functional fluids
Use--nonincorporative activities		Other
Use--nonincorporative activities	Textile and Fabric Finishing Mills	pH-regulating agents
Not Readily Obtainable	NRO	Not Readily Obtainable
Additional line item(s) may be claimed as CBI		

Table 2 Commercial/ Consumer Uses Reported in 2006 IUR		
Commercial/ Consumer Product Category Description	**Highest maximum concentration range**	**Use in Children's Products**
Agricultural products (non-pesticidal)	Confidential	No
Fabrics, textiles and apparel	Less than 1%	Yes
Other	61% - 90%	No
Other	Greater than 90%	NRO
Other	NRO	Yes
Metal products	Greater than 90%	NRO
Metal products	Greater than 90%	No
Rubber and plastic products	Less than 1%	Yes
Rubber and plastic products	Confidential	No
Paper products	Less than 1%	Yes
Soaps and detergents	Confidential	No
Not Readily Obtainable	NRO	NRO
Additional line item(s) may be claimed as CBI	Confidential	Confidential

Non Confidential IUR Data Summary: Citric acid, tripotassium salt (CAS# 866-84-2)

Manufacturing/Import Information

Production and import volume:	500,000 to 1 million pounds
List of non-CBI companies/ sites*:	Archer Daniels Midland Company / Southport, NC Henkel Corporation / Warren, MI
Maximum number of exposed workers**:	1,000 or greater (including those of manufacturing, industrial processing and use)
Highest non-CBI maximum concentration*:	up to 100% by weight
Non-CBI physical forms*:	dry powder

* There may be other companies/ sites, concentrations and physical forms that are claimed confidential.
** There may be additional potentially exposed industrial workers that are not included in this estimate since not all submitters were required to report on industrial processing and use and/or there may be at least one use that contains a "Not Readily Obtainable" (NRO) response among the submissions.

Table 1
Industrial Processing and Use Information
Reported in 2006 IUR

Processing Activity	Industrial Sector	Function in Ind. Sector
Processing as a reactant	Paper Mills	pH-regulating agents
Processing--repackaging	Other Chemical and Allied Products Merchant Wholesalers	Not Readily Obtainable
Additional line item(s) may be claimed as CBI		

Table 2
Commercial/ Consumer Uses
Reported in 2006 IUR

Commercial/ Consumer Product Category Description	Highest maximum concentration range	Use in Children's Products
Other	1% - 30%	No
Paper products	Less than 1%	Yes
Additional line item(s) may be claimed as CBI	Confidential	Confidential

Non Confidential IUR Data Summary: Citric acid, sodium salt - (CAS# 994-36-5)

Manufacturing/Import Information

Production and import volume:	<500,000 pounds
List of non-CBI companies/ sites*:	Emerald Performance Materials LLC / Charlotte, NC OMNOVA Solutions Inc. / Chester, SC Piedmont Chemical Industries Inc / High Point, NC
Maximum number of exposed workers**:	Less than 100 (including those of manufacturing, industrial processing and use)
Highest non-CBI maximum concentration*:	up to 60% by weight
Non-CBI physical forms*:	liquid

* There may be other companies/ sites, concentrations and physical forms that are claimed confidential.
** There may be additional potentially exposed industrial workers that are not included in this estimate since not all submitters were required to report on industrial processing and use and/or there may be at least one use that contains a "Not Readily Obtainable" (NRO) response among the submissions.

Table 1
Industrial Processing and Use Information
Reported in 2006 IUR

Processing Activity	Industrial Sector	Function in Ind. Sector
Processing--incorporation into formulation, mixture, or reaction product	All Other Chemical Product and Preparation Manufacturing	Functional fluids
Additional line item(s) may be claimed as CBI		

Table 2
Commercial/ Consumer Uses
Reported in 2006 IUR

Commercial/ Consumer Product Category Description	Highest maximum concentration range	Use in Children's Products
Other	Less than 1%	No
Additional line item(s) may be claimed as CBI	Confidential	Confidential