UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

August 1, 2006

ACTION MEMORANDUM

SUBJECT: Inert Ingredient Tolerance Reassessments: Two Exemptions from the Requirement of a Tolerance for Alkyl (C_8-C_{24}) Benzenesulfonic Acid and its Ammonium, Calcium, Magnesium, Potassium, Sodium, and Zinc Salts

FROM: Pauline Wagner, Chief Pauline Wagner 8/1/06
Inert Ingredient Assessment Branch

TO: Lois A. Rossi, Director
Registration Division

I. FQPA REASSESSMENT ACTION

Action: Reassessment of two (2) inert ingredient exemptions from the requirement of a tolerance. Current exemptions are to be maintained.

Chemical: Alkyl (C_8-C_{24}) benzenesulfonic acid and its ammonium, calcium, magnesium, potassium, sodium, and zinc salts (see Table 1).

Table 1. Tolerance Exemptions for Alkyl (C_8-C_{24}) Benzenesulfonic Acid and its Ammonium, Calcium, Magnesium, Potassium, Sodium, and Zinc salts

40 CFR 180	Inert Ingredients	Limits	Uses	CAS Reg. Nos. and CAS 9th Collective Index Names
910[a]	Alkyl (C_8-C_{24}) benzenesulfonic acid and its ammonium, calcium, magnesium, potassium, sodium, and zinc salts	None	Surfactants, related adjuvants of surfactants	See Appendix A
930[b]			Surfactants, emulsifier, related adjuvants of surfactants	

[a] Residues listed in 40 CFR 180.910 are exempted from the requirement of a tolerance when used in accordance with good agricultural practice as inert (or occasionally active) ingredients in pesticide formulations applied to growing crops or to raw agricultural commodities (RAC)s after harvest.
[b] Residues listed in 40 CFR 180.930 are exempted from the requirement of a tolerance when used in accordance with good agricultural practice as inert (or occasionally active) ingredients in pesticide formulations applied to animals.

Use Summary: Alkyl (C_8-C_{24}) benzenesulfonic acid and its ammonium, calcium, magnesium, potassium, sodium, and zinc salts are surfactants with a wide variety of manufacturing uses. As inert ingredients, alkyl (C_8-C_{24}) benzenesulfonic acid and its ammonium, calcium, magnesium, potassium, sodium, and zinc salts are used as surfactants and related adjuvants of surfactants in pesticide formulations applied to growing crops and raw agricultural commodities, and as surfactants and emulsifiers in pesticide formulations applied to animals.

Background: A risk assessment in support of the Alkylbenzene Sulfonates (ABS) Reregistration Eligibility Decision (RED) [Case No. 4006] was completed on July 19, 2006 (Appendix B). The ABS RED considered both the active ingredient and inert ingredient uses of ABS as part of the overall aggregate exposure and risk assessment.

The ABS RED concluded that "there is no concern for aggregate food and drinking water exposures to the alkylbenzene sulfonates resulting from their use as pesticide inert ingredients." The alkylbenzene sulfonates evaluated in the ABS risk assessment are: sodium dodecylbenzene sulfonate (CAS Reg. No. 25155-30-0); dodecylbenzene sulfonic acid (CAS Reg. No.27176-87-0); benzenesulfonic acid, C_{10}-C_{16} alkyl derivatives (CAS Reg. No. 68584-22-5).

The alkylbenzene sulfonates considered under the ABS RED risk assessment represent the alkylbenzene sulfonates used as active ingredients but which also comprise the predominant segment of the alkylbenzene sulfonate inert ingredient tolerance exemption expression given in Table 1. The alkylbenzene sulfonates considered under the ABS RED risk assessment have been determined to have identical or similar physical, chemical and toxicological properties to the alkylbenzene sulfonates included under the tolerance exemptions given in Table 1, therefore the risk assessment findings in the ABS RED also apply to the inert ingredient tolerance exemptions given in Table 1.

Taking into consideration all available information on alkyl (C_8-C_{24}) benzenesulfonic acid and its ammonium, calcium, magnesium, potassium, sodium, and zinc salts, it has been determined that there is a reasonable certainty that no harm to any population subgroup will result from aggregate exposure to these chemicals when considering exposure through food commodities and all other non-occupational sources for which there is reliable information. Therefore, it is recommended that the two exemptions from the requirement of a tolerance (one exemption under 40 CFR 180.910 and one exemption under 40 CFR 180.930) established for residues of alkyl (C_8-C_{24}) benzenesulfonic acid and its ammonium, calcium, magnesium, potassium, sodium, and zinc salts can be considered reassessed as safe under section 408(q) of the FFDCA.

List Classification Determination: Because EPA has determined that there is a reasonable certainty that no harm to any population subgroup will result from aggregate exposure to these

chemicals when used as an inert ingredients in pesticide formulations, the List Classification determination for each of alkyl (C_8-C_{24}) benzenesulfonic acid and its ammonium, calcium, magnesium, potassium, sodium, and zinc salts listed in Appendix A will be List 4B.

II. MANAGEMENT CONCURRENCE

I concur with the reassessment of the two (2) exemptions from the requirement of a tolerance for the inert ingredient alkyl (C_8-C_{24}) benzenesulfonic acid and its ammonium, calcium, magnesium, potassium, sodium, and zinc salts as well as the List Classification determination described above. I consider the exemptions established in 40 CFR 180.910 and 40 CFR 180.930 for alkyl (C_8-C_{24}) benzenesulfonic acid and its ammonium, calcium, magnesium, potassium, sodium, and zinc salts to be reassessed for purposes of FFDCA's section 408(q) as of the date of my signature, below. A Federal Register Notice regarding this tolerance exemption reassessment decision will be published in the near future.

Lois Rossi

Lois A. Rossi, Director
Registration Division

Date: August 1, 2006

cc: Debbie Edwards, SRRD
Joe Nevola, SRRD

APPENDIX A

CAS 9th Collective Index Names and CAS Reg. Nos. for Alkyl (C_8-C_{24}) Benzenesulfonic Acid and its Ammonium, Calcium, Magnesium, Potassium, Sodium, and Zinc Salts	
CAS 9th Collective Index (9CI) Name	**CAS. Reg. No**
Benzenesulfonic acid, (1-methylundecyl)-, sodium salt (6CI, 7CI, 9CI)	27987-00-4
Benzenesulfonic acid, 4-(1-ethyldecyl)-, sodium salt (9CI)	2212-50-2
Benzenesulfonic acid, dodecyl-, sodium salt (8CI, 9CI)	25155-30-0
Benzenesulfonic acid, 4-(1-propylnonyl)-, sodium salt (9CI)	2212-51-3
Benzenesulfonic acid, 4-(1-pentylheptyl)-, sodium salt (9CI)	2212-52-4
Benzenesulfonic acid, isododecyl-, sodium salt (9CI)	59952-82-8
Benzenesulfonic acid, 3-dodecyl-, sodium salt (9CI)	19589-59-4
Benzenesulfonic acid, octadecyl-, sodium salt 8CI, 9CI)	27177-79-3
Benzenesulfonic acid, 4-sec-dodecyl-, sodium salt (9CI)	68628-60-4
Benzenesulfonic acid, undecyl-, sodium salt (9CI)	27636-75-5
Benzenesulfonic acid, 4-(1-methylundecyl)-, sodium salt (9CI)	2211-99-6
Benzenesulfonic acid, 2-dodecyl-, sodium salt (9CI)	15163-46-9
Benzenesulfonic acid, 4-decyl-, sodium salt (9CI)	2627-06-7
Benzenesulfonic acid, dodecyl-, calcium salt (7CI, 8CI, 9CI)	26264-06-2
Benzenesulfonic acid, dodecyl- (8CI, 9CI)	27176-87-0
Benzenesulfonic acid, dodecyl-, potassium salt (8CI, 9CI)	27177-77-1
Benzenesulfonic acid, mono-C10-16-alkyl derivs., sodium salts	68081-81-2
Benzenesulfonic acid, dodecyl-, branched	68411-32-5
Benzenesulfonic acid, C10-16-alkyl derivs.	68584-22-5
Benzenesulfonic acid, C10-16-alkyl denvs., calcium salts	68584-23-6
Benzenesulfonic acid, C10-16-alkyl derivs., magnesium salts	68584-26-9
Benzenesulfonic acid, 4-hexadecyl-, sodium salt (9CI)	16693-91-7
Benzenesulfonic acid, dodecyl-, zinc salt (8CI, 9CI)	12068-16-5
Benzenesulfonic acid, 4-dodecyl-, sodium salt (9CI)	2211-98-5
Benzenesulfonic acid, 4-octadecyl-, sodium salt (9CI)	109027-47-6
Benzenesulfonic acid, decyl, sodium salt (6CI, 7CI, 8CI, 9CI)	1322-98-1
Benzenesulfonic acid, 4-(1-hexyldecyl)-, sodium salt (9CI)	64116-22-9
Benzenesulfonic acid, 4-(1-heptylnonyl)-, sodium salt (9CI)	67267-95-2
Benzenesulfonic acid, pentadecyl-, sodium salt (7CI, 8CI, 9CI)	30227-71-5
Benzenesulfonic acid, 4-tetradecyl-, sodium salt (9CI)	1797-33-7
Benzenesulfonic acid, tetradecyl-, sodium salt (6CI, 7CI, 8CI, 9CI)	28348-61-0
Benzenesulfonic acid, tridecyl-, sodium salt (6Cl, 8CI, 9CI)	26248-24-8
Benzenesulfonic acid, 2-dodecyl-, sodium salt (9CI)	15163-46-9
Benzenesulfonic acid, C10-16-alkyl derivs., potassium salts	68584-27-0
Benzenesulfonic acid, dodecyl-, branched, calcium salts	70528-83-5
Benzenesulfonic acid, octyl-, potassium salt (9CI)	52286-56-3

CAS 9th Collective Index Names and CAS Reg. Nos. for Alkyl (C_8-C_{24}) Benzenesulfonic Acid and its Ammonium, Calcium, Magnesium, Potassium, Sodium, and Zinc Salts	
CAS 9th Collective Index (9CI) Name	**CAS. Reg. No**
Benzenesulfonic acid, dodecyl-, magnesium salt (8CI, 9CI)	27479-45-4
Benzenesulfonic acid, 4-dodecyl-, calcium salt (9CI)	47236-10-2
Benzenesulfonic acid, isodecyl-, calcium salt (9CI)	67890-05-5
Benzenesulfonic acid, undecyl-, ammonium salt (9CI)	61931 -75-7
Benzenesulfonic acid, mono-C10-13-alkyl derivs., sodium salts	90194-45-9

APPENDIX B

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

Date: July 19, 2006

MEMORANDUM

SUBJECT: **Alkylbenzene Sulfonates (ABS) Risk Assessment** for the Reregistration Eligibility Decision (RED) Document. PC Codes: 079010, 190116 and 098002.(active); 790102, 790116, 790101 (inert) Case No. 4006. DP Barcode: D330338

Regulatory Action: Reregistration Eligibility Decision (RED) (Phase I)
Risk Assessment Type: Single Chemical Aggregate

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TO: Heather Garvie, Chemical Review Manager, Reregistration Team 36

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Attached is the Risk Assessment for the Alkylbenzene Sulfonates (ABS) for the purpose of issuing a Reregistration Eligibility Decision (RED). This document has been revised to address public comments. The disciplinary science chapters and other supporting documents for the Alkylbenzene Sulfonates RED are also included as attachments as follows:

Occupational and Residential Exposure Assessment for Alkylbenzene Sulfonates for the Reregistration Eligibility Decision Document (RED) (Active Uses). T. Milano. July 6, 2006. D330329

Residential Exposure Inert Assessment of Alkylbenzene Sulfonates for the Reregistration Eligibility Decision Document (RED). T. Milano/C. Walls, July 6, 2006. D330330

Environmental Fate Assessment of Alkylbenzene Sulfonates for the Reregistration Eligibility Document (RED). T. Milano.July 6, 2006. D323968

Product Chemistry Science Chapter for Benzene Sulfonic Acid, C_{10}-C_{16} Derivatives and Sodium Salt. A. N. Shamim. July 11, 2006. D330332.

Ecological Hazard and Environmental Risk Assessment of Alkylbenzene Sulfonates for the Registration Eligibility Document (RED). R. Petrie. July 12, 2006. D330326.

Dietary Exposure Assessments for the Reregistration Eligibility Decision. R. Quick. March 23, 2006. D327731.

Toxicology Disciplinary Chapter for the Reregistration Eligibility Decision (RED) Document, A.Assaad/W.Dyksra/L.Scarano, July 6, 2006, D330328

Inert Ingredient Dietary Risk Assessment for Linear Alkyl Benzenesulfonate. K. Leifer. March 23, 2006.

1.0 EXECUTIVE SUMMARY

The alkylbenzene sulfonates evaluated in this risk assessment are: (1) sodium dodecylbenzene sulfonate (CAS # 25155-30-0), (2) dodecylbenzene sulfonic acid (CAS # 27176-87-0), and (3) benzenesulfonic acid, C10-C16 alkyl derivatives (CAS # 68584-22-5). These compounds are collectively called DDBSA by the DDBSA Joint Venture Task Force. Dodecylbenzene sulfonic acid is not considered to be a pure compound, and is included in the mixture of benzenesulfonic acid, C10-16 alkyl derivatives.

The alkylbenzene sulfonates are both active and inert ingredients in pesticide products. As active ingredients, there are currently twenty-three registered end-use products used as a disinfectant, food-contact sanitizer, bacteriocide/bacteriostat, microbiocide/microbiostat, fungicide/fungistat, and virucide. Alkylbenzene sulfonates are in cleaners and sanitizers that are designated for use in agricultural, food handling and commercial/institutional/industrial settings. Examples of registered uses for alkylbenzene sulfonates include, but are not limited to: application to indoor hard surfaces (e.g. urinals, shower stalls, toilet bowls, etc.), food dispensing equipment (e.g. pre-mix and post-mix vending machines), food contact surfaces (glasses, dishes, silverware, countertops, etc.), agricultural tools, and fruits and vegetables (post-harvest). As active ingredients, there are no residential or outdoor uses currently registered. Concentrations of alkylbenzene sulfonates as an active ingredient in products range from 0.036% to 25.6%. Products containing alkylbenzene sulfonates are formulated as soluble concentrates, flowable concentrates, ready-to-use solutions, or water soluble packaging.

As inert ingredients, there are approximately 350 registered end-use products containing these chemicals. Many of these products are used in residential settings, and outdoors in agricultural settings. The percent formulations for most of the products that contain alkylbenzene sulfonates as an inert ingredient range from 0.01% to 5%. However, the majority of the labels in this range contain 2% alkylbenzene sulfonates. It should be noted that a few sanitizing products have inert levels as high as 30% and the highest concentration of alkylbenzene sulfonates are found in wood preservative products up to 65 %.

Approximately 300,000 pounds of alkylbenzene sulfonates are used in EPA registered antimicrobial products, which is a small fraction of the approximately 860 million pounds produced each year. The majority of uses of alkylbenzene sulfonates are as household laundry and dish detergents. The alkylbenzene sulfonates are listed on the EPA High Production Volume (HPV) Challenge Program. HPV chemicals are those that are manufactured or imported into the U.S. in production volumes greater than one million pounds per year. The alkylbenzene sulfonates are sponsored by the Linear Alkylbenzene (LAB) Sulfonic Acids Coalition, which has generated data for these chemicals.

Hazard: The toxicology database for the alkylbenzene sulfonates consists almost entirely of published literature, and is essentially complete and of acceptable

quality to assess the potential hazard to humans. The alkylbenzene sulfonates are readily absorbed following oral ingestion, but not following dermal exposure. Following oral exposure, they are readily metabolized, excreted fairly rapidly, and do not accumulate in any tissues. Available acute toxicity data show that alkylbenzene sulfonates are not highly acutely toxic (Categories III-IV), are irritating to the eye and skin (categories I and II, respectively), and they are not skin sensitizers. Subchronic and chronic exposures show that the liver, kidney and intestinal tract (following oral exposures) are the major target organs of toxicity. Both *in vitro* and *in vivo* genotoxicity data show that alkylbenzene sulfonates are not genotoxic. The alkylbenzene sulfonates did not cause reproductive or developmental toxicity in acceptable studies. Early (pre-GLP) carcinogenicity studies indicate that alkylbenzene sulfonates do not cause an increase in tumor incidence.

Toxicity Endpoints: The toxicity endpoints used in this document to assess potential risks include chronic dietary, short-term incidental oral, and short-, intermediate- and/or long-term inhalation exposure scenarios. The Health Effects Division's Toxicity Advisory Clinic (TAC) was consulted and agreed with the choice of toxicity endpoints of concern selected for the aforementioned exposure scenarios in December 2005 for the alkylbenzene sulfonates as a group.

Acute and Chronic Reference Dose (RfDs): No acute dietary endpoint was selected because there were no effects attributable to a single dose exposure.

The chronic RfD is 0.5 mg/kg/day for all populations, using a no-observable adverse effect level (NOAEL) of 50 mg/kg/day based on a weight of evidence from three toxicological studies that observed decreased pup body weight at 250 mg/kg/day and increased caecum weight and slight kidney damage at 114 mg/kg/day. An uncertainty factor of 100 (10X for interspecies extrapolation, 10X for intraspecies variability) was applied to the NOAEL to obtain the chronic RfD.

Incidental oral Exposure: For the short-term incidental oral exposure, a NOAEL of 50 mg/kg/day was selected based on a weight of evidence from three toxicological studies that observed decreased pup body weight at 250 mg/kg/day and increased caecum weight and slight kidney damage at 114 mg/kg/day. The target margin of exposure (MOE) is 100 (10X for interspecies extrapolation, 10X for intraspecies variability, and 1X FQPA factor discussed below).

Dermal Exposure: The Agency determined that quantitation of dermal risk is not required because: (1) the alkylbenzene sulfonates are surfactants that are dermal irritants at concentrations generally greater than 20% solution (WHO 1996). Thus, dermal exposure would be self-limiting to preclude dermal irritation. Most pesticide formulations have less than 5% alkylbenzene sulfonates as an inert ingredient, with the vast majority of household products containing approximately 2%. Additionally, the requirement of the dermal toxicity studies with the end-use product will determine whether personal protective clothing would be necessary to protect against irritation during product use; (2) no systemic toxicity was seen following repeated dermal

applications to rabbits at 200 mg/kg/day (with an end use product); (3) no developmental toxicity concerns were seen following repeated dermal applications to pregnant mice, rats or rabbits (developmental effects were seen either in the presence of maternal toxicity or at doses higher than those that caused maternal toxicity); and (4) there is no residential exposure to alkylbenzene sulfonates as an active ingredient, however, residential exposure from its use as an inert ingredient in pesticide formulations is expected to be of an intermittent nature (i.e, no continuous, constant contact, multi-day exposure) from household products.

Inhalation Exposure: For the short-, intermediate- and long-term inhalation exposure a NOAEL of 1 mg/m^3 was selected (equivalent to 0.14 mg/kg/day) from a subchronic inhalation monkey study that noted weight loss and decreased weight gain at 10 mg/m^3 (1.4 mg/kg/day) following exposure to a detergent dust containing 13% active ingredient of alkylbenzene sulfonates. In the absence of data, it was conservatively assumed that inhalation absorption is 100% to convert the air concentration into a dose equivalent. The target MOE is 100 for both residential and occupational exposures (10X for interspecies extrapolation, 10X for intraspecies variability, includes 1X FQPA factor discussed below).

FQPA Safety Factor. The TAC agreed that the FQPA safety factor should be **removed (1X).** A number of developmental studies via the oral route have been performed with alkylbenzene sulfonates in rats, mice and rabbits. The available information in these studies does not suggest any qualitative or quantitative evidence for susceptibility between the fetuses and maternal animals. The alkylbenzene sulfonates were tested in several multigeneration studies in rats, and there were no effects on offspring toxicity in any of these tests at doses up to 250 mg/kg/day.

Based on OPP policy, the cRfD modified by a FQPA safety factor is a population adjusted dose (PAD)[1]. OPP calculated a chronic PAD and used this value to estimate chronic dietary risk.

Dietary (Food/Drinking Water) Exposure and Risk: The Agency has conducted three chronic dietary exposure and risk assessments for the alkylbenzene sulfonates: (1) as active ingredients in food contact sanitizing solutions; (2) as active ingredients in a fruit and vegetable wash; and (3) as inert ingredients in pesticide formulations that may be applied to growing agricultural crops, raw agricultural commodities after harvest, and to animals. An acute dietary assessment was not conducted because there are no adverse effects attributable to a single dose.

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[1] PAD = Population Adjusted Dose = $\frac{\text{Chronic RfD}}{\text{FQPA Safety Factor}}$

In assessing the food contact sanitizing uses, the Agency believes that a counter top, utensils or glassware that are treated with these products may come into contact with food, which in turn may be ingested. This is considered to be an indirect food use. Dodecylbenzene sulfonic acid (27176-87-0) and sodium dodecylbenzene sulfonate (25155-30-0) have tolerance exemptions as specified in 40 CFR 180.940 (b) and (c). Both dodecylbenzene sulfonic acid and sodium dodecylbenzene sulfonate have limitations for the ready-to-use end-use concentration not to exceed 400 ppm and 430 ppm, respectively for food processing equipment and utensils. However, dodecylbenzene sulfonic acid has a much lower limitation of 5.5 ppm for use on dairy processing equipment.

When assessing chronic (non-cancer) dietary risk, the Agency considered potential dietary exposure to the U.S. population including infants and children, as well as to females of childbearing age (13-50 years). EPA expresses dietary risk estimates as a percentage of the chronic PAD. Dietary exposures that are less than 100% of the cPAD are below the Agency's level of concern.

Active Ingredient Dietary Risk Estimates. There are no currently registered outdoor uses of alkylbenzene sulfonates that are being supported by the registrant as an active ingredient. Thus, the dietary assessment for active uses was limited to potential food exposures. The risk analysis assumes daily exposure from the hard surface sanitation of counter tops, utensils, glassware and food processing equipment (i.e., beverage plants, meat and poultry processing plants, milk and dairy plants). The dietary risk estimates for the fruit and vegetable wash were considered separately, because this use is regulated by the Food and Drug Administration (FDA). The dietary risk estimates for the total food contact sanitizing uses are below the Agency's level of concern for all age groups (less than **11% of the cPAD**). In addition, the dietary risk estimates for the fruit and vegetable wash are below the Agency's level of concern for all age groups (less than **71.2% of the cPAD**). These risk estimates are based on a number of conservative assumptions, and thus may overestimate the actual risks.

Inert Ingredient Dietary Risk Estimates. The alkylbenzene sulfonates have some uses as inert ingredients in food-use pesticide products that are used outdoors on agricultural crops. Thus, the inert assessment considered both food and drinking water exposures. The Agency utilized a conservative screening level dietary exposure model [Dietary Exposure Evaluation Model (DEEM™)] that assumed 100% of all commodities, and 100% of all crops were treated with the alkylbenzene sulfonates, with no limitation on the fraction of inert ingredient. The highest dietary risk estimate is **84% of the cPAD** for children 1-2 years of age, which is below the Agency's level of concern. The conservative screening-level drinking water assessment predicted chronic Estimated Drinking Water Concentrations (EDWC) of 6.6 ppb using the FQPA Index Reservoir Screening Tool (FIRST), which represents **<0.1% of the cPAD**. The Agency concludes there is no concern for aggregate food and drinking water exposures to the alkylbenzene sulfonates resulting from their use as pesticide inert ingredients.

Residential (Non-Occupational) Exposure and Risk: There are no residential use sites for the alkylbenzene sulfonates as active ingredients. However, alkylbenzene sulfonates are formulated as inert ingredients in approximately 350 registered end-use products, many of which are used in residential settings. Some examples of the specified use sites on the products consist of indoor hard non-porous surfaces (e.g. floors, walls etc.), carpets, food contact surfaces (glasses, dishes, silverware, countertops, etc.), agricultural tools and crops, lawns and turfs, fruits and vegetables (post-harvest), wood preservatives, materials preservatives, metalworking fluids, and pet products. In this screening level assessment, the Agency selected representative scenarios for the vast majority of products, based on end-use product application methods and use amounts. The Agency evaluated the following high end exposure scenarios: (1) outdoor residential turf treatment (ready to use liquid); (2) indoor hard surface cleaner (ready to use liquid; and (3) pet flea and tick products (aerosol can spray). For each of the use sites, the Agency assessed residential handler (applicator) inhalation exposure and post application incidental ingestion by toddlers.

For most scenarios, the Agency utilized EPA's Pesticide Inert Risk Assessment Tool (PiRat) to estimate residential applicator and post-application exposures from the use of alkylbenzene sulfonates as inert ingredients in residential products. For the pet product scenario and the hard surface cleaner post application exposure assessment, the Agency used assumptions based on the Residential Exposure Assessment Standard Operating Procedures (SOPs). Because there are a large number of products that contain alkylbenzene sulfonates as an inert ingredient, and to be conservative the Agency assessed a representative high end formulation product. A dermal assessment was not conducted because a dermal endpoint was not selected. An inhalation post-application assessment was not conducted because the vapor pressure of the sulfonates is extremely low. The duration of exposure was assumed to be short-term (1-30 days) for all residential scenarios assessed.

Residential Handler Risk Estimates. For residential handlers that handle products containing alkylbenzene sulfonates as inert ingredients, the short-term inhalation MOEs were above the target MOEs (i.e., >100) and thus, do not exceed the Agency's level of concern, with the exception of the flea and tick product where the MOE was 87 for the high-end formulation containing 24% alkylbenzene sulfonates. However, this scenario is conservative because it assumes a person treats his/her pet with 0.5 cans of flea product that contains 24% alkylbenzene sulfonates every day for a month.

Residential Postapplication Risk Estimates. There are no residential postapplication risk concerns for the household products that contain alkylbenzene sulfonates as an inert ingredient. All of the scenarios evaluated have short-term MOEs above 100, and thus are not of concern including postapplication incidental oral risks to children that may contact turf, hard surfaces or a pet treated with pesticide products containing alkylbenzene sulfonates as an inert ingredient.

The alkylbenzene sulfonates caused dermal irritation following repeated dermal

exposure, generally to concentrations greater than 20%. Thus, dermal exposure would be self-limiting to preclude dermal irritation. The majority of residential products contain less than 5% alkylbenzene sulfonates. The Agency intends to consider the potential for irritation in recommended labeling language of pesticide products containing the alkylbenzene sulfonates, and consider available dermal toxicity data on a diluted end-use formulation.

Aggregate Exposure and Risk: In order for a pesticide registration to continue, it must be shown that the use does not result in "unreasonable adverse effects on the environment". Section 2 (bb) of FIFRA defines this term to include "a human dietary risk from residues that result from a use of a pesticide in or on any food inconsistent with standard under section 408..." of FFDCA. As mandated by the FQPA amendments to FIFRA and the Federal Food, Drug and Cosmetic Act (FFDCA), the Agency must consider total aggregate exposure from food, drinking water and residential sources of exposure to alkylbenzene sulfonates.

An acute aggregate assessment was not conducted because there are no adverse effects attributable to acute exposure. An intermediate-term aggregate assessment was not conducted because there are no residential exposures of this duration. In addition, because there are no long-term residential exposures, the chronic aggregate assessment only considered food and drinking water exposures from the inert uses that were previously determined to not be of risk concern. Thus, only short-term and chronic aggregate assessments were conducted. Oral and inhalation exposure and risk estimates were conservatively combined for the aggregate risk assessment because these endpoints both identify adverse effects on body weight. Dermal exposures were not considered in the risk assessment because a toxicological endpoint was not established.

Short-Term. This assessment considers both the active and inert uses of the alkylbenzene sulfonates. For children, the short-term aggregate assessment includes average dietary exposure (food and drinking water) from both the active food contact sanitizer uses and the inert uses on agricultural commodities, in addition to estimated incidental oral exposures to children from residential uses such as hard surface cleaning products as an inert ingredient. For adults, the aggregate assessment includes dietary (food and drinking water) from both active and inert uses and residential inhalation exposures from wiping a hard surface cleaning products since this scenario represents the highest exposure from the inert use. Individual scenarios that had risks of concern were not included in the aggregate assessment.

The aggregate oral and inhalation risks are not of concern for adults, as the total aggregate MOE is 340 which is greater than the target of 100. For children, the aggregate risk estimate is very close to the target MOE of 100 (MOE=99). As noted previously, several conservative assumptions were used in this assessment.

Chronic Aggregate. The chronic aggregate assessment considers average dietary exposure (food and drinking water) from both the active food contact sanitizer uses and the inert uses on agricultural commodities. The dietary exposures from the

fruit and vegetable wash were not considered because it would be overly conservative to assume simultaneous exposure to alkylbenzene sulfonates from three different use patterns. For children, the dietary aggregate risk is **95% of the cPAD**, while for adults it is **29% of the cPAD**.

It should also be recognized that the majority of the uses of alkylbenzene sulfonates are not in pesticide products, but rather are used in household laundry and dish detergents. Over 800 millions pounds of these compounds are produced each year, while only 300,000 pounds are used in EPA registered antimicrobial products. The Agency did not consider potential exposure and risks from the numerous other residential exposures to alkylbenzene sulfonates because the Agency lacks reliable information at this time to assess the consumer product uses of these chemicals.

Occupational Exposure and Risk. Based on examination of product labels describing uses for the product, it has been determined that exposure to handlers can occur in a variety of occupational environments. The representative scenarios selected by the Agency for assessment were evaluated using maximum application rates as recommended on the product labels for the three alkylbenzene sulfonate active ingredients assessed in this report.

To assess the handler risks, the Agency used surrogate unit exposure data from both the proprietary Chemical Manufacturers Association (CMA) antimicrobial exposure study and the Pesticide Handlers Exposure Database (PHED). Only inhalation risks were evaluated because a dermal toxicity endpoint was not selected. For the occupational handler inhalation risk assessment, the short- and intermediate-term risks calculated at baseline exposure (no respirators) were above target MOEs for all scenarios (i.e., inhalation MOEs were >100) for all scenarios except the following:

- ST and IT inhalation exposure from cleaning hard surfaces via wiping in the food handling category, inhalation MOE = 93.

Many product labels have use directions that recommend both cleaning and sanitizing with the same product. Thus, the Agency estimated total risks resulting from use of these specific products. The following scenarios had risks of concern (i.e., MOE < 100).

- ST and IT inhalation exposure from cleaning indoor hard surfaces via wiping and then following with sanitizing via immersion/flooding in the food handling premises category, inhalation MOE = 93.
- ST and IT inhalation exposure from cleaning indoor hard surfaces via wiping and then following with sanitizing via low pressure spray in the food handling premises category, inhalation MOE = 90.
- ST and IT inhalation exposure from cleaning indoor hard surfaces via sponge/mesh/wiping and then sanitizing via immersion/flooding in the food handling premises category, inhalation MOE = 90.

Although all the inhalation risks of concern are for baseline exposures, the Agency does not believe it is practicable to require the use of respiratory protection on cleaning products used in janitorial situations. In addition, engineering controls are not feasible for the current use patterns on the labels.

As noted previously, the alkylbenzene sulfonates are dermal irritants at concentrations greater than 20%. Thus, dermal exposure would be self-limiting to preclude dermal irritation. The Agency intends to consider the potential for irritation in recommended labeling language of pesticide products containing the alkylbenzene sulfonates, and consider available dermal toxicity data on a diluted end-use formulation. The Agency should confirm that all products with greater than 20% require the use of gloves.

For most of the occupational scenarios, postapplication dermal exposure is not expected to occur or is expected to be negligible based on the application rates and chemical properties of the chemical. The alkylbenzene sulfonates have a low vapor pressure (less than 10^{-9} mmHg), so that any standing solutions that may result in post application exposure were deemed negligible.

Environmental Hazard and Risk. The alkylbenzene sulfonates are slightly toxic to the Northern bobwhite quail, and moderately toxic to freshwater fish and freshwater invertebrates following acute exposure. The available data indicate that the alkylbenzene sulfonates are slightly toxic to green algae.

Available literature for linear alkylbenzene sulfonate (LAS) detergent use indicates that the alkylbenzene sulfonates are not expected to bioaccumulate in the environment or aquatic organisms (i.e. fish) and are expected to be soluble in water such that they will exhibit mobility through the soil. The model-calculated linear and non-linear biodegradation probabilities suggest that these chemicals will most likely biodegrade rapidly. The short half life indicates that if these chemicals are present in the soil, they are not likely to be volatile and are expected to degrade rapidly in the environment.

Minimal or no environmental exposure is expected to occur from the majority of alkylbenzene sulfonate antimicrobial pesticide uses because a very small number of pounds of this chemical are sold for antimicrobial use per data provided by the manufacturers.

The inert agricultural uses of alkylbenzene sulfonates are not expected to adversely affect avian or mammalian species on an acute or chronic basis. Aquatic organisms are also not expected to be adversely affected by inert alkylbenzene sulfonates use acutely or chronically due to the low predicted level of alkylbenzene sulfonates in water. A chronic freshwater fish toxicity test NOAEC of 400 ug/L alkylbenzene sulfonates is considered protective of ecosystem structure and function in

experimental streams. Therefore, the predicted concentration of 6.6 ppb in water is well below the Agency's chronic Level of Concern (LOC).

Use of alkylbenzene sulfonates in agricultural pesticide formulations is not expected to result in significant environmental exposure. Therefore, no adverse effects (NE) to listed species are anticipated.

2.0 PHYSICAL AND CHEMICAL PROPERTIES

The physical and chemical properties for the three alkylbenzene sulfonates assessed in this document: (1) sodium dodecylbenzene sulfonate, (2) benzene sulfonic acid, C10-16-alkyl derivatives, and (3) dodecylbenzene sulfonic acid are provided in Table 1. The product chemistry chapter (memo from N. Shamim, July 2006, D330332) provides a comprehensive list of the different physical/chemical properties. Below is the chemical structure for a representative C12-linear alkylbenzene sulfonate (LAS).

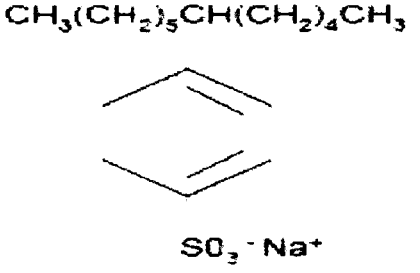

Figure 1: Sodium Dodecylbenzene Sulfonate (also named as dodecylbenzene sulfonic acid, sodium salt)

Table 1 Physical/Chemical Properties of Linear Alkylbenzene Sulfonates			
Parameter	**Sodium Dodecylbenzene Sulfonate**	**Benzene Sulfonic Acid, C10-16-alkyl derivatives**	**Dodecylbenzene Sulfonic Acid (DDBSA)**
PC Chemical Code	079010 (active) 790102 (inert)	190116 (active) 790116 (inert)	098002 (active) 790101 (inert)
Cas Number	25155-30-0	68584-22-5	27176-87-0

Table 1 Physical/Chemical Properties of Linear Alkylbenzene Sulfonates			
Molecular Formula	$C_{18}H_{29}O_3S$ Na	$C_{18}H_{20}O_3S$	$C_{18}H_{30}O_3S$
Synonyms	Alkyl(C12)benzenesulfonic acid, sodium salt Benzenesulfonic acid, dodecyl-, sodium salt Dodecylbenzene sodium sulfonate Dodecylbenzenesulfonic acid, sodium salt Sodium laurylbenzenesulfonate		Benzenesulfonic acid, dodecyl
Molecular Weight	348.48 g/mol	326.6 g/mol	326.50 g/mol
Henry Law Constant	6.02×10^{-17} atm.-m^3/mol	2.8×10^{-11} atm-m^3/mol	4.8×10^{-11} atm-m^3/mol
Melting Point	287.6°C	167.7 °C	178 °C
Boiling Point	660°C	437 °C	460 °C
Water Solubility	800 mg/L	400 g/L (25 ° C)	400 g/L (25 ° C)
log K_{ow}	1.96	3.80	4.78
Vapor Pressure	6.02×10^{-15} mm Hg	5.1×10^{-10} mm Hg (25° C)	7.9×10^{-11} mm Hg (25° C)
Half-life in air	0.66 days = 7.9 hours	0.79 days = 9.48 hours	0.654 days = 7.85 hours

3.0. ENVIRONMENTAL FATE

Detailed information on environmental fate is presented in the attached memo from T. Milano (July 6, 2006, D323968). A brief summary is provided below.

The environmental fate properties of dodecylbenzene sulfonic acid are assumed to be represented by the conclusions made pertaining to benzenesulfonic acid, C10-C16 alkyl derivatives. This is because dodecylbenzene sulfonic acid (DDBSA) is not considered to be a pure compound, and is actually included in the mixture of benzenesulfonic acid, C10-16 alkyl derivatives. These compounds will be addressed as a group, DDBSA.

The environmental fate assessment for DDBSA is based on US EPA=s Estimation Programs Interface (EPI) Suite. EPI Suite provides estimations of physical/chemical properties and environmental fate properties.

Based on the output of the model, sodium dodecylbenzene sulfonate is highly unlikely to bioaccumulate in the environment or aquatic organisms (i.e. fish) because the low value for the log Kow (1.96). This also supports that the chemical is soluble in water such that it will exhibit mobility through the soil. In addition, the low log Koc (4.22) further supports the expected soil mobility. The model-calculated linear and non-linear biodegradation probabilities suggest that the linear carbon chain will biodegrade rapidly, whereas the benzene ring is not expected to biodegrade as rapidly. The extremely low vapor pressure along with the short half life of approximately 7.9 hours indicates that if this chemical is present in the soil, it is not likely to be volatile and is expected to degrade rapidly.

Based on the output of the model, DDBSA is expected to behave very similarly as what is projected for sodium dodecylbenzene sulfonate. Based on the low Kow value (3.8), DDBSA is highly unlikely to bioaccumulate in the environment or aquatic organisms (i.e. fish). The chemical is also expected to be soluble in water such that it will exhibit mobility through the soil. In addition, the log Koc (3.69) is low, and this further supports the expected soil mobility. The model-calculated linear and non-linear biodegradation probabilities suggest that the chemical will most likely biodegrade rapidly. The extremely low vapor pressure along with the short half life of approximately 9.48 hours indicates that this chemical is not likely to be volatile and is expected to degrade rapidly.

The output parameters from the EPI Suite model support that any potential impacts of these chemicals are expected to be very short-lived. This is because they are not likely to persist in water or microbial soils and sediments. As a result, the environmental fate of alkylbenzene sulfonate is not likely to be of concern.

4.0 HAZARD CHARACTERIZATION

4.1 Hazard Profile

The toxicology database for the alkylbenzene sulfonates consists almost entirely of published literature, is essentially complete and of acceptable quality to assess the potential hazard to humans.

A detailed Toxicology Assessment for the linear alkylbenzene sulfonates is presented in the attached memorandum (memo from A. Assaad/W. Dykstra/L. Scarano, July 2006). Table 2 highlights the acute toxicity studies for the alkylbenzene sulfonates. A detailed summary of the key toxicological studies is presented in Appendix A because of the large number of available toxicological information on these compounds. A brief hazard assessment is presented below.

Acute Toxicity. Alkylbenzene sulfonates exhibit a wide range of acute toxicity via the oral route in rats (LD_{50}s of 404 – 1980 mg/kg), with a narrower range in mice (LD_{50}s of 1259-2300 mg/kg). This spans the acute oral toxicity categories of III-IV. Alkylbenzene sulfonates are classified as acute toxicity category II for the dermal route and category IV (least toxic) via

the inhalation route. They are irritants to the eye (category I), and skin (category II), and are not skin sensitizers.

Absorption, Distribution, Metabolism, Excretion. In animal tests (oral – monkeys, pigs, rats), alkylbenzene sulfonates are readily absorbed from the gastrointestinal tract, are distributed throughout the body, and are extensively metabolized. Excretion is via both the urine and feces. Available dermal absorption data (rats and guinea pigs) indicate that alkylbenzene sulfonates are poorly absorbed from the skin, although prolonged contact may lead to irritation and thus compromise the skin to permit more absorption (WHO, 1996 and HERA, 2004).

Repeated Dose Toxicity (Subchronic and Chronic). There have been many oral repeated dose studies performed with alkylbenzene sulfonates ranging from a 28-day study in monkeys to nine month studies conducted with rats and mice. There have also been repeated dose dermal (guinea pigs, rabbits, and rats) and inhalation studies (dogs and monkeys). Collectively, the animal data suggest that the liver, kidney and caecum (for oral studies) are the major target organs for toxicity. The liver and kidney effects were dose and duration related in that mild effects (organ weight changes and serum enzyme/clinical chemistry changes indicative of mild organ effects) were seen at lower doses, but increased in severity with both dose and time.

For the purposes of this hazard assessment, several studies were considered collectively to determine a NOAEL of 50 mg/kg/day for the chronic dietary endpoint. This is based on: increased caecum weight and slight kidney damage (at a LOAEL of 114 mg/kg/d in the six month rat study); reduced body weight in 21-day old pups (at a LOAEL of 250 mg/kg/day in a reproductive toxicity rat study); and significant decreases in renal biochemical parameters (at a LOAEL of 145 mg/kg/day in a nine month drinking water study in rats).

Developmental Toxicity. A number of developmental studies via the oral and dermal routes have been performed with alkylbenzene sulfonates in rats, mice and rabbits; there were also several subcutaneous injection developmental studies reported in mice (WHO, 1996). There is a spectrum of quality in the 20+ studies in terms of dosing (some had only one or two doses), purity of alkylbenzene sulfonates used (some used formulated products that ranged from 1-45% alkylbenzene sulfonates content), and overt toxicity to the pregnant females in the dermal studies due to severe irritating effects. It is concluded that some developmental effects (including some terata) were observed at high doses at which maternal toxicity was observed and the available information does not suggest any qualitative or quantitative susceptibility differences between fetuses and maternal animals.

Reproductive Toxicity. Alkylbenzene sulfonates were tested in several multigeneration studies in rats. There were no effects on reproductive parameters in any of these tests at doses up to 250 mg/kg/day.

Carcinogenicity. The available long-term studies that assessed carcinogenicity were older studies (pre-1970) that would not be acceptable under current standards (due to low number of animals used, insufficient number of doses and duration of dosing, and limited histopathological examinations. However, the limited studies provide no evidence of carcinogenicity in animals given alkylbenzene sulfonates orally.

Genotoxicity. The toxicological data show that alkylbenzene sulfonates were not genotoxic in vitro or in vivo.

Neurotoxicity. There is no evidence in the available toxicity studies or scientific literate to indicate neurotoxic effects of the alkylbenzene sulfonates in humans or laboratory animals.

Table 2 Acute Toxicity Studies for Alkylbenzene Sulfonates

Guideline No./ Study Type	MRID No.	Results	Toxicity Category
870.1100 Acute oral toxicity	Multiple	LD_{50} = range from 404 to over 5000 mg/kg	III-IV
870.1200 Acute dermal toxicity	94032006	LD_{50} = 1200 mg/kg	II
870.1300 Acute inhalation toxicity	003442*	LC_{50} = 200 mg/L	IV
870.2400 Acute eye irritation	0033443*	Corneal opacity not reversed at 72 hours.	I
870.2500 Acute dermal irritation	003444*	Severe irritation at 72 hours	II
870.2600 Skin sensitization	Open Literature	Non-Sensitizer	

* Toxicity record No.

4.2 FQPA Considerations

Under the Food Quality Protection Act (FQPA), P.L. 104-170, which was promulgated in 1996 as an amendment to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Federal Food, Drug and Cosmetic Act (FFDCA), the Agency was directed to "ensure that there is a reasonable certainty that no harm will result to infants and children" from aggregate exposure to a pesticide chemical residue. The law further states that in the case of threshold effects, for purposes of providing this reasonable certainty of no harm, "an additional tenfold margin of safety for the pesticide

chemical residue and other sources of exposure shall be applied for infants and children to take into account potential pre- and post-natal toxicity and completeness of the data with respect to exposure and toxicity to infants and children. Notwithstanding such requirement for an additional margin of safety, the Administrator may use a different margin of safety for the pesticide residue only if, on the basis of reliable data, such margin will be safe for infants and children."

The toxicology database is complete with respect to assessing the increased susceptibility to infants and children as required by FQPA for alkylbenzene sulfonates. The prenatal developmental and reproduction studies showed no qualitative or quantitative evidence of increased susceptibility (i.e., developmental NOAELs/LOAELs were the higher than those for maternal effects). Therefore, the FQPA factor was reduced to 1X.

Several reproduction and many developmental studies have been performed with alkylbenzene sulfonate in a number of animal species. In the developmental studies, whenever toxicity was observed in adults, it was generally for mild effects (slight body weight changes, intestinal disturbances) except for severe dermal irritation effects in dermal developmental studies. Any developmental toxicity observed in these same studies included minor increases in visceral/skeletal anomalies and some fetal losses; but only at maternally toxic doses.

In one reproduction study (Buehler et al., 1971), there were slight changes in hematology and histopathology (both within historical control ranges) and slight decreases in body weight in the offspring at the highest dose of 250 mg/kg/d (at which there were no effects on the parental generation). There were no effects in either the parents or offspring in the other two reproductive toxicity studies (see Toxicity Profile Table) – high doses of 70 or 170 mg/kg/day.

There is no evidence in the available toxicity studies or scientific literature to indicate neurotoxic effects of the alkylbenzene sulfonates in humans or laboratory animals.

Based on hazard data, the Agency recommended the special FQPA SF be reduced to 1X because there are no concerns and no residual uncertainties with regard to pre- and/or postnatal toxicity. The risk assessment team evaluated the quality of the exposure data; and based on these data the team also recommended that the special FQPA SF be reduced to 1X. There is no need for a special FQPA factor because the mid-dose level of 50 mg/kg/day (NOAEL for offspring effects) in a reproduction study (Buehler et al. 1971) is the basis for the chronic RfD of 0.5 mg/kg/day. Thus, the chronic hazard value is based on slight pup effects and is protective of laboratory animals of all ages in this hazard assessment.

4.3 Dose-Response Assessment

The Health Effects Division's Toxicity Advisory Clinic (TAC) was consulted and agreed with the choice of toxicity endpoints of concern in December 2005 for the alkylbenzene sulfonates as a group.

Table 3. Summary of Toxicological Dose and Endpoints for Alkylbenzene Sulfonates			
Exposure Scenario	**Dose Used in Risk Assessment, UF**	**Special FQPA SF*, endpoint and Level of Concern for Risk Assessment**	**Study and Toxicological Effects**
Acute Dietary (All populations)	No endpoint was selected. No effects are attributable to a single dose.		
Chronic Dietary (All populations)	Systemic/ Reproductive NOAEL= 50 mg/kg/day UF = 100 **Chronic RfD** = 0.5 mg/kg/day	FQPA SF = 1X **cPAD** = chronic RfD / FQPA SF = 0.5 mg/kg/day	Systemic/Reproductive LOAEL = 250 mg/kg/day based on decreased Day 21 female pup body weight (Buehler, E. et al. 1971. Tox. Appl. Pharmacol. 18:83-91) **plus** LOAEL= 145 mg/kg/day from 9 month drinking water rat study based on decreased body weight gain, and serum/ biochemical and enzymatic changes in the liver and kidney (Yoneyama et al. 1976 Ann. Rep. Tokyo Metrop. Res. Lab. Public Health 27(2):105-112) **plus** LOAEL= 114 mg/kg/day (0.2%) based on increased caecum weight and slight kidney damage in a 6 month rat dietary study (Yoneyama et al 1972 Ann. Rep. Tokyo Metrop. Res. Lab. Public Health 24:409-440)

Table 3. Summary of Toxicological Dose and Endpoints for Alkylbenzene Sulfonates			
Exposure Scenario	**Dose Used in Risk Assessment, UF**	**Special FQPA SF*, endpoint and Level of Concern for Risk Assessment**	**Study and Toxicological Effects**
Short-Term Incidental Oral (1-30 days)	Oral NOAEL= 50 mg/kg/day	**Residential** LOC for MOE < 100	Systemic/Reproductive LOAEL = 250 mg/kg/day based on decreased Day 21 female pup body weight (Buehler, E. et al. 1971. Tox. Appl. Pharmacol. 18:83-91) **plus** LOAEL= 145 mg/kg/day from 9 month drinking water rat study based on decreased body weight gain, and serum/ biochemical and enzymatic changes in the liver and kidney (Yoneyama et al. 1976 Ann. Rep. Tokyo Metrop. Res. Lab. Public Health 27(2):105-112) **plus** LOAEL= 114 mg/kg/day (0.2%) based on increased caecum weight and slight kidney damage in a 6 month rat dietary study (Yoneyama et al 1972 Ann. Rep. Tokyo Metrop. Res. Lab. Public Health 24:409-440)

Table 3. Summary of Toxicological Dose and Endpoints for Alkylbenzene Sulfonates			
Exposure Scenario	**Dose Used in Risk Assessment, UF**	**Special FQPA SF*, endpoint and Level of Concern for Risk Assessment**	**Study and Toxicological Effects**
Short-, intermediate- and Long-Term Inhalation (1 to 30 days, 1-6 months, >6 months)	Inhalation study NOAEL= 1mg/m^3 detergent dust combined with up to 0.1 mg/m^3 enzyme dust Equivalent to approximately 0.14 mg/kg/day (a) (inhalation absorption rate = 100%) purity= 13% active ingredient	**Residential** LOC for MOE < 100 **Occupational** LOC for MOE < 100	Subchronic Inhalation Monkey Study LOAEL = 10 mg/m^3 detergent combined with 0.1 mg/m^3 enzyme dust based on weight loss and decreased weight gain (W. Coates, et al 1978. Tox. Appl. Pharmacol. 45: 477-496) This air concentration is equivalent to approximately 1.4 mg/kg/day (a)

Table 3. Summary of Toxicological Dose and Endpoints for Alkylbenzene Sulfonates			
Exposure Scenario	**Dose Used in Risk Assessment, UF**	**Special FQPA SF*, endpoint and Level of Concern for Risk Assessment**	**Study and Toxicological Effects**
Dermal Endpoint	Quantification of dermal risk is not required since: 1) the alkylbenzene sulfonates are surfactants that are dermal irritants at concentrations generally greater than 20% solution (WHO 1996). Thus, dermal exposure would be self-limiting to preclude dermal irritation. Most pesticide formulations have less than 5% alkylbenzene sulfonates as an inert ingredient, with the vast majority of household products containing approximately 2%. Additionally, the requirement of the dermal toxicity studies with the end-use product will determine whether personal protective clothing would be necessary to protect against irritation during product use; 2) no systemic toxicity was seen following repeated dermal applications to rabbits at 200 mg/kg/day (with an end use product); 3) no developmental toxicity concerns were seen following repeated dermal applications to pregnant mice, rats or rabbits (developmental effects were seen either in the presence of maternal toxicity or at doses higher than those that caused maternal toxicity); and 4) there is no residential exposure to alkylbenzene sulfonates as an active ingredient, however, residential exposure from its use as an inert ingredient in pesticide formulations is expected to be of an intermittent nature (i.e, no continuous, constant contact, multi-day exposure) from household products.		
Cancer (oral, dermal, inhalation)	No evidence of carcinogenicity in reported studies in rats done before 1980 GLPs		

UF = uncertainty factor, FQPA SF = Special FQPA safety factor, NOAEL = no observed adverse effect level, LOAEL = lowest observed adverse effect level, PAD = population adjusted dose (a = acute, c = chronic) RfD = reference dose, MOE = margin of exposure, LOC = level of concern, NA = Not Applicable

(a) Equation used to convert inhalation air concentration to a dose= mg/L* absorption*respiratory volume (L/hr)*duration (hrs) * activity factor / body weight. Thus, 0.001 mg/L * 1*67.94 L/hr (based on default respiratory volumes for a New Zealand Rabbit which is used as a surrogate for a cynomolgus monkey) * 6 hrs * 1 / 2.98 kg (body weight for New Zealand Rabbit used as a surrogate for cynomolgus monkey, study reports monkey body weight ranges from 1.6 to 3.7 kg).

4.4 Endocrine Disruption

EPA is required under the FFDCA, as amended by FQPA, to develop a screening program to determine whether certain substances (including all pesticide active and other ingredients) "may have an effect in humans that is similar to an effect produced by a naturally occurring estrogen, or other such endocrine effects as the Administrator may designate." Following recommendations of its Endocrine Disruptor and Testing Advisory Committee (EDSTAC), EPA determined that there was a scientific basis for including, as part of the program, the androgen and thyroid hormone systems, in addition to the estrogen hormone system. EPA also adopted EDSTAC's recommendation that the Program include evaluations of potential effects in wildlife. For pesticide chemicals, EPA will use FIFRA and, to the extent that effects in wildlife may help determine whether a substance may have an effect in humans, FFDCA authority to require the wildlife evaluations. As the science develops and resources allow, screening of additional hormone systems may be added to the Endocrine Disruptor Screening Program (EDSP).

In the available toxicity studies on the alkylbenzene sulfonates, there was no estrogen, androgen, and/or thyroid mediated toxicity. When additional appropriate screening and/or testing protocols being considered under the Agency's EDSP have been developed, alkylbenzene sulfonates may be subjected to further screening and/or testing to better characterize effects related to endocrine disruption.

5.0 PUBLIC HEALTH DATA

Incident Reports. There are no human incident reports associated with alkylbenzene sulfonates. The Agency consulted the following databases for poisoning incident data for alkylbenzene sulfonates:

(1) **OPP Incident Data System (IDS)** - The Incident Data System of The Office of Pesticide Programs (OPP) of the Environmental Protection Agency (EPA) contains reports of incidents from various sources, including registrants, other federal and state health and environmental agencies and individual consumers, submitted to OPP since 1992. Reports submitted to the Incident Data System represent anecdotal reports or allegations only, unless otherwise stated. Typically no conclusions can be drawn implicating the pesticide as a cause of any of the reported health effects. Nevertheless, sometimes with enough cases and/or enough documentation risk mitigation measures may be suggested.

(2) **Poison Control Centers (1993-2003)** - as the result of a data purchase by EPA, OPP received Poison Control Center data covering the years 1993 through 2003 for all pesticides. Most of the national Poison Control Centers (PCCs) participate in a national data collection system, the Toxic Exposure Surveillance System, which obtains data from about 65-70 centers at hospitals and universities. PCCs provide telephone consultation for

individuals and health care providers on suspected poisonings, involving drugs, household products, pesticides, etc.

(3) **California Department of Pesticide Regulation (1982-2004)** - California has collected uniform data on suspected pesticide poisonings since 1982. Physicians are required, by statute, to report to their local health officer all occurrences of illness suspected of being related to exposure to pesticides. The majority of the incidents involve workers. Information on exposure (worker activity), type of illness (systemic, eye, skin, eye/skin and respiratory), likelihood of a causal relationship, and number of days off work and in the hospital are provided.

(4) **National Pesticide Telecommunications Network (NPTN)** - NPTN is a toll-free information service supported by OPP. A ranking of the top 200 active ingredients for which telephone calls were received during calendar years 1984-1991, inclusive, has been prepared. The total number of calls was tabulated for the categories human incidents, animal incidents, calls for information, and others.

6.0 EXPOSURE ASSESSMENT AND CHARACTERIZATION

Dietary exposure to alkylbenzene sulfonates can occur from its use in food contact sanitizing solutions as an active ingredient, and as an inert ingredient in food-use pesticide products applied to agricultural crops, and animals. There are no currently registered products used in residential settings where alkylbenzene sulfonates are considered to be an active ingredient. However, alkylbenzene sulfonates are used as an inert ingredient in pesticide products used in residential settings, including hard surface and carpet cleaners, lawn products, and pet products. Postapplication residential exposure can occur in children from hand-to-mouth incidental oral exposure from treated surfaces, and contacting pets treated with flea and tick products. Occupational exposure to alkylbenzene sulfonates can occur from mixing/loading/application activities in various use sites, including agricultural food handling, and commercial/institutional/industrial premises.

Approximately 300,000 pounds of alkylbenzene sulfonates are used in EPA registered antimicrobial products, which is a small fraction of the approximately 860 million pounds produced each year. The majority of uses of alkylbenzene sulfonates are as household laundry and dish detergents. The alkylbenzene sulfonates are listed on the EPA HPV Challenge Program. HPV chemicals are those that are manufactured or imported into the U.S. in production volumes greater than one million pounds per year. The HPV Challenge Program is a voluntary partnership between industry, environmental groups, and the EPA which invites chemical manufacturers and importers to provide basic hazard data on the HPV chemicals they produce/import. The goal of this program is to facilitate the Public's right-to-know about the potential hazards of chemicals found in their environment, their homes, their workplace, and in consumer products. The alkylbenzene sulfonates are sponsored by the Linear Alkylbenzene (LAB) Sulfonic Acids Coalition, which has generated data for these chemicals.

6.1 Summary of Registered Uses

The alkylbenzene sulfonates are both active and inert ingredients in pesticide products. As active ingredients, they are currently in twenty-three registered end-use products as a disinfectant, food-contact sanitizer, bacteriocide/bacteriostat, microbiocide/microbiostat, fungicide/fungistat, and virucide. Alkylbenzene sulfonates are in cleaners and sanitizers that are designated for use in agricultural, food handling and commercial/institutional/industrial settings. Examples of registered uses for alkylbenzene sulfonates include, but are not limited to: application to indoor hard surfaces (e.g. urinals, shower stalls, toilet bowls, etc.), food dispensing equipment (e.g. pre-mix and post-mix vending machines), food contact surfaces (glasses, dishes, silverware, countertops, etc.), agricultural tools, and fruits and vegetables (post-harvest). As active ingredients, there are no residential or outdoor uses currently registered. As active ingredients, concentrations of alkylbenzene sulfonates in products range from 0.036% to 25.6%. Products containing alkylbenzene sulfonates are formulated as soluble concentrates, flowable concentrates, ready-to-use solutions, or water soluble packaging. The application rates used in this assessment were the maximum application rates as recommended on the product labels.

As inert ingredients, there are approximately 350 registered end-use products containing these chemicals. Some of the inert functions of alkylbenzene sulfonates in the registered products are listed as solvent, surfactant, dispersant, detergent, and wetting agent. Products that contain alkylbenzene sulfonates as an inert are designated for use in agricultural settings, food handling premises, medical premises, commercial/institutional/industrial settings, and residential settings. Some examples of the specified use sites of the products consist of indoor hard non-porous surfaces (e.g. floors, walls etc.), carpets, food contact surfaces (glasses, dishes, silverware, countertops, etc.), agricultural tools and crops, lawns and turfs, fruits and vegetables (post-harvest), wood preservatives, materials preservatives, metalworking fluids, and pet products. Many of these products are formulated as soluble concentrates, flowable concentrates, ready-to-use solutions, or water-soluble packaging.

As inert ingredients, the percent formulations for most of the products that contain alkylbenzene sulfonates as an inert ingredient range from 0.01% to 5%. However, the majority of the labels in this range contain 2% alkylbenzene sulfonates. Because there are a large number of pesticide products that contain alkylbenzene sulfonates as an inert ingredient, the Agency assessed risks at an appropriate high-end formulation, which is dependent upon the product type. It should be noted that a few sanitizing products have inert levels as high as 30% and the highest concentration of alkylbenzene sulfonates are found in wood preservative products up to 65 %.

6.2 Dietary Exposure and Risk

6.2.1 Dietary Exposure for Active Ingredient Uses

Estimates of dietary risk from the use of alkylbenzene sulfonates as active ingredients in pesticide products are based upon the detailed analysis in the Dietary Exposure Assessment memorandum (memo from R. Quick, March 2006, D327731) and are summarized here for completeness. Dodecylbenzenesulfonic acid (27176-87-0) and sodium dodecylbenzene sulfonate (25155-30-0) have uses in food-contact surface sanitizing solutions with tolerance exemptions as specified in 40 CFR 180.940 (b) and (c), and summarized in the Table below. Residues for these compounds are exempt from the requirement of a tolerance when used in accordance with good manufacturing practice as ingredients in an antimicrobial pesticide formulation, provided that the substance is applied on a semi-permanent or permanent food-contact surface (other than being applied on food packaging) with adequate draining before contact with food. Both dodecylbenzene sulfonic acid, and sodium dodecylbenzene sulfonate have limitations for the ready-to-use end-use concentration not to exceed 400 ppm and 430 ppm, respectively for food processing equipment and utensils. However, dodecylbenzene sulfonic acid has a much lower limitation of 5.5 ppm for use on dairy processing equipment. The Agency estimates that the 430 ppm limitation for the sodium salt is equivalent to approximately 400 ppm of the free acid form.

Table 4. Tolerance Exemptions for Food Contact Sanitizer Uses (Active Uses)

Tolerance Exemption Expression/ Chemical Name	CAS No.	PC Code	40 CFR 180.	Use Pattern (Pesticidal)
Benzenesulfonic acid, dodecyl-	27176-87-0	098002	940 (b)	food contact sanitizing solutions for dairy processing equipment, and food processing equipment and utensils; end use concentration not to exceed 5.5 ppm
			940 (c)	food contact sanitizing solutions for food processing equipment and utensils; end use concentration not to exceed 400 ppm
Benzenesulfonic acid dodecyl-, sodium salt	25155-30-0	079010	940 (c)	food contact sanitizing solutions for food processing equipment and utensils; end use concentration not to exceed 430 ppm

Based on the pesticide labels, the Agency assessed dietary exposure that could result from the use of alkylbenzene sulfonates in the food service industry (treated surfaces, dishes, utensils, glassware, pots and pans), in the food processing industry (food processing equipment such as breweries and beverage plants, meat and poultry processing plants, milk and dairy products/packing plants etc), and as a fruit and vegetable wash.

Food Handling Establishments. In the absence of residue data for residues of alkylbenzene sulfonates on treated food contact surfaces, the Agency estimated residue levels that may occur in food from the application rates on food contact surfaces. To determine the Estimated Daily Intake (EDI), the Agency has used an FDA model. The maximum ingredient percentage for dodecylbenzene sulfonates in food handling establishments from the various labels is 400 ppm. The Agency estimates that use of this product results in food residues of 530 ppb (µg/kg). The Agency assumed that food can contact 4000 cm^2 of treated surfaces, utensils, glassware, or pots and pans and that 100% of the pesticide migrates to food based on the standard assumptions used in the FDA Sanitizing Solution Guidelines. It was assumed that an adult and child consume 3000 and 1500 grams of food per day, respectively that will contact the treated surfaces.

Food Processing Equipment. The Agency used the FDA milk truck model to estimate residues in milk that could result from the use of alkylbenzene sulfonates in the food processing equipment, as representative of the potential uses in the food processing industry. As a conservative measure, the Agency assessed the maximum application rate of 400 ppm for dodecylbenzene sulfonates, as listed on the labels, although the current tolerance exemption has a limitation of 5.5 ppm for dairy processing equipment. The Agency estimates that use of this product results in maximum milk residues of 10 ppb (µg/kg).

Fruit and Vegetable Wash. The Agency also estimated dietary exposure from the fruit and vegetable wash of the alkylbenzene sulfonates. This use is regulated by the FDA in 21 CFR 173.315, which permits the wash solution to contain dodecylbenzene sulfonic acid up to 0.2% (2000 ppm), without a potable rinse. Most of the pesticide labels are in compliance with this limitation. One label however, allows a vegetable wash solution containing 0.31% (3100 ppm) dodecylbenzene sulfonic acid, but requires a potable rinse following washing.

In the absence of data for residues on fruits and vegetables, the Agency developed a model and used a number of conservative assumptions. The Agency assumed the maximum application rate of 2000 ppm in wash solution, along with assumptions for Thompson Seedless grapes as a surrogate to represent residues on all treated fruits and vegetables. The model estimates dodecylbenzene sulfonic acid residues of 9.25 ppm, which were used to estimated dietary exposure using the Dietary Exposure Evaluation Model (DEEM-FDIC™), Version 2.03 which uses food consumption data from the USDA's Continuing Surveys of Food Intake by Individuals (CSFII) from

1994-1996 and 1998. This assessment is Tier 1, conservative (assumes 100% of fruits and vegetables are washed) and uses the deterministic approach.

The daily estimates for the above three use patterns were conservatively used to assess chronic dietary risks, which are shown below in Table 5. As noted previously, an acute dietary assessment was not conducted because there are no adverse effects attributable to a single dose exposure.

The dietary risk estimates for the total food contact sanitizing uses are below the Agency's level of concern for all age groups (less than 11% of the cPAD). In addition, the dietary risk estimates for the fruit and vegetable wash for adults and young children are below the Agency's level of concern for all age groups (less than 71.2% of the cPAD). These risk estimates are based on a number of conservative assumptions, and thus may overestimate the actual risks.

Table 5. Summary of Dietary Exposure and Risk for Alkylbenzene Sulfonates Pesticidal Active Uses

Use	Population Subgroup	Chronic Dietary	
		Dietary Exposure (mg/kg/day) a	% cPAD b
Food Service Industry (treated surfaces, utensils, glassware, etc)	adult male	0.023	4.6
	females (13-50 years)	0.027	5.4
	infants/children	0.053	10.6
Food Processing Industry (Food Processing Equipment)	adult male	0.00043	0.086
	females (13-50 years)	0.0005	0.1
	infants/children	0.001	0.2
Total Food Contact Surface Sanitizing Uses	adult male	0.023	4.6
	females (13-50 years)	0.027	5.4
	infants/children	0.054	10.8
Fruit and Vegetable Wash	U.S population	0.0979	19.6
	children 1-2 yrs	0.3558	71.2
	children 3-5 yrs	0.2573	51.5

NA=not applicable

a-- chronic exposure analysis based on body weights of 70 kg, 60 kg, and 15 kg for adult males, females and children, respectively.

b-- %PAD = dietary exposure (mg/kg/day) / cPAD, where cPAD=0.5 mg/kg/day for all populations.

6.2.2 Dietary Exposure for Inert Ingredient Uses

Included in this risk assessment is the reassessment of the alkylbenzene sulfonates when used as an inert ingredient in pesticide products. Estimates of dietary risk from the inert uses of alkylbenzene sulfonates are based upon the detailed analysis in the Inert Ingredient Dietary Risk Assessment memorandum (memo from K. Leifer, March 2006, D327731). As noted previously, some of the inert functions of alkylbenzene sulfonates in the registered products are listed as solvent, surfactant, dispersant, detergent, and wetting agent. Some of these products are designated for use in agricultural settings (i.e., pre- and post-harvest and when applied to animals), where there is a potential for dietary exposure.

The alkylbenzene sulfonates assessed in this document are constituents of a larger group of compounds that have a tolerance exemption as an inert ingredient in 40 CFR 180.910 and 180. 930. As shown in Table 6, the tolerance exemption is listed as Alkyl (C8-C24) benzenesulfonic acid and its ammonium, calcium, magnesium, potassium, sodium and zinc salts.

Table 6. Tolerance Exemptions for Inert Use

Tolerance Exemption Expression	40 CFR 180. (a)	Use Pattern
Alkyl (C8-C24) benzenesulfonic acid and its ammonium, calcium, magnesium, potassium , sodium and zinc salts	910	Surfactants, related adjuvants of surfactants
	930	Surfactants, emulsifier, related adjuvants of surfactants

(a) Residues listed in 40 CFR §180.910 are exempted from the requirement of a tolerance when used as inert ingredients in pesticide formulations when applied to growing crops or to raw agricultural commodities after harvest (i.e., pre- and post-harvest). Residues listed in 40 CFR §180.930 are exempted from the requirement of a tolerance when used as inert ingredients in pesticide formulations when applied to animals only.

A dietary exposure analysis for the inert ingredient use of the alkylbenzene sulfonates was conducted using the generic screening model for estimating inert ingredient dietary exposure. The dietary assessment is unrefined and extremely conservative in nature because the screening model assumes that the inert ingredient is used on all commodities, and that 100 percent of crops are treated with the inert ingredient, with no limitation on the fraction of inert ingredient. Further, the model assumes residues will be present for every consumed commodity (including meat, milk, poultry and eggs) that is included in the Dietary Exposure Evaluation Model (DEEM™). The conservative nature of this assessment is believed to capture all potential dietary exposures, including those from direct application to animals.

Based on the use of the screening level inert ingredient dietary exposure model, there are no risk concerns associated with dietary exposures as the estimated dietary exposures for the U.S. population and all population subgroups are below 100% of the cPAD. As noted, a number of conservative assumptions were used in this screening level dietary risk assessment[1] of inert uses.

Table 7. Summary of Dietary Exposure and Risk for Alkylbenzene Sulfonates as Inert Ingredients

Population Subgroup	Chronic Dietary	
	Dietary Exposure (mg/kg/day)	% cPAD a
U.S. population	0.12	24
females (13-50 years)	0.087	17
children 1-2 yrs	0.422	84
children 3-5 yrs	0.31	62

a-- %PAD = dietary exposure (mg/kg/day) / cPAD, where cPAD=0.5 mg/kg/day for all populations.

6.3 Drinking Water Exposure and Risk for Inert Ingredient Uses

There are no currently registered outdoor uses of the alkylbenzene sulfonates as active ingredients that are being supported by the registrant. However, these compounds are inert ingredients in many residential and agricultural products that are

[1] A review of those products listed as containing ingredients Benzenesulfonic acid, dodecyl- (CAS Reg. No. 27176-87-0); Sodium dodecylbenzenesulfonate (CAS Reg. No. 25155-30-0); and Benzenesulfonic acid, C10-16-alkyl derivs (CAS Reg. No.68584-22-5) was conducted. The results of that review indicate that the linear alkylbenzenesulfonates are primarily used in low concentrations (typically less than 5% w/w) in herbicide products that typically are applied in a preemergent or early post-emergent fashion.

used outdoors. The majority of these products contain alkylbenzene sulfonates at low concentrations that are generally less than 5%. Based on the "Environmental Fate Assessment of Alkylbenzene Sulfonates for the Registration Eligibility Document (RED)" (T. Milano, March 2006), linear alkyl benzenesulfonates are water soluble, nonvolatile and mobile, but also readily biodegradable. There are no readily available data on the occurrence of linear alkyl benzenesulfonates in ambient or treated drinking water. No ambient water quality criteria, drinking water maximum contaminant levels or health advisory levels have been established for these compounds by EPA's Office of Water. The potential for transport into drinking water resulting from pesticide inert ingredient uses of these substances do exist, therefore the Agency estimated drinking water concentrations resulting from the inert ingredient uses of these substances. Details of this analysis are presented in the Inert Ingredient Dietary Risk Assessment memorandum from K. Leifer, March 23, 2006.

The drinking water analysis is based on a derivation of estimated upper bound Tier I drinking water concentrations from these substances' use as pesticide inert ingredients from the FQPA Index Reservoir Screening Tool (FIRST). A number of conservative assumptions were utilized as inputs into the inert ingredient drinking water exposure assessment model. For example, it was assumed that the linear alkylbenzene sulfonates were stable, and pesticide products were applied via aerial spray. The results of the model were scaled to account for a linear alkylbenzene sulfonate weight fraction of 5% (which is a 95th percentile value). The Estimated Drinking Water Concentration (EDWC) for chronic drinking water exposure is 6.6 ug/L (ppb).

The Agency did not estimate acute drinking water risks for the inert ingredient use because an acute dietary endpoint (i.e., aPAD) was not selected as there were no effects attributable to a single dose exposure. The estimated chronic drinking water concentration and drinking water level of concern for chronic exposure to linear alkyl benzenesulfonates is given in Table 8 below.

Table 8. Chronic Drinking Water Exposure Estimates for Inert Ingredient Uses of Alkylbenzene Sulfonates

Population Subgroup	EDWC[1] (µg/L)	%cPAD[2]	DWLOC[3] (µg/L)
U.S. Population (total)	6.6	<0.1%	38 -1,500
Children (1-2 years)	6.6	<0.1%	8 - 500

1 Estimated Drinking Water Concentration (EDWC) for chronic drinking water exposure as determined by the use of FIRST modeling analysis described above for inert ingredient use. [The EDWC for linear alkyl benzenesulfonates is the value reported as the "Adjusted Annual Average (Chronic) Untreated Water Concentration"]

2 %cPAD = drinking water exposure (mg/kg/day) / cPAD, where cPAD=0.5 mg/kg/day for all populations. It was assumed that a 15 kg child ingests 1 L water per day and that a 70 kg adult ingests 2L water per day.

3 Drinking Water Level of Comparison (DWLOC) is the maximum contribution from water allowed in the diet based on food and drinking water from inert use only. In this case, since the allowable risk contribution from food is based on a screening level model, the use of a single, deterministic value for the DWLOC is not appropriate. Rather a DWLOC range is given, with the values in the range corresponding to an upper value of range of drinking water concentrations ranging from 100% of the cPAD (i.e., assuming no food exposure) to a lower value that considers food exposures to be at the dietary screening level value.

For chronic drinking water exposures to linear alkyl benzenesulfonates as inert ingredients, the Drinking Water Level of Comparison (DWLOC) range for chronic exposure is 38-1500 µg/L for the general U.S. population and 8-500 µg/L for children 1-2 years old. The EDWC used to assess chronic (non-cancer) dietary risk from drinking water is 6.6 µg/L. The chronic estimated concentration is below the DWLOCs for the general U.S. population and all population subgroups. Drinking water risks, therefore, are not of concern.

The Agency concludes that there are no risk concerns for chronic aggregate dietary and drinking water exposures to the alkylbenzene sulfonates as pesticide inert ingredients. This is based on the conservative assumptions used in the screening level dietary exposure model, as well as the estimated upper bound drinking water concentrations from these substances' use as pesticide inert ingredients derived from FIRST.

6.4 Residential Exposure and Risks from Inert Ingredient Use

Exposure Scenarios

As noted previously, there are no residential use sites for the alkylbenzene sulfonates as active ingredients. However, alkylbenzene sulfonates are formulated as inert ingredients in approximately 350 registered end-use products, many of which are used in residential settings. Some examples of the specified use sites on the products consist of indoor hard non-porous surfaces (e.g. floors, walls etc.), carpets, food contact surfaces (glasses, dishes, silverware, countertops, etc.), agricultural tools and crops, lawns and turfs, fruits and vegetables (post-harvest), wood preservatives, materials preservatives, metalworking fluids, and pet products. Details of the residential inert exposure assessment can be found within the companion memorandum (memorandum from T. Milano/C. Walls, July 2006, D330330). A summary of the residential assessment is presented below.

For the purposes of this screening level assessment, the Agency selected representative scenarios for the vast majority of products, based on end-use product application methods and use amounts. These scenarios reflect high-end exposure and risk estimates for all products represented. The following residential use sites were

assumed to be the high-end representative scenarios for inert uses of alkylbenzene sulfonates. These include:

1) outdoor residential turf treatment (ready to use liquid),
2) indoor hard surface cleaner (ready to use liquid), and
3) pet flea and tick products (aerosol can spray).

For each of the use sites, the Agency assessed residential handler (applicator) inhalation exposure and post application incidental ingestion by toddlers. Residential postapplication exposures result when bystanders, such as children come in contact with alkylbenzene sulfonates in areas where end-use products have recently been applied (e.g., treated hard surfaces/floors), or when children incidentally ingest the residues through mouthing the treated end products/treated articles (i.e., hand-to-mouth or object-to-mouth contact). Although the alkylbenzene sulfonates are also present in carpet cleaners as an inert ingredient, the Agency believes that the risk associated with a toddler contacting treated hard surfaces are representative of risks associated with a toddler contacting a treated carpet. As previously mentioned, there is no dermal endpoint, and therefore, there were no dermal assessments conducted (handler or post application).

Exposure Data and Assumptions

For most residential scenarios, the Agency used EPA's Pesticide Inert Risk Assessment Tool (PiRat) to estimate residential applicator and post-application exposures and risks from the use of alkylbenzene sulfonates as an inert ingredient in representative residential products. Background information and the downloadable executable file for PiRat can be found at http://www.epa.gov/opptintr/exposure/docs/pirat.htm. The Agency utilized all of PiRat's default values, along with high-end percent formulations based on the review of the Confidential Statements of Formula (CSFs) for the various residential products that contain the alkylbenzene sulfonates as inert ingredients. For the assessment of the pet products and hard surface cleaners, the Agency used assumptions in the Residential Standard Operating Procedures (SOPs). Typically, most products used in a residential setting result in exposures occurring over a short-term duration. Thus, the residential handler and postapplication scenarios are assumed to be of short- term duration (1-30 days).

Because there are a large number of products that contain alkylbenzene sulfonates as an inert ingredient, the Agency assessed a representative high-end formulation product to be conservative.

An inhalation post-application assessment was not conducted because the vapor pressure of the alkylbenzene sulfonates is extremely low (5.1×10^{-10} to 6×10^{-15} mmHg). In addition, a dermal assessment was not conducted because of the lack of a dermal toxicological endpoint.

Risk Characterization

A summary of the residential handler exposure and risk estimates are presented on Table 9, while the postapplication incidental oral exposure and risk estimates are presented in Table 10. The non-cancer risk estimates are expressed in terms of the MOE. For residential handlers that handle products containing alkylbenzene sulfonates as inert ingredients, the short-term inhalation MOEs were above the target MOEs (i.e., >100) and thus, do not exceed the Agency's level of concern, with the exception of the flea and tick product where the MOE was 87 for the high-end formulation containing 24% alkylbenzene sulfonates. This scenario is conservative because it assumes a person treats their pet with 0.5 cans of flea product that contains 24% alkylbenzene sulfonates every day for a month. However, there are no risk concerns for the majority of pet products containing 2% alkylbenzene sulfonates.

There are no residential postapplication risk concerns for the household products that contain alkylbenzene sulfonates as an inert ingredient as shown on Table 10. All of the scenarios evaluated have short-term MOEs above 100, and thus are not of concern including postapplication incidental oral risks to children that may contact turf, hard surfaces or a pet treated with pesticide products containing alkylbenzene sulfonates as an inert ingredient. The postapplication MOEs range from 106 to 7,400.

Alkylbenzene sulfonates are considered to be dermal irritants in formulations that have listed amounts generally greater than 20%. Thus, dermal exposure would be self-limiting due to dermal irritation. The vast majority of residential products contain less than 5% alkylbenzene sulfonates. The Agency intends to consider the potential for irritation in recommended labeling language of pesticide products containing the alkylbenzene sulfonates, and consider available dermal toxicity data on a diluted end-use formulation. The Agency should confirm that all products with greater than 20% require the use of gloves.

Table 9.
Estimates of Inhalation Exposures and Risks to Residential Handlers of Alkylbenzene Sulfonates as Inert Ingredients (Short-Term Duration)

Product Use	Application Method	Area Treated/Quantity Handled[a]	Inhalation Exposure (mg/kg/day)	Inhalation MOEs[c] (Target MOE ≥ 100)
Outdoor Products				
Ready to Use Liquid Turf spot/gardens[b]	Low pressure handwand; MLAP	1000 ft^2/day (spot)	$7.07x10^{-6}$	20,000

Table 9. Estimates of Inhalation Exposures and Risks to Residential Handlers of Alkylbenzene Sulfonates as Inert Ingredients (Short-Term Duration)				
Product Use	**Application Method**	**Area Treated/Quantity Handled[a]**	**Inhalation Exposure (mg/kg/day)**	**Inhalation MOEs[c] (Target MOE ≥ 100)**
	Hose end sprayer; MLAP	$2x10^4$ ft^2/day (full broadcast)	$4.48x10^{-5}$	3,100
	Backpack; MLAP	1000 ft^2/day (spot)	$7.07x10^{-6}$	20,000
	Sprinkling can; MLAP		$2.24x10^{-6}$	63,000
Indoor Products				
Ready to Use Liquid (hard surface cleaner)[d,e]	Low pressure handwand; MLAP	0.5 gallons/day	$1.37x10^{-4}$	1.000
Pet Flea and Tick Product[f]	Aerosol Can Spray	0.5 6 oz can	$1.61x10^{-3}$	**87**

a: Standard PiRat model input parameters, except for pet products and hard surface cleaner, which are based on an AD assumption.
b: percent formulation used = 11%; an application rate of 0.00015 lb product/ft^2 was assumed for all scenarios and the body weight = 70kg.
c: MOEs = NOAEL / exposure where inhalation NOAEL = 0.14 mg/kg/day and the target MOE ≥ 100
d: % formulation used = 8%
e: An application rate of 8 lb/gallon, which is the density of water, was assumed for all scenarios and the body weight =70kg.
f= % formulation = 24%.

Table 10. Summary of Short-Term Residential Postapplication Exposure and Risk Estimates from Alkylbenzene Sulfonates as Inert Ingredients[a]			
Product Use	**Route of Exposure**	**Exposure mg/kg/day[b]**	**MOEs[c] (Target MOE ≥ 100**
Ready to Use Liquid Turf spot/gardens[d]	Incidental ingestion: hand to mouth	1.08×10^{-2}	4,600
Ready to Use Liquid (hard surface cleaner)[a, e]		0.0068	7,400
Pet Flea and Tick Product[f]	Incidental ingestion: hand to mouth	0.4739	106

a: The representative use sites assessed through using PiRAT for incidental oral post application exposures to toddlers are turf products. Exposure from hard surface cleaner and pet products was based on AD assumptions.
b: The body weight used in this calculation was 15kg, which is assumed to be the body weight of a toddler.
c: MOEs = NOAEL / exposure where incidental oral NOAEL = 50 mg/kg/day. Target MOE ≥ 100.
d: % formulation used = 11%
e: % formulation used = 8%
f: % formulation used = 24%

7.0 AGGREGATE RISK ASSESSMENTS AND RISK CHARACTERIZATION

In order for a pesticide registration to continue, it must be shown that the use does not result in "unreasonable adverse effects on the environment". Section 2 (bb) of FIFRA defines this term to include "a human dietary risk from residues that result from a use of a pesticide in or on any food inconsistent with standard under section 408..." of FFDCA. As mandated by the FQPA amendments to FIFRA and the Federal Food, Drug and Cosmetic Act (FFDCA), the Agency must consider total aggregate exposure from food, drinking water and residential sources of exposure to alkylbenzene sulfonates. Aggregate exposure is the total exposure to a single chemical (or its residues) that may occur from dietary (i.e., food and drinking water), residential, and other non-occupational sources, and from plausible exposure routes (oral, dermal, and inhalation).

Typically, aggregate risk assessments are conducted for acute (1 day), short-term (1-30 days), intermediate-term (1-6 months) and chronic (6 months to lifetime) exposures. However, an acute aggregate assessment was not conducted because

there are no adverse effects attributable to acute exposure. An intermediate-term aggregate assessment was not conducted because there are no residential exposures of this duration. In addition, because there are no long-term residential exposures, the chronic aggregate assessment only considered food and drinking water. Thus, only short-term and chronic aggregate assessments were conducted. Oral and inhalation exposure and risk estimates were conservatively combined for the aggregate risk assessment because these endpoints both identify adverse effects on body weight. Dermal exposures were not considered in the risk assessment because a toxicological endpoint was not established.

In performing aggregate exposure and risk assessments, the Office of Pesticide Programs has published guidance outlining the necessary steps to perform such assessments (General Principles for Performing Aggregate Exposure and Risk Assessments, November 28, 2001; available at http://www.epa.gov/pesticides/trac/science/aggregate.pdf). Steps for deciding whether to perform aggregate exposure and risk assessments are listed, which include: identification of toxicological endpoints for each exposure route and duration; identification of potential exposures for each pathway (food, water, and/or residential); reconciliation of durations and pathways of exposure with durations and pathways of health effects; determination of which possible residential exposure scenarios are likely to occur together within a given time frame; determination of magnitude and duration of exposure for all exposure combinations; determination of the appropriate technique (deterministic or probabilistic) for exposure assessment; and determination of the appropriate risk metric to estimate aggregate risk.

Short-Term Aggregate Risk. Aggregate short term risk assessments are designed to provide estimates of risk likely to result from exposures to the pesticide or pesticide residues in food, water, and from residential (or other non-occupational) pesticide uses. This assessment considers both the active and inert uses of the alkylbenzene sulfonates. For children, the short-term aggregate assessment includes average dietary exposure (food and drinking water) from both the active food contact sanitizer uses and the inert uses on agricultural commodities, in addition to estimated incidental oral exposures to children from residential uses such as hard surface cleaning products as an inert ingredient. For adults, the aggregate assessment includes dietary (food and drinking water) from both active and inert uses and residential inhalation exposures from wiping a hard surface cleaning products since this scenario represents the highest exposure from the inert use.

Individual scenarios that had risks of concern were not included in the aggregate assessment. These include exposure to some of the high-end formulation products such as the residential handler of pet flea and tick products (inhalation MOE is 87 compared to target MOE>100). As noted previously, a number of very conservative assumptions were used to derive these risk estimates.

Aggregate risks were calculated using the total MOE approach outlined in OPP guidance for aggregate risk assessment (August 1, 1999, Updated "Interim Guidance

for Incorporating Drinking Water Exposure into Aggregate Risk Assessments"). The assumptions and equations are presented in the footnotes on Table 11.

Table 11 presents a summary of the short-term aggregate risk MOEs. The aggregate oral and inhalation risks are not of concern for adults, as the total aggregate MOE is 340 which is greater than the target of 100. For children, the aggregate risk estimate is very close to the target MOE of 100 (MOE=99. As noted previously, several conservative assumptions were used in this assessment. For example, dietary exposure from both the active sanitizer use and the inert uses were considered together to estimate an upper-bound exposure estimate, since these use patterns are very different and thus could co-occur. To compensate for this conservative assumption, the Agency only included one representative residential use scenario in the aggregate assessment even though these compounds are used extensively as inert ingredients in approximately 350 pesticide products.

It should also be recognized that the majority of the uses of alkylbenzene sulfonates are not in pesticide products, but rather are used in household laundry and dish detergents. Over 800 millions pounds of these compounds are produced each year, while only 300,000 pounds are used in EPA registered antimicrobial products. The Agency did not consider potential exposure and risks from the numerous other residential exposures to alkylbenzene sulfonates because the Agency lacks reliable information at this time.

Table 11
Summary of Short-Term Aggregate Risk Estimates

Exposure Scenario	Dose [a] (mg/kg/day)		Total MOE[b] (Target MOE≥100)	
	Child (15 kg)	Adult	Child (15 kg)	Adult
Oral Exposure				
Dietary Exposure				
Food Contact Sanitizer	0.054	0.027	926 (10.8% of cPAD)	1,850 (5.4% of cPAD)
Inert Ingredient Uses (Food)	0.422	0.12	118 (84% of cPAD)	417 (24% of the cPAD)
Drinking Water Exposure (Inert) c	0.00044	0.000189	114,000 (<1% of cPAD	227,000 (<1% of cPAD)
Hard Surface Cleaner	0.0068	NA	7,400	NA
Inhalation Exposure				
Handler of hard surface	NA	0.000137	NA	1,000

Table 11 Summary of Short-Term Aggregate Risk Estimates				
Exposure Scenario	**Dose [a] (mg/kg/day)**		**Total MOE[b] (Target MOE≥100)**	
	Child (15 kg)	**Adult**	**Child (15 kg)**	**Adult**
cleaning products				
Total Aggregate Dose and MOE	0.5	0.147	**99**	340

NA= Not applicable

(a) Chronic dietary exposure for females 13-50 years for sanitizer use. The total general population dietary exposure was used to assess inerts, since this population has higher exposure than females 13-50 years.

(b) MOE = NOAEL (mg/kg/day) / potential dose rate (mg/kg/day) [Where short-term oral NOAEL = 50 mg/kg/day]. Target MOE ≥ 100.

(c) Exposure estimates assume a 15 kg child ingests 1L water/day and that a 60 kg adult female ingests 2L water per day of 6.6 ppb (the chronic estimated drinking water concentration (EDWC) based on the inert ingredient use.

Chronic Aggregate Risk. The chronic aggregate assessment considers average dietary exposure (food and drinking water) from both the active food contact sanitizer uses and the inert uses on agricultural commodities. The dietary exposures from the fruit and vegetable wash were not considered because it would be overly conservative to assume simultaneous exposure to alkylbenzene sulfonates from three different use patterns. As shown on Table 12, the dietary aggregate risk is **95% of the cPAD for children**, while for adults it is **29% of the cPAD**.

Table 12 Summary of Chronic Aggregate Risk Estimates				
Exposure Scenario	**Dose [a] (mg/kg/day)**		**%cPAD[b]**	
	Child (15 kg)	**Adult**	**Child (15 kg)**	**Adult**
Oral Exposure				
Dietary Exposure				
Food Contact Sanitizer	0.054	0.027	10.8%	5.4%
Inert Ingredient Uses (Food)	0.422	0.12	84%	24%
Drinking Water	0.00044	0.000189	<1%	<1%

Table 12 Summary of Chronic Aggregate Risk Estimates				
Exposure Scenario	**Dose [a] (mg/kg/day)**		**%cPAD[b]**	
	Child (15 kg)	**Adult**	**Child (15 kg)**	**Adult**
Exposure (Inert) c				
Total Aggregate Dose and Risk	0.476	0.147	95%	29%

NA= Not applicable

(a) Chronic dietary exposure for females 13-50 years for sanitizer use. The total general population dietary exposure was used to assess inerts, since this population has higher exposure than females 13-50 years.

(b) %cPAD = dietary exposure (mg/kg/day) / cPAD, where cPAD -= 0.5 mg/kg/day for all populations.

(c) Exposure estimates assume a 15 kg child ingests 1L water/day and that a 60 kg adult female ingests 2L water per day containing 6.6 ppb alkylbenzene sulfonates. The 6.6 ppb estimate is based on the chronic estimated drinking water concentration (EDWC)) resulting from agricultural use of products that contain the alkylbenzene sulfonates as an inert ingredient.

8.0 CUMULATIVE EXPOSURE AND RISK

Another standard of section 408 of the FFDCA which must be considered in making an unreasonable adverse effect determination is that the Agency considers "available information" concerning the cumulative effects of a particular pesticide's residues and "other substances that have a common mechanism of toxicity."

Unlike other pesticides for which EPA has followed a cumulative risk approach based on a common mechanism of toxicity, EPA has not made a common mechanism of toxicity finding as to the alkylbenzene sulfonates and any other substances and the alkylbenzene sulfonates do not appear to produce a toxic metabolite produced by other substances. For the purposes of this tolerance action, therefore, EPA has not assumed that alkylbenzene sulfonates have a common mechanism of toxicity with other substances. For information regarding EPA's efforts to determine which chemicals have a common mechanism of toxicity and to evaluate the cumulative effects of such chemicals, see the policy statements released by EPA's Office of Pesticide Programs concerning common mechanism determinations and procedures for cumulating effects from substances found to have a common mechanism on EPA's website at http://www.epa.gov/pesticides/cumulative/.

9.0 OCCUPATIONAL EXPOSURE AND RISK

The Agency has assessed the exposures and risks to occupational workers that handle alkylbenzene sulfonates (memorandum from T. Milano, July 6, 2006, D330329). This section summarizes the results of the occupational exposure assessment.

Based on examination of product labels describing uses for the product, it has been determined that exposure to handlers can occur in a variety of occupational settings. Additionally, postapplication exposures are likely to occur in these settings. The representative scenarios selected by the Agency for assessment were evaluated using maximum application rates as recommended on the product labels for alkylbenzene sulfonates.

Occupational Handlers. The Agency has determined that there is potential for dermal and inhalation worker exposure to alkylbenzene sulfonates at various use sites

including agricultural premises, food handling, and commercial/institutional/industrial premises. Representative scenarios were selected for evaluation based on the use sites and maximum application rates for all three of the active ingredients in this assessment.

As noted previously, the Agency did not select a dermal endpoint, and thus only inhalation exposure and risk estimates are presented. The alkylbenzene sulfonates are dermal irritants, and all of the labels require the use of gloves by workers, except for Reg. #71094-2 (0.036% ai, ready to use product). The occupational exposure scenarios, and estimated risks are presented in Table 13.

To assess the handler risks, AD used surrogate unit exposure data from both the proprietary Chemical Manufacturers Association (CMA) antimicrobial exposure study and the Pesticide Handlers Exposure Database (PHED).

For the occupational handler inhalation risk assessment, the short- and intermediate- term risks calculated at baseline exposure (no respirators) were above target MOEs for all scenarios (i.e., inhalation MOEs were >100), except the following:

- ST and IT inhalation exposure from cleaning hard surfaces via wiping in the food handling category, inhalation MOE = 93.

The Agency also calculated a total MOE for one of the active ingredients, sodium dodecylbenzene sulfonate (25155-30-0) based on the label use directions, which recommend the same product be used for both cleaning and sanitizing. As shown on Table 14, all total inhalation MOEs for cleaning and sanitizing (baseline) were above the target MOEs for all scenarios (i.e., inhalation MOEs were >100), except the following:

- ST and IT inhalation exposure from cleaning indoor hard surfaces via wiping and then following with sanitizing via immersion/flooding in the food handling premises category, inhalation MOE = **93.**
- ST and IT inhalation exposure from cleaning indoor hard surfaces via wiping and then following with sanitizing via low pressure spray in the food handling premises category, inhalation MOE = **90.**
- ST and IT inhalation exposure from cleaning indoor hard surfaces via sponge/mesh/wiping and then sanitizing via immersion/flooding in the food handling premises category, inhalation MOE = **90.**

Although all the inhalation risks of concern are for baseline exposures, the Agency does not believe it is practicable to require the use of respiratory protection on cleaning products used in janitorial situations. In addition, engineering controls are not feasible for the current use patterns on the labels.

Table 13 Short-, and Intermediate-Term Inhalation Risks for Occupational Handlers (Representative Scenarios)				
Exposure Scenario	**Method of Application**	**Application Rate (lb ai/ gallon)**	**Quantity Handled/ Treated per day (gallons)**	**Baseline Inhalation MOE (a) (Target MOE≥100)**
Agricultural Premises and Equipment				
Application to hard surfaces	Brush	0.0667	0.26	2,000
	Mechanical Foam	0.0667	0.26	430
	Flooding	0.00183	10	280
	Cleaning in place (CIP)	0.00195	10,000	1,200
	High Pressure spray	0.00326	40	630
	Immersion	0.00334	10	160
	Low pressure spray	0.00334	10	430
	Trigger Pump Spray	0.00334	0.26	8,700
Food Handling				
Application to indoor hard surfaces	Brush	0.0667	0.26	2,000
	Mechanical Foam	0.0667	0.26	430
	Immersion	0.00334	10	160
	Trigger Pump Spray	0.00334	0.26	8,700
	Low pressure handwand (clean)	0.00603	2	1,200
	High pressure spray (sanitize)	0.0115	40	180
	Immersion, flooding for RTU (sanitize)	0.003	10	170
	Mopping	0.00244	2	840
	Wiping (clean)	0.00603	0.26	**93**
	Sponge/mesh wipe (clean)	0.003	0.26	190
	Cleaning in Place (CIP) (clean and sanitize)	0.00358	10,000	680

Table 13 Short-, and Intermediate-Term Inhalation Risks for Occupational Handlers (Representative Scenarios)				
Exposure Scenario	**Method of Application**	**Application Rate (lb ai/ gallon)**	**Quantity Handled/ Treated per day (gallons)**	**Baseline Inhalation MOE (a) (Target MOE≥100)**
Food dispensing equipment	Cleaning in Place (CIP) (clean)	0.00603	10,000	400
	Cleaning in Place (CIP) (sanitize)	0.00302	10,000	810
Fruits and vegetables	Immersion	0.00455	10	110
	Trigger pump spray	0.003	0.26	9,700
Commercial/Institutional Premises				
Application to indoor hard surfaces (includes utensils and silverware)	Brush	0.0667	0.26	2,000
	Mechanical Foam	0.0667	0.26	430
	Immersion	0.00334	10	160
	Low Pressure Handwand	0.00334	2	2,200
	Trigger Pump Spray	0.00334	0.26	8,700
Shower stalls and toilets	Mopping	0.0177	2	120
	Swabbing after a liquid pour	0.0177	0.26	1,100

(a) MOE = NOAEL (mg/kg/day) / Daily Dose [Where short-and intermediate-term NOAEL = 0.14 mg/kg/day for inhalation exposure] Target MOE is ≥ 100.

Table 14 Short, and Intermediate Term Inhalation Risks to Occupational Handlers Cleaning and Sanitizing with Products That Contain Sodium Dodecylbenzene Sulfonate				
Representative Use	**Registration #**	**Method of CLEANING Application (Baseline MOE)**	**Method of SANITIZING Application (Baseline MOE)**	**Total Inhalation MOE (Baseline) (Target MOE≥100)**
Food Handling/Storage Establishments Premises and Equipment				
Indoor Hard Surfaces	1020-13	High pressure spray (1,100)	High pressure spray (180)	150

Table 14 Short, and Intermediate Term Inhalation Risks to Occupational Handlers Cleaning and Sanitizing with Products That Contain Sodium Dodecylbenzene Sulfonate				
Representative Use	**Registration #**	**Method of CLEANING Application (Baseline MOE)**	**Method of SANITIZING Application (Baseline MOE)**	**Total Inhalation MOE (Baseline) (Target MOE≥100)**
(includes dishes and silverware)			Brush (12,000)	1,000
		Brush (75,000)	High pressure spray (180)	180
			Brush (12,000)	10,000
	71094-1	Low pressure spray (1,200)	Immersion/Flooding ($1.4X10^6$)	1,200
			Low pressure spray (2,400)	800
		Wiping (93)	Immersion/Flooding ($1.4X10^6$)	**93**
			Low pressure spray (2,400)	**90**
		Foam (4,800)	Immersion/Flooding ($1.4X10^6$)	4,800
			Low pressure spray (2,400)	1,600
		Brush (22,000)	Immersion/Flooding ($1.4X10^6$)	22,000
			Low pressure spray (2,400)	2,000
	71094-2	Sponge/Mesh/Wiping (190)	Immersion/Flooding (170)	**90**
			Trigger Pump (9,700)	190
		Low Pressure Spray (2,400)	Immersion/Flooding (170)	160
			Trigger Pump (9,700)	1,900
		Brush (45,000)	Immersion/Flooding (170)	170
			Trigger Pump (9,700)	8,000
	1020-13	CIP (680)	CIP (680)	340
Food dispensing equipment	71094-1	CIP (400)	CIP (810)	270

Postapplication Exposure and Risk. For most of the occupational scenarios, postapplication dermal exposure is not expected to occur or is expected to be negligible based on the application rates and chemical properties of these chemicals. The alkylbenzene sulfonates have a low vapor pressure ($5.1x10^{-10}$ to $6.02x10^{-15}$ mmHg), so that any standing solutions that may result in post application exposure were deemed negligible.

10.0 ENVIRONMENTAL RISK

10.1 Active Ingredient Uses

A detailed ecological hazard and environmental risk assessment for the alkylbenzene sulfonates is presented in the attached memorandum for the active ingredient pesticidal uses (memo from R. Petrie, July 12, 2006). A brief summary is presented below.

Ecological Toxicity Data.

Acute toxicity to terrestrial organisms: As shown in the acute toxicity summary Table 15, alkylbenzene sulfonates are slightly toxic to the Northern bobwhite quail on an acute oral basis. The avian acute oral LD50 is > 500 ppm, therefore, an avian environmental hazard statement for birds is not required on manufacturing use product labels. No evidence of endocrine disrupting effects was observed in mammalian toxicity studies. No data are available or required for terrestrial plants.

Acute toxicity to aquatic organisms: As shown in Table 15, supplemental acute studies indicate that alkylbenzene sulfonates are moderately toxic to freshwater fish and freshwater aquatic invertebrates. In addition, 11 acute freshwater fish studies using commercially relevant LAS and LAB formulations indicate the LC50 values range from 1.67 to 7.7 mg/L [LAS SIDS Initial Assessment Report, (SIAR)]. Data using LAB sulfonic acids in the LAS SIAR report range in toxicity from 3.0 to 10.0 mg/L. Research by Fairchild et al. (1993) indicates that "Degradation processes rapidly reduce chain lengths of LAS in the environment to averages lower than C12. Thus, hazard assessments of LAS to aquatic organisms should focus on environmentally relevant mixtures of average chain lengths of C12 or less." Based on study results above (MRIDs 44260002, 44260009) and studies presented in LAS SIAR, an environmental hazard statement for fish is not required on manufacturing use products under consideration in this RED.

In aquatic invertebrates, LAS toxicity is variable, depending on the length of the carbon chain. LAS/SIAR (page 37) summarizes 11 *Daphnia* magna studies on commercially relevant LAS that range in EC50 values from 1.62 to 9.3 mg/L. Data on the LAB sulfonic acids give EC50 values for *Daphnia* magna ranging from 2.9 to 12 mg/L. Formulations tested included the C10-C16 benzene sulfonic acid and the dodecylbenzene sulfonic acid. Even though the higher carbon chains are more toxic, the CLER (Council for LAB/LAS Environmental Research) ensures that the typical LAS

or LAB formulations contain less than 1 - 10% carbon chains C14 or greater. The LAS SIAR report cites 11 *Daphnia magna* studies on commercial LAS formulations with EC50 values ranging from 1.62 to 9.3 mg/L. LAB formulations ranged in toxicity from 2.9 to 12 mg/L. Research by Fairchild et al. (1993) states: "Degradation processes rapidly reduce chain lengths of LAS in the environment to averages lower than C12. Thus, hazard assessments of LAS to aquatic organisms should focus on environmentally relevant mixtures of average chain lengths of C12 or less." Based on study results above (MRID 47025025) and studies presented in LAS SAIR, an environmental hazard statement for aquatic invertebrates is not required on manufacturing use products under consideration in this RED.

Chronic toxicity to aquatic organisms: Chronic toxicity testing (Fish early life stage, 850.1300/72-4a and aquatic invertebrate life cycle, 850.1400/72-4b) is required for pesticides when certain conditions of use and environmental fate apply. Chronic aquatic organism tests are not required for alkylbenzene sulfonates because the currently registered uses are indoor applications. A 28 day chronic freshwater fish toxicity test was found in the literature. The NOAEC was 0.7 mg/L for a carbon chain C11.7 (Fairchild et al, 1993). Scientists studying alkylbenzene sulfonates have concluded that a laboratory derived NOAEC of 0.4 mg/L-alkylbenzene sulfonates is protective of ecosystem structure and function in experimental streams.–Alkylbenzene sulfonates literature indicates slight toxicity to green algae.

Table 15. Acute Toxicity of Alkylbenzene Sulfonates

Species	Chemical, % active ingredient (ai)	Endpoint	Toxicity Category (TGAI)	Satisfies Guidelines/ Comments	Reference
Birds					
Northern bobwhite *(Colinus virginianus)*	87.6%Carbon chain not identified. (Nacconal 90G used)	LD_{50} > 1382 mg/kg NOEL = 279 mg/kg	Slightly toxic	Yes. Acceptable. 14 day test	MRID: 41143901
Freshwater Fish					
Fathead Minnow (*Pimephales promelas*)	14.0% (Carbon chain not identified.)	96hr LC50 = 3.4 mg/L	Moderately toxic	Yes. Supplemental study.	44260002
Rainbow trout *Oncorhynchus*	65.0% C11, C12	96 hr LC50 = 1.68 mg/L	Moderately toxic	Yes. Supplemental study.	44260009

Table 15. Acute Toxicity of Alkylbenzene Sulfonates					
Species	**Chemical, % active ingredient (ai)**	**Endpoint**	**Toxicity Category (TGAI)**	**Satisfies Guidelines/ Comments**	**Reference**
mykiss)					
Freshwater Invertebrates					
Waterflea *(Daphnia magna)*	Not reported.	48-hr. EC_{50} = LAS-C10 = 29.5 mg/L, LAS-C12 = 6.84 mg/L, LAS-C14 = 0.80 mg/L, LAS-C16 = 0.20 mg/L.	C-12 = Moderately toxic	Yes. Supplemental study.	47025025
Green Algae					
Selenastrum capricornutum	Not Reported. (Carbon chain not identified.)	96 hr. EC50 = 70.27 ppm	Slightly toxic	No. Supplemental.	42439803

Data Requirements: There are no outstanding ecological data requirements. The guideline requirements for a freshwater fish acute test (Guideline 850.1075), and freshwater invertebrate (Guideline 850.1010) have been fulfilled. Acute estuarine/marine tests, chronic toxicity testing (Fish early life stage, 850.1300/72-4a and aquatic invertebrate life cycle, 850.1400/72-4b) and non-target plant phytotoxicity tests are not required for indoor uses.

Environmental Fate and Exposure Assessment.

No fate studies for alkylbenzene sulfonates are available in US EPA's files. Thus, the Agency has relied on scientific literature and the Agency's EPI Suite model to obtain different environmental properties for the alkylbenzene sulfonates. The EPI Suite model predicts that alkylbenzene sulfonates are not likely to persist in water or microbial soils and sediments. The Agency also conducted a literature search to further support the output parameters that were provided by the EPI Suite model. Extensive literature are available that describe the fate and significance of alkylbenzene sulfonates in the environment from a long history of detergent use.

Environmental exposure modeling was not conducted for alkylbenzene sulfonic acids and sulfonates because the currently registered uses are indoor spray applications. Uses such as urinals and toilet bowls could result in minimal exposure to the environment when flushed, however, significant environmental exposure is not expected for the following reasons: total alkylbenzene sulfonate usage for these industrial applications is very minor - a very small percentage of the total pounds used

in antimicrobials; commercial only use precludes broad environmental exposures that might occur with residential use; applications are mostly sprayed on and allowed to air dry; alkylbenzene sulfonate breakdown and degrade rapidly in the environment; alkylbenzene sulfonates are significantly reduced by sewage treatment; and industrial water treatment requires a NPDES permit in order to discharge effluents.

Ecological Risk Characterization.

Sodium dodecylbenzene sulfonate, and DDBSA are unlikely to bioaccumulate in the environment or aquatic animals and are expected to be soluble in water such that they will exhibit mobility through the soil. Available modeling and literature suggest that these chemicals will most likely biodegrade rapidly in soil due to microbial degradation. Minimal or no environmental exposure to terrestrial or aquatic organisms is expected to occur from the majority of alkylbenzene sulfonate antimicrobial indoor pesticide uses given that only a very small number of total DDBSA pounds are used for these purposes.

Linear alkyl benzene sulfonates (LAS) have been the principal ingredient in laundry detergent for 30+ years. Volume 12 (10) of the 1993 issue of Environmental Toxicology and Chemistry featured a series of papers on environmental impacts of LAS in a special symposium: Surfactants and Their Environmental Safety - convened by R.A. Kimerle, N.T. De Oude and T.W. La Point. Two papers provide excellent summaries of ecotoxicity endpoints from literature, and feature laboratory vs field analysis of detergent generated LAS impacts on aquatic organisms. An assessment of short and long-term impacts of LAS detergents on the environment was conducted. Increases and decreases in natural periphyton community abundance were observed, but determined to be insignificant for the three major species evaluated: *Amphora perpusilla, Navicula minima, and Schizothrix calcicola* (Lewis et al, 1993). Monitoring indicates that concentrations of 0.230 mg/L (continuous criterion concentration) and 0.625 mg/L (criterion maximum concentration) are rarely exceeded in aquatic systems protected by activated sludge treatment systems. Ecotoxicity studies indicate that a laboratory derived NOAEC value of 0.40 mg/L for LAS is protective of structure and function of experimental streams (Fairchild et al, 1993).

No environmental exposure is expected to occur from the majority of linear alkylbenzene sulfonate uses and it is unlikely that any appreciable exposure to terrestrial or aquatic organisms would occur from limited commercial down-the-drain use because of the very small number of pounds sold for these uses plus rapid degradation in the environment.

Endangered Species Considerations

Section 7 of the Endangered Species Act, 16 U.S.C. Section 1536(a)(2), requires all federal agencies to consult with the National Marine Fisheries Service (NMFS) for marine and andronomus listed species, or the United States Fish and Wildlife Services (FWS) for listed wildlife and freshwater organisms, if they are proposing an "action" that may affect listed species or their designated habitat. Each federal agency is required under the Act to insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a

listed species or result in the destruction or adverse modification of designated critical habitat. To jeopardize the continued existence of a listed species means "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of the species." 50 C.F.R. ' 402.02.

To facilitate compliance with the requirements of the Endangered Species Act subsection (a)(2) the Environmental Protection Agency, Office of Pesticide Programs has established procedures to evaluate whether a proposed registration action may directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of any listed species (U.S. EPA 2004). After the Agency's screening-level risk assessment is performed, if any of the Agency's Listed Species LOC Criteria are exceeded for either direct or indirect effects, a determination is made to identify if any listed or candidate species may co-occur in the area of the proposed pesticide use. If determined that listed or candidate species may be present in the proposed use areas, further biological assessment is undertaken. The extent to which listed species may be at risk then determines the need for the development of a more comprehensive consultation package as required by the Endangered Species Act.

For certain use categories, the Agency assumes there will be minimal environmental exposure, and only a minimal toxicity data set is required (Overview of the Ecological Risk Assessment Process in the Office of Pesticide Programs U.S. Environmental Protection Agency - Endangered and Threatened Species Effects Determinations, 1/23/04, Appendix A, Section IIB, pg.81). Chemicals in these categories therefore do not undergo a full screening-level risk assessment, and are considered to fall under a "no effects" determination. The active ingredient uses of alkylbenzene sulfonic acids and sulfonates fall into this category for the following reasons:

1. The amount that will actually reach the environment is very small based on usage data for down-the-drain uses.
2. Use for toilets and urinals is limited (no home-owner or residential uses are registered).
3. Breakdown of alkylbenzene sulfonate in the environment and via sewage treatment is rapid and well documented in the literature.

The labeled antimicrobial uses of alkylbenzene sulfonic acids and sulfonates are not expected to result in significant environmental exposure. Therefore, no adverse effects (NE) to listed species are anticipated. Use of alkylbenzene sulfonates as inert ingredients in agricultural pesticide formulations is not expected to result in significant environmental exposure. Therefore, no adverse effects (NE) to listed species are anticipated.

10.2 Inert Ingredient Use

The alkylbenzene sulfonates are used as "inert" ingredients in agricultural herbicide formulations. Preplant incorporated and preemergence herbicide treatments are typically applied once per year to the tilled, minimally tilled or no-tilled field before planting or before crop emergence in the spring. Spray applications are primarily via ground spray boom and occasionally by aircraft if a wet spring. Movement of the alkylbenzene sulfonates from the treated field to the aquatic environment can occur at the time of application due to spray drift, or following application via surface water/soil flow or by percolation to groundwater. The FIRST model has predicted a maximum potential concentration of 6.6 ppb alkylbenzene sulfonates in drinking water from inert agricultural uses (memo from K. Leifer, 2006). Available modeling and literature suggest that these chemicals will most likely biodegrade rapidly in soil due to microbial degradation.

The inert agricultural uses of alkylbenzene sulfonates are not expected to adversely affect avian or mammalian species on an acute or chronic basis. Aquatic organisms are also not expected to be adversely affected by inert alkylbenzene sulfonates use acutely or chronically due to the low predicted level of alkylbenzene sulfonates in water by FIRST. A chronic freshwater fish toxicity test NOAEC of 400 ug/L alkylbenzene sulfonates is considered protective of ecosystem structure and function in experimental streams. Therefore, the predicted concentration of 6.6 ug/L in water is well below our chronic Level of Concern (LOC).

11.0 DEFICIENCIES/DATA NEEDS

Hazard Data Gaps. The toxicology database for the alkylbenzene sulfonates consists almost entirely of published literature, is essentially complete and of acceptable quality to assess the potential hazard to humans. Due to limitations with the monkey inhalation study, which used 13% LAS, in addition to the presence of enzyme, the Agency requests a 90-day nose only rat inhalation study using DDBSA.

Ecological Data Gaps. There are no outstanding ecological data requirements

Label Hazard Statements for Terrestrial and Aquatic Organisms

Manufacturing and end-use products must state:

> "Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authorities are notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA."

Residential/Occupational Data Gaps. Confirmatory worker exposure data are necessary, due to the significant limitations of the existing exposure data used in this assessment. The

Agency is requesting worker exposure studies that evaluate inhalation (Guideline 875.1400) exposure for indoor uses.

12.0 REFERENCES

MRID 41143901 - Lloyd, D.; Grimes, J.; Jaber, M. (1989) Nacconol 90G: An Acute Oral Toxicity Study with the Bobwhite: Final Report: Wildlife International Ltd. Project No. 257-101. Unpublished study prepared by Wildlife International Ltd. 26p.

MRID 42439803 - Bollman, M.A. et. al. (1990) Report on the Algal Toxicity Tests of Selected Office of Toxic Substances (OTS) Chemicals. US EPA Environmental Research Laboratory. 179p.

MRID 44260002 - McKim, J. M.; Arthur, J.W.; Thorslund, T.W. (1975) Toxicity of Linear Alkylate Sulfonate Detergent to Larvae of Four Species of Freshwater Fish. USEPA, Nat. Water Qual. Lab., Duluth, MN. Bulletin of Environmental Contamination and Toxicology. Vol 14 (1) pg. 1-7.

MRID 44260009 - Calamari, D.; Marchetti, R. (1973) The Toxicity of Mixtures of Metals and Surfactants to Rainbow Trout (*Salmo gairdneri rich.*) Water Research. Vol. 7(10) pg. 1453-1464.

MRID 47025025 - Maki, A.W.; Bishop, W.E. (1979) Acute Toxicity Studies of Surfactants to *Daphnia magna* and *Daphnia pulex*. Archives of Environmental Contamination and Toxicology. Vol. 8, p. 599-612. Sponsored by The Proctor and Gamble Company USA, Ivorydale Technical Ctr., Cincinnati, OH.

Fairchild, J. F., F. J. Dwyer, T. W. La Point, S. A. Burch, and C. G. Ingersoll. 1993. Evaluation of a Laboratory-Generated NOEC For Linear Alkylbenzene Sulfonate In Outdoor Experimental Streams. Environmental Toxicology and Chemistry. Vol. 12(10): 1763-1775. Symposium on Surfactants and Their Environmental Safety, 11th Annual Meeting, Society of Environmental Toxicology and Chemistry, Arlington, VA, Nov. 11-15, 1990.

Human and Environmental Risk Assessment (HERA). 2004. *LAS – Linear Alkylbenzene Sulphonates (CAS No. 68411-30-3)*

Lewis, M.A., C.A. Pittinger, D.H. Davidson and C.J. Ritchie. 1993. In Situ Response of Natural Periphyton To An Anionic Surfactant And An Environmental Risk Assessment For Phytotoxic Effects. Environmental Toxicology and Chemistry. Vol. 12(10): 1803-1812. Symposium on Surfactants and Their Environmental Safety, 11th Annual Meeting, Society of Environmental Toxicology and Chemistry, Arlington, VA, Nov. 11-15, 1990.

OECD SIDS Initial Assessment Report (SIAR). 2005. April. Linear Alkylbenzene Sulfonate (LAS).

World Health Organization (WHO). 1996. *Environmental Health Criteria Document for Linear Alkylbenzene Sulfonates and Related Compounds.* (EHC 169, available at http://www.inchem.org/documents/ehc/ehc/ehc169.htm)

Appendix A
Toxicity Profile for Alkylbenzene Sulfonates

Table A-1 Toxicity Profile of Alkylbenzene Sulfonates			
Guideline No./ Study Type	**MRID No./ Reference Information/ Study Classification**	**Dosing and Animal Information**	**Results**
Subchronic Toxicity			
870.3100 Oral Subchronic (rodent)	Bornmann et al (1963) Study of a Detergent Based on Dodecylbenzene Sulfonate. Fette Seifen Anstrichm, 65 (10): 818-824. (EHC 169) **Open Literature**	0.01% of a preparation containing 51% LAS was administered in the drinking water for 100 weeks Rats (60/sex) Purity: Not Reported	No detrimental effects on body weight and no pathological effects, including tumors, were reported
870.3100 Oral Subchronic (rodent)	Ikawa et al., (1980)/ Ann. Rep. Tokyo Metrop. Res. Lab. Public Health. 29(2): 51-54(Z). 1978 (in Japanese, see WHO, 1996 and HERA, 2004). **Open Literature**	LAS was administered for 2, 4, or 12 weeks at a single dose of 1.5% in the diet (750 mg/kg/d). Male rats (five/group) Purity not reported.	LAS suppressed body weight gain and the relative liver weight was increased after two weeks. Serum biochemical alterations included: significant increases in ALP, GTP (at 2, 4, 12 weeks); significant decreases in cholesterol and protein (4 weeks); decreases in liver enzymes G6Pase and G6PDH and increases in isocitrate DH (all at 2, 4, 12 weeks). The following enzymes associated with kidney function were also altered: decreases in G6Pase, 5'nucleotidase (at 2, 4, 12 weeks) and Na,K-ATPase (12 wks); increase in LDH (12 wks) and IDH (2,4 wks).
870.3100 Oral Subchronic (rodent)	Ito, et al. (1978) Acute, Subacute, and Chronic Toxicity of Magnesium LAS (LAS-Mg). J. Med. Soc. Toho Univ. 25: 850-875. **Open Literature**	Administration by oral gavage at doses of 0, 155, 310, or 620 mg/kg/day (LAS-Mg) and 125, 250, and 500 mg/kg/day (LAS-Na) for one month Sprague-Dawley Rats (12/sex/group) Purity: 99.5%	LAS-Na: Body weight increase was suppressed; feed-efficacy was decreased, and liver weight increased at 500 mg/kg/day. NOAEL: 125 mg/kg bw/d.
870.3100 Oral Subchronic (rodent)	**MRID No. 43498412** Kay et al. (1965) Subacute Oral Toxicity of a Biodegradable, Linear Alkylbenzene Sulfonate. Toxicol Appl. Pharmacol. 7: 812-818 (HERA) **Acceptable** Guideline	SDDBS administered in the diet at dietary levels of 0, 200, 1000, and 5000 ppm for 90 days Weanling Sprague-Dawley Rat (10/sex/dose) Purity: 87.9% a.i.	NOEL: 5000 ppm (HDT) Two low dose males died early in the study from respiratory illness There was no compound-related effects in body weight, food consumption, hematology, urine analysis, organ weight, and histopathology.
870.3100 Oral Subchronic (rodent)	MRID No. 43511401 Mathur et al. (1986) Toxicological Evaluation of a Synthetic Detergent after Repeated Oral Ingestion in Rats. Industrial Toxicology Research Centre, Mahatma Ganghi	LAS was administered as a commercial synthetic detergent solution at doses of 0, 50, 100, or 250 mg/kg/day in the feed for 10 weeks F Albino Rat (9/group)	NOEL: < 50 mg/kg/d LOEL: 50 mg/kg/d based on alterations of several enzymes indicative of liver and kidney damage

Table A-1 Toxicity Profile of Alkylbenzene Sulfonates			
Guideline No./ Study Type	**MRID No./ Reference Information/ Study Classification**	**Dosing and Animal Information**	**Results**
	Marg, Lucknow Study **No. DDBSA JV-RP-013.** Acceptable	Purity: Not Reported	
870.3100 Oral Subchronic (rodent)	MRID No. 43498402 Oser et al. (1965) Toxicologic Studies with Branched and Linear Alkyl Benzene Sulfonates in the Rat. Toxicol. Appl. Pharmacol. 7: 819-825. (HERA) **Acceptable** Guideline	LAS and ABS were administered at dietary levels of 0, 50, or 250 mg/kg/day, adjusted for bw and fc, for 90 days FDRL Strain (Wistar-derived) Rat (15/sex/dose) Purity: Not Reported	NOEL: 50 mg/kg/d LEL: 250 mg/kg/d for increased absolute and relative liver weight in both sexes (21%) and increased relative cecal weight (21%) in males
870.3100 Oral Subchronic (rodent)	Watari et al. (1977) Ultrastructural Observations of the Protective Effect of Glycyrrhizin for Mouse Liver Injury Caused by Oral Administration of Detergent Ingredients (LAS), J. Clin. Electron. Microscopy (Nihon Rinsho Denshikenbikyo Kaishi) 10 (1-2): 121-139. **Open Literature**	Benzenesulfonic acid, C10-13- alkyl derivatives, sodium salt was administered in the drinking water for 6 months at 0 and 100 ppm with 2 months recovery (M: 0 and 17 mg/kg bw, F: 0 and 20 mg/kg bw) M/F ddy Mouse Purity: Not Reported	Liver effects were observed at the only dose tested (17-20 mg/kg/d), but they disappeared following the 2-month recovery period.
870.3100 Oral Subchronic (rodent)	Yoneyama & Hiraga (1977) Effect of Linear Alkylbenzene Sulfonate on Serum Lipid in Rats, J Ann Rep Tokyo Metrop Res Lab, Public Health 28(2): 109-111. (HERA) **Open Literature**	LAS was administered in the diet at concentrations of 180, 360, or 540 mg/kg bw/d for two and four weeks M Wistar Rat (5/group) Purity: 60% a.i.	Body weight gain was suppressed in the group receiving 540 mg/kg bw/d at four weeks, and the relative liver weight was increased at two weeks and thereafter in the groups receiving 360 mg/kg bw/d and 540 mg/kg bw/d. The levels of triglyceride and total lipids in the serum had decreased markedly at two weeks in all the experimental groups, and the levels of phospholipids and cholesterol in the serum had decreased significantly at two weeks in the groups given 360 and 540 mg/kg bw/d. These changes were less apparent at four weeks, but triglyceride, phospholipid, and cholesterol levels in serum were significantly decreased in the group given 540 mg/kg bw. Significant increases in triglyceride levels were seen in the liver after two weeks in the groups receiving 180 and 540 mg/kg bw/d, and in cholesterol levels in the group given 180 mg/kg bw.
870.3100 Oral Subchronic (rodent)	Yoneyama et al. (1978) Effects of LAS on Incorporation of Acetate-1-14C in Liver Lipids in Rats. J Ann Rep Tokyo Metrop Res Lab Public Health, 29 (2): 55-57.	LAS was administered at a concentration of 200 mg/kg bw/d in the diet or in drinking water (560 mg/kg bw/d) for two weeks to determine the effect on the synthesis of lipids in the liver M Wistar Rat (5/group)	Uptake of acetate-1-14C by lipids in the liver was increased in both groups; uptake of phospholipids and triglycerides tended to increase, and that of phospholipids increased significantly in rats given LAS in the diet.

Table A-1 Toxicity Profile of Alkylbenzene Sulfonates			
Guideline No./ Study Type	**MRID No./ Reference Information/ Study Classification**	**Dosing and Animal Information**	**Results**
	Open Literature	Purity: Not Reported	
870.3100 Oral Subchronic (rodent)	MRID No. 43498413 Heywood et al. (1978) Toxicology Studies of Linear Alkyl Sulphonate (LAS) in Rhesus Monkeys I. Simultaneous Oral and Subcutaneous Administration for 28 Days. Toxicol. Appl. Pharmacol. 11: 245-250. (HERA) Acceptable Guideline	LAS was given to four groups of three males and three females at doses of 30, 150, 300 mg/kg bw/day per gavage (po) and simultaneously with 0.1, 0.5, or 1.0 mg/kg bw/day subcutaneously (sc). Control groups were used. Rhesus Monkey (3/sex/dose), 18-36 months old Purity: Not Reported	At 300 (po) and 1.0 (sc) mg/kg bw/day, the monkeys vomited frequently and usually within 3 hours of administration. An increased frequency of loose or liquid faeces was recorded for animals receiving 150 (po) and 0.5 (sc) mg/kg bw/day. These effects are probably related to the inherent irritative effects of LAS rather than to its systemic toxicity. Fibrosis of the injection sites was found among the entire test group, the incidence and severity being dose related. Ophthalmoscopy, laboratory examination of blood and urine, organ weight analysis and histopathological investigation did not detect any further treatment-related responses. The LOAEL is 150 mg/kg bw/day (po) + 0.5 mg/kg bw/day (sc) based on an increase in liquid feces and the NOAEL is 30 mg/kg/d
870.3200 21-Day Dermal	Mathur et al. (1992) Effect of Dermal Exposure to LAS Detergent and HCH Pesticide in Guinea Pigs: Biochemical and Histopathologic Changes in Liver and Kidney. J Toxicol Cutan Ocular Toxicol, 11(1): 3-13. (WHO 1996) **Open Literature**	A solution of LAS in distilled water equivalent to 60 mg/kg bw was applied to a 4-cm2 area of clipped dorsal skin daily for 30 days 12 Guinea Pigs Purity: Not Reported	The activities of B-glucuronidase, gamma-glutamyl transpeptidase, 5-nucleotidase, and sorbitol dehydrogenase were increased in liver and kidney. Lipid peroxidation was increased in the kidney but not in liver, and the glutathione content was unchanged in both organs. Extensive fatty changes were found in hepatic lobules, with dilation of sinusoids; tubular lesions were found in the kidney, predominantly in the proximal and distal portions.
870.3200 21-Day Dermal	Tox Record No. 003441 Subchronic (28-day) Percutaneous Toxicity (Rabbit) of Compound: B0002.01, (Bio/dynamics Inc., Project No. 4717-77, March 17, 1978, submitted by Procter and Gambel Company, May 10, 1978). **Unacceptable** Core-Minimum Data	SDDBS (end use product Comet Cleanser) was applied to the skin of rabbits for 28 days at 200 mg/kg/d. The hair of each rabbit was clipped from its trunk, so as to expose approximately 25% of the total body surface area and the skin was abraded daily just prior to treatment. 20 M/F Albino New Zealand White Rabbits (5/sex/group) Purity: 10%	NOEL: > 200 mg/kg/d
870.3465 90-Day Inhalation	MRID No. 43498403 Coate et al. (1978) Respiratory Toxicity of Enzyme Detergent Dust. Toxicol. Appl. Pharmacol., 45: 477-	SDDBS was administered a SDDBS mixture at levels of 0, 100(detergent), and [.001, .01, 0.1 and 1 (enzyme)] together with	NOEL: 1 mg/m3 detergent dust combined with up to 0.1 mg/m3 enzyme dust. The detergent dust alone at 100 mg/m^3 caused gross signs of respiratory distress, pulmonary histopathological effects, and pulmonary function

Table A-1 Toxicity Profile of Alkylbenzene Sulfonates			
Guideline No./ Study Type	**MRID No./ Reference Information/ Study Classification**	**Dosing and Animal Information**	**Results**
	496. Acceptable Guideline	[+0, 1, 10, and 100 (detergent)] mg/m3 for 6 hours daily, 5 days a week, for 6 months 12 groups of 5 M/4 F Cynomolgus Monkeys Purity: 13%	impairment indicative of constricted bronchioles. Exposure to 10 or 100 mg/m^3 together with 0.01 and 0.1 mg/m^3 enzyme dust produced the same effects along with weight loss and decreased weight gain.
Developmental Toxicity			
870.3700a Developmental Toxicity (rodent)	Daly et al. (1980) A Teratology Study of Topically Applied LAS in Rats, Fd. Cosmet. Toxicol. 18: 55-58. (HERA) **Open Literature**	LAS was applied to the skin on days 0 through 21 of gestation at doses of 20, 100, and 400 mg/kg bw/d Rat Purity: Not Reported	NOAEL (maternal): 20 mg/kg bw/d NOAEL (fetuses): 400 mg/kg bw/d Maternal toxicity: the dams treated with 400 mg/kg bw/day and 100 mg/kg bw/day showed inhibition of body weight gain and llocal skin effects that compromised the integrity of the skin and caused overt toxicity, like inhibition of the body weight gain. Teratogenicity: there were no findings indicative of effects of LAS on the foetal parameters evaluated. There were no indications of teratogenic or embryotoxic effects.
870.3700a Developmental Toxicity (rodent)	Endo et al. (1980) Studies of the Chronic Toxicity and Teratogenicity of Synthetic Surfactants, Ann. Rep. Tokyo Metrop. Res. Inst. Environ. Prot. (Tokyo Kogai Kenkyujo Nempo), 236-246. (HERA) **Open Literature**	LAS was administered in the drinking water at 0.1%, corresponding to 383 mg/kg bw/d for rats and up to 3030 mg/kg bw/d for rabits from day 6 to 15 (rats) and day 6 to 18 (rabbits) of pregnancy. F Rat and Rabbit Purity: Not Reported	NOAEL (maternal): 383 mg/kg bw/d (rat) LOAEL (maternal): 3030 mg/kg bw/d (rabbit) NOAEL (fetuses): 383 mg/kg bw/d (rat) LOAEL (fetuses): 3030 mg/kg bw/d (rabbit) The effect on the dams was a slight inhibition of body weight gain in the rabbits. The litter parameters of both species did not show any significant differences from those of the controls. Delayed ossification was observed in rabbits, but there was no increase in malformations in either the rabbits or the rats.
870.3700a Developmental Toxicity (rodent)	Imahori et al. (1976) Effects of LAS Applied Dermally to Pregnant Mice on the Pregnant Mice and their Fetuses, J. Jpn. J. Public Health (Nihon Koshueisei Zasshi) 23(2): 68-72. (HERA) **Open Literature**	LAS was applied daily at dermal doses of 15, 150, and 1500 mg/kg bw/d on days 6 through day 15 of pregnancy F Mouse Purity: Not Reported	NOAEL (maternal): 150 mg/kg bw/d NOAEL (fetuses): 1500 mg/kg bw/d The 1500 mg/kg bw/day group showed a clear decrease in the pregnancy rate (67.9%) when compared with a rate of 96.3% in the controls. However, there were no decreases in the litter size, and no changes in the litter parameters with the exception of a slight decrease in foetal body weight. There were no significant increases in the incidence of malformations in the foetuses.
870.3700a Developmental Toxicity (rodent)	**MRID No. 43498423** Masuda et al. (1974) Effects of LAS Applied Dermally to Pregnant Mice on the Development of their	LAS was applied dermally at a level of 0.5 ml. The ICR-JCL strain received doses of 0, 0.85, 1.7, 2.55, and 3.4% solutions daily	NOEL (maternal and developmental toxicity - ddY): 1.7% (HDT) NOEL (maternal toxicity - ICR-JCL): 2.55% NOEL (developmental toxicity - ICR-JCL): 1.7% At 3.4% LAS, maternal body weight and the

Table A-1 Toxicity Profile of Alkylbenzene Sulfonates			
Guideline No./ Study Type	**MRID No./ Reference Information/ Study Classification**	**Dosing and Animal Information**	**Results**
	Fetuses. 15: 349-355. **Acceptable** Guideline	from days 1 to 13 of gestation and the ddY strain received doses of 0, 0.017, 0.17, and 1.7% solutions daily from days 2 to 14 of gestation. Mouse (ICR-JCL strain and ddY strain) Purity: Not Reported	absolute weight of liver, kidney, spleen were significantly increased over control.. Pregnancy rates were significantly less (33.35) compared to controls (69%). The number of implantations, live fetuses, sex ratio, dead or resorbed fetuses, placenta weight and external malformations were comparable with control. Fetal body weights of 2.55% and 3.4% LAS-treated groups were significantly less than controls.
870.3700a Developmental Toxicity (rodent)	MRID 43498424 and 43498425 Nomura, T et al. (1980) The Synthetic Surfactants AS and LAS Interrupt Pregnancy in Mice. Life Sciences, 26: 49-54. (HERA) Nomura, T. et al. (1987) Killing of Preimplantation Mouse Embryos by AS and LAS. Mutation Research 190: 25-29. (HERA) **Acceptable** Guideline	LAS (0.1 ml) was applied at a concentration of 20% to the dorsal skin of pregnant mice during the pre-implantation period twice a day from day 0 to day 3 of pregnancy Female ICR/Jcl Mouse, 9-10 weeks old Purity: 20%	Development was retarded and cleavage of eggs was interrupted. Significantly higher numbers of embryos were found to be deformed in the LAS group in comparison to controls, and most of these embryos were in the morula stage, whereas they were mostly in the last blastocyst stage in controls. Some dead, deformed, and growth-retarded embryos were observed in the treated group. Although the authors stated that these effects were not due to maternal toxicity since no maternal organs were affected, this statement is probably not correct in view of the high concentration of LAS and its irritation effects. A secondary effect due to maternal toxicity appears much more likely.
870.3700a Developmental Toxicity (rodent)	**MRID 43498426** Palmer et al. (1975) Assessment of the Teratogenic Potential of Surfactants, (Part I), Toxicology 3: 91-106. **Acceptable** Guideline	LAS was administered by gavage on days 6-15 of pregnancy in rats and mice and days 6-18 of pregnancy in rabbits at doses of 0.2, 2, 300, and 600 mg/kg bw/d 20 CD Rats, 20 CD-1 Mice, and 13 New Zealand White Rabbits Purity: 17%	NOAEL (rat - maternal): 300 mg/kg bw/d NOAEL (mouse - maternal): 2.0 mg/kg bw/d (However, there is a large difference between this dose and the next highest dose of 300 mg/kg bw/d, this study does not allow determination of a reliable maternal NOAEL for mice) NOAEL (rabbit - maternal): 2.0 mg/kg b/d (However, the study does not allow determination of reliable NOAELs, given the large difference between the maternal no-effects doses of 2 mg/kg bw/d and the maternal LOAEL dose (300 mg/kg bw/d) that is also the dose for which effects on litters could not be determined due to the high mortality rate in parent animals) NOAEL (rat - developmental): 300 mg/kg bw/d NOAEL (mouse - developmental): 2.0 mg/kg bw/d NOAEL (rabbit - developmental): 2.0 mg/kg bw/d NOAEL (rat - fetal): 600 mg/kg bw/d NOAEL (mouse - fetal): 300 mg/kg bw/d (Due to a high mortality rate of parent animals, no assessment was possible at 600 mg/kg bw/d) NOAEL (rabbit - fetal): could not be determined
870.3700a Developmental Toxicity (rodent)	**MRID 43511403** Palmer, et al. (1975) Assessment of the Teratogenic Potential of Surfactants, (Part III) - Dermal Application of LAS	LAS was administered percutaneously to shaved skin at solutions of 0.03%, 0.3%, and 3% during pregnancy on days 2-13 in mice, 2-15	LOEL (maternal toxicity, mice): 0.3% (50 mg/kg/d) LOEL (maternal toxicity, rats): 3.0% (60 mg/kg/d) LOEL (maternal toxicity, rabbits): 0.3% (9.0 mg/kg/d) NOEL (maternal toxicity, mice): 0.03% (5.0 mg/kg/d)

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Guideline No./ Study Type	**MRID No./ Reference Information/ Study Classification**	**Dosing and Animal Information**	**Results**
	and Soap. Huntingdon Research Centre, Huntingdon, Great Britain. Study No. DDBSA JV-RP4-029. Toxicology 4: 171-181. **Acceptable** Guideline	in rats, and 1-16 in rabbits. Dosages employed were 0.5 ml/rat or mouse/day and 10 ml/rabbit/day CD-1 Mice (20/group), CD Rats (20/group), N2W Rabbits (13/group) Purity: 0.03%, 0.3%, and 3%	NOEL (maternal toxicity, rats): 0.3% (6.0 mg/kg/d) NOEL (maternal toxicity, rabbits): 0.03% ((0.9 mg/kg/d) LOEL (developmental toxicity): 0.3% (50 mg/kg/d) LOEL (developmental toxicity): 3.0% (60 mg/kg/d) LOEL (developmental toxicity): 3.0% (90 mg/kg/d) NOEL (developmental toxicity): 0.03% (5.0 mg/kg/d) NOEL (developmental toxicity): 0.3% (6.0 mg/kg/d) NOEL (developmental toxicity): 0.3% (9.0 mg/kg/d) Marked local skin reaction, irritability, weight loss and failure to maintain or establish pregnancy was evident in mice treated with LAS 3% soap, 3 or 30%: marked local reaction and weight loss also occurred in rabbits receiving LAS 3%. Moderate maternal toxicity was observed among mice treated with LAS, 0.3% and mild maternal toxicity in rats receiving LAS 3% or soap 30% and rabbits receiving LAS 0.3%. Effects on litter parameters were dose-dependent, causing marked maternal toxicity in mice, the principal higher fetal loss, reduction in viable litter size. LAS at 3% showed marked maternal toxicity in the rabbit The moderate maternal toxicity of LAS, 0.3% in the mouse correlated with a higher incidence of embryonic deaths and lower litter size but only the former differed significantly from the corresponding control value.
870.3700a Developmental Toxicity (rodent)	Sato et al. (1972) Studies on the Toxicity of Synthetic Detergents: (III), Examination of Teratogenic Effects of Alkylbenzene Sulfonates Spread on the Skin of Mice. Ann. Rep. Tokyo Metrop. Res. Lab. Public Health 24: 441-448. (HERA) **Open Literature**	LAS was applied to the skin of female mice daily on days 0 through 13 of pregnancy with a single LAS dose of 110 mg/kg bw/d. Control group not specified. F Mouse Purity: Not Reported	NOAEL (maternal): 110 mg/kg bw/d No abnormalities were seen in the dam or foetuses.
870.3700a Developmental Toxicity (rodent)	Shiobara S., Imahori A. (1976) Effects of LAS Orally Administered to Pregnant Mice on the Pregnant Mice and their Fetuses. J.Food Hyg. Soc. Jpn. (Shokuhin Eiseigaku Zasshi) 17(4): 295-301.	LAS was administered by gavage at doses of 10, 100, and 300 mg/kg bw/d at day 6 through 15 of gestation ICR-SLC Mouse (25-33/dose) Purity: Not Reported	LOAEL (maternal): 10 mg/kg bw/d NOAEL (fetuses): 300 mg/kg bw/d 1. Marked maternal and embryonic toxicities, such as maternal death, premature delivery, total litter loss and high fetal death rate, were observed at 300 mg/kg group. 2. Slight suppression of maternal body weight gain and slight body weight suppression of live fetuses were observed in each treated group.

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Guideline No./ Study Type	**MRID No./ Reference Information/ Study Classification**	**Dosing and Animal Information**	**Results**
	Open Literature		3. External malformations such as cleft palate and exencephaly were observed sporadically both in the control and the treated groups. However, the incidence of these malformations was not significant, and considered to be within the spontaneous incidence of ICR mice.
870.3700a Developmental Toxicity (rodent)	Takahashi et al. (1975) Teratogenicity of Some Synthetic Detergent and LAS. Ann. Rep. Tokyo Metrop. Res. Lab. Public Health 26(2): 67-78. (HERA) **Open Literature**	LAS doses of 40, and 400 mg/kg bw/d were administered daily from day 0 to day 6 of pregnancy or from day 7 to 13 of pregnancy by gavage Mouse (13-14/group) Purity: not reported	NOAEL (maternal): 40 mg/kg bw/d NOAEL (fetuses): 400 mg/kg bw/d At 400 mg/kg bw/day, the pregnancy rate was 46.2% compared to 92.9% in the controls. There was no increase in malformations. Although no information on maternal toxicity is available, it appears likely that maternal toxicity was present at the high dose group.
870.3700a Developmental Toxicity (rodent)	Tiba et al. (1976) Effects of LAS on Dam, Fetus, and Newborn Rat. J. Food Hyg. Soc. Jpn. (Shokuhin Eiseigaku Zassh) 17(1): 66-71. (HERA) **Open Literature**	LAS was administered in the diet at doses of 80 and 780 mg/kg bw/d from day 0 to 20 of gestation F Rat (16/dose) Purity: Not Reported	NOAEL (maternal): 780 mg/kg bw/d NOAEL (fetuses): 780 mg/kg bw/d At 780 mg/kg bw/day there were no abnormalities in the body weight gains of the dams, or in the occurrence and maintenance of pregnancy. The values of the litter parameters did not differ from those of the controls and there was no evidence of teratogenicity. The number of offsprings was rather low in the highest dose group, and the weaning rate of 78.3% was lower than the 100% rate observed in the controls. However, there were no abnormalities in body weight gain, organ weights or functions in the offsprings.
Reproduction Toxicity			
870.3800 Reproduction	**MRID 43498416** Buehler, E., Newmann, E., and King, W. (1971) Two Year Feeding and Reproduction Study in Rats with Linear Alkylbenzene Sulfonate (LAS). Tox. Appl. Pharm. 18: 83-91. (HERA) **Acceptable** Guideline	LAS was administered in the diet at doses of 0, 0.02, 0.1, and 0.5% , equivalent to (0, 10, 50, 250 mg/kg bw/day) for 84 days. Weanling Charles River CD Rat (20/sex/dose) Purity: 98.1%	NOAEL Parental: 250 mg/kg bw/day NOAEL Offspring: 50 mg/kg/d. The LOAEL of 250 mg/kg/day in the offspring is due to slight (non-significant) changes in hematology and histopathology and slight decrease in day 21 body weights.
870.3800 Reproduction	Endo et al. (1980) Studies of the Chronic Toxicity and Teratogenicity of Synthetic Surfactants, Ann. Rep. Tokyo Metrop. Res. Inst. Environ. Prot. (Tokyo Kogai Kenkyujo Nempo), 236-246. (HERA) **Open Literature**	LAS was administered at 70 mg/kg bw/day in the drinking water in a four generation rat study. M/F Wistar Rat Purity: Not Reported	NOAEL: > 70 mg/kg (only dose tested) No effects of LAS administration were observed

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Guideline No./ Study Type	**MRID No./ Reference Information/ Study Classification**	**Dosing and Animal Information**	**Results**
870.3800 Reproduction	Palmer et al. (1974) Effect of CLD Reproductive Function of Multiple Generations in the Rat, Report LFO10/731029, Unpublished results. (HERA) **Open Literature**	A commercial light duty liquid detergent of LAS (17%) and alkyl ethoxylate sulphate (7%) was continuously administered in the diet for three generations 60 days prior to mating at concentrations of 0, 40, 200, and 1000 mg/kg bw/d. The corresonding administration of LAS was of 0, 6.8, 34, and 170 mg/kg bw/d. Rat Purity: 17%	NOAEL: 170 mg/kg bw/d Among parental animals over the three generations there were no signs of adverse effects of treatment. Food consumption and bodyweight changes showed no consistent relationship to dosage. Necroscopy revealed no changes due to treatment. The mating performance, the pregnancy rate and the duration of gestation were unaffected. Among litter parameters, organ weight analysis, histopathology and skeletal staining of representative young from the F3b generation revealed no changes that could be conclusively related to treatment.
Chronic Toxicity			
870.4100a Chronic Toxicity (rodent)	Taniguchi et al. (1978) Results of Studies on Synthetic Detergents. Tokyo, Science and Technology Agency, Research and Coordination Bureau, pp. 18-54. (WHO 1996) **Open Literature**	LAS were applied to the dorsal skin of rats three times per week at doses of 1, 5, or 25 mg/rat for 24 months. Each application was washed from the skin with warm water after 24 hours. SLC-Wistar Rats Purity: 19.7% a.i.	Treatment had no effect on organ weights or histopathological appearance, and there was no evidence of toxicity or carcinogenicity.
870.3100 Chronic Toxicity (rodent)	Yoneyama et al. (1976) Subacute Toxicity of LAS, Ann. Rep. Tokyo Metrop. Res. Lab. Public Health27(2): 105-112, See: IPCS, 1996. (HERA) **Open Literature**	LAS was administered in the diet at concentrations of 500 and 1000 mg/kg bw/d and in drinking water at concentrations of 100, 250, 600 mg/kg bw/d for males and 100, 250, 900 mg/kg bw/d for females for 9 months Mouse (8 or 9/sex/dose) Purity: Not Reported	LOAEL: 500 mg/kg bw/d (in diet) NOAEL: 250 mg/kg bw/d (in water) LAS in diet: in the mice given 500 mg/kg bw/day, body weight gain was not suppressed, but the weight of the liver increased in male and female mice. Enzymatic examinations revealed significant decreases in LDH of the liver and in acid phosphatase of the kidneys in the male mice. LAS in drinking water: body weight was depressed at the highest dose for male and females, increase in liver weight in females, significant decreases in renal Na,K-ATPase.
870.3100 Chronic Toxicity (rodent)	Yoneyama et al. (1976) Subacute Toxicity of LAS, Ann. Rep. Tokyo Metrop. Res. Lab. Public Health27(2): 105-112, See: IPCS, 1996. (HERA) **Open Literature**	LAS was administered for 9 months in the drinking water at doses of 85, 145, 430 mg/kg bw/day M/F Wistar Rat Purity: Not Reported	NOAEL: 85 mg/kg bw/d LOAEL: 145 mg/kg bw/d Haematological examination revealed no significant changes in any experimental group and no organ weight changes were observed. Body weight gain was suppressed in the males of the highest dose group and also serum-biochemical and enzymatic parameters of the liver and kidney were affected. A significant decrease in renal Na,K-ATPase was seen in the group given 145 mg/kg bw/day of LAS.
870.4100a	Yoneyama et al.	Technical-grade LAS	NOAEL: 0.07% (40 mg/kg bw/day)

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Guideline No./ Study Type	**MRID No./ Reference Information/ Study Classification**	**Dosing and Animal Information**	**Results**
Chronic Toxicity (rodent)	(1972) Studies on the Toxicity of Synthetic Detergents. (II) Subacute Toxicity of Linear and Branched Alkyl Benzene Sulfonates in Rats. Ann Rep Tokyo Metrop Res Lab Public Health, 24: 409-440. **Open Literature**	was administered in the feed for 6 months at a concentration of 0, 0.07, 0.2, 0.6, or 1.8% Wistar SLC Strain Rat (10/sex/dose) Purity: Not Reported	At 1.8%, diarrhea, decrease in body weight gain and tissue damage in caecum liver and kidney were observed. The damage to the kidney was especially remarkable. At 0.6% of the LAS or ABS, the adverse effects observed were a slight decrease of body weight, increase of ceacum weight, increased activity of alkaline phosphatase, decrease of total protein in blood, and the tissue damage in the kidney. At 0.2% of the LAS or ABS, an increase of caecum weight and a slight damage to the kidney were observed.
Carcinogenicity			
870.4200a Oncogenicity (Rat)	**MRID 43498416** Buehler, E., Newmann, E., and King, W. (1971) Two Year Feeding and Reproduction Study in Rats with Linear Alkylbenzene Sulfonate (LAS). Tox. Appl. Pharm. 18: 83-91. (HERA) **Acceptable** Guideline	LAS was administered in the diet at doses of 10, 50, and 250 mg/kg/day for 2 years Weanling Charles River CD Rats (50/sex/group) Purity: Not Reported	Negative at 250 mg/kg/day (HDT)
870.4200a Oncogenicity (Rat)	Endo et al. (1980) Studies of the Chronic Toxicity and Teratogenicity of Synthetic Surfactants, Ann. Rep. Tokyo Metrop. Res. Inst. Environ. Prot. (Tokyo Kogai Kenkyujo Nempo), 236-246. (HERA) **Open Literature**	LAS was administered in the drinking water at the dose of 200 mg/kg bw/d 62 M/F Wistar Rat Purity: 38.74% a.i.	The administration of LAS had no effect on the intake of water, mortality, body weight gain, or general condition. In pathological examinations, looseness, atrophy, and fatty change of the hepatic cells in the liver were found in the experimental control group at 6 months, together with significant increases in GOT, GTP and bilirubin. In hematological examinations no effects due to LAS were observed.
870.4200a Oncogenicity (Rat)	Fujii et al. (1977) Pathological Examination of Rats Fed with LAS for their Lifespan, Ann. Rep. Tokyo Metrop. Res. Lab. Public Health 28(2): 85-108. (HERA) Yoneyama et al. (1977) Toxicity of LAS by Dietary Administration for Life-Span to Rats, Ann. Rep. Tokyo Metrop. Res. Lab. Public Health 28(2): 73-84. (HERA)	LAS was administered in the feed at a concentration of 0.04, 0.16, and 0.60% for 24 months or lifespan Wistar Weanling Rat (15/sex/dose) Purity: Not Reported	Histopathological examination revealed that there was no evidence of a treatment-related effect on any tissue examined. Whereas a variety of tumors were observed in both linear alkylbenzene sulfonate treated and control rats, none was attributed for the exposure to linear alkylbenzene sulfonate. There was no relationship among the dosage groups, sex, type of tumor, or the site of occurrence.

Table A-1 Toxicity Profile of Alkylbenzene Sulfonates			
Guideline No./ Study Type	**MRID No./ Reference Information/ Study Classification**	**Dosing and Animal Information**	**Results**
	Open Literature		
870.4200a Oncogenicity (Rat)	**MRID 43498420** Takahasi et al. (1969) Effect of Alkylbenzenesulfonate as a Vehicle for 4-Nitroquinoline-1-Oxide on Gastric Carcinogenesis in Rats. GANN: 8, 241-261. **Acceptable** Guideline	For 560 days; Group I (79 rats): 1 mg 4-NQO and 80 mg SDDBS 2-3x per week for 18 weeks; Group I' (17 rats): same as Group 1, but fasted for 12 hours prior to dosing,; Group II (37 rats): 1 mg 4-NQO only; Group III (28 rats): 80 mg SDDBS only 97 M Wistar Rats Purity: Not Reported	In Groups I and I', the presence of SDDBS shifts the incidence of benign papillomas to malignant papillomas of the forestomach and the incidence of adenocarcinoma and sarcoma of the stomach were increased in comparison to Group II with only 4-NQO. The administration of SDDBS by itself has no effect on gastric tumors (Group III). The study authors concluded that the increased carcinogenicity produced by SDDBS was due to the better uptake of 4-NQO via LAS's surfactive/detersive effects on the protective mucous barrier which is normally found in the glandular stomach and other gastric compartments of the rat. The effect of SDDBS was physical rather than chemical in promoting the increased tumorigenicity.
870.4200a Oncogenicity (Rat)	**MRID 43498419** Takahasi et al. (1970) Effect of 4-Nitroquinoline-1-Oxide with Alkylbenzenesulfonate on Gastric Carcinogenesis in Rats. GANN: 61, 27-33. **Acceptable** Guideline	Rats were divided into three groups and gavaged with the following regimen for 560 days: Group I (37 rats) - 1 mg 4-NQO + 80 mg SDDBS + 20 mg ethanol in a 1 ml gavage for 18 weeks; Group II (13 rats) - 4-NQO and ethanol for 18 weeks; Group III (13 rats) - SDDBS + ethanol for 18 weeks 64 M Motoyama Strain Rat Purity: Not Reported	Survival: Mortality was 59% in Group I, 31% in Group II, and 23% in Group III Tumors: Group III - no gastric tumors; Group II - 9 benign papillomas of forestomach; Group I - 8 benign papillomas of forestomach, 2 malignant papillomas of forestomach, 1 hemangiosarcoma of forestomach. In glandular stomach, 2 adenocarcinomas, 1 hemangiosarcoma, 1 hemangioma, 5 squamous cell carcinomas, and 2 rats exhibited atrophic gastritis. The increased toxicity in Group I produced increased mortality and increased numbers of malignant tumors. The role of SDDBS in the tumorigenesis of 4-NQO was to promote increased absorption of 4-NQO through the forestomach and glandular stomach.
870.4200a Oncogenicity (Rat)	**MRID 43498421, -22** Takahasi et al. (1973) Carcinogenic Effect of N-Methyl-N'-Nitro-N-Nitrosoguanidine with Various Kinds of Surfactant in the Glandular Stomach of Rats. **Acceptable** Guideline	SDDBS was administered to 5 groups of rats: (I) 13 rats received 0.1g of MNNG + 4000 mg Tween 60 per L of drinking water for 36 weeks; (II) 16 rats received 0.1 g MNNG + 2000 mg nonipol per L of drinking water for 36 weeks; (III) 15 rats received 0.1 g of MNNG + 1000 mg branched ("hard") SDDBS per L of drinking water for 63 weeks; (IV) 10 rats received 0.1 g MNNG + 1000 mg of linear ("soft") SDDBS per L of drinking water for 63 weeks; (V) 14 rats received o.1 g MNNG per L of drinking water for 63 weeks M Wistar Rats	Survivial was 100% in Groups I, III, and IV, and 93% and 94% in Groups V and II, respectively. The Group I and II rats had more tumors than the controls (Group V), whereas, the rats in Group III, ("hard" SDDBS, and particularly, Group IV (linear "soft" SDDBS) had the fewest tumors in comparison to controls.

Table A-1 Toxicity Profile of Alkylbenzene Sulfonates			
Guideline No./ Study Type	**MRID No./ Reference Information/ Study Classification**	**Dosing and Animal Information**	**Results**
		Purity: Not Reported	
870.4200a Oncogenicity (Rat)	Tiba S (1972) Studies on the Acute and Chronic Toxicity of LAS, J. Food Hyg. Soc. Jpn. (Shokuhin Eiseigaku Zasshi) 13(6): 509-516. (HERA) **Open Literature**	LAS was administered in drinking water for 2 years at doses of 20, 100, and 200 mg/kg bw/d M Wistar Rat (20/group) Purity: Not Reported	There were no changes due to the administration of LAS in regard to growth, mortality, the weight of major organs, or histopathological findings
Mutagenicity			
870.5100 Bacterial reverse mutation test	Huls, Report No. AM-93/12, Unpublished data, 1993. (As cited in HERA-2004) **Open Literature**	LAS was tested at 8-5000 ug/plate with and without metabolic activation. The cytotoxicity concentration was >5000 ug/plate. Salmonella typhimurium, strains TA 98, TA 100, TA 1535, TA 1537, and TA 1538 Purity: Not Reported	Negative results
870.5100 Bacterial reverse mutation test	**MRID 43498429** Inoue et al. (1980) Studies of In Vitro Cell Transformation and Mutagenicity by Surfactants and other Compounds, Food. Cosmet. Toxicol 18: 289-296. (HERA) **Acceptable** Guideline	SDDBS was tested at cytotoxic levels or limit concentrations of 2,000-30,000 ug/plate for 2 days (Salmonella) or 8 days (SHE) Strain: Salmonella typhimurium - TA 98 and TA 100 cells and Embryonic Syrian Golden Hamster cells (SHE) Purity: Not Reported	Negative (both with and without S-9 metabolic activation)
870.5100 Bacterial reverse mutation test	Sunakawa et al. (1981) Studies on the Mutagenicity of Surfactants Following Activation with Various Liver Homogenates (S-9) and Mutagenicity in the Presence of Norharman, Hyg. Chem. (Eisei Kagaku) 27(4): 204-211, See: WHO, 1996. **Open Literature**	LAS was tested at up to 500 ug/plate Salmonella typhimurium Purity: Not Reported	Negative Results
870.5300 In Vitro mammalian cell gene	Inoue, K. et al. (1977) Osaka-furitsu Koshu Eisei Kenkyusho Kenkyu Hokoku, Shokuhin Eisei Hen 8: 25-8. (HERA)	Sodium alkylbenzenesulfonate was added to culture at 62.5 ug/ml and 125 ug/l Hamster Lung Cell	At 62.5 ug/ml: induced cell mutation, no effect on sister chromatid exchange At 125 ug/ml: destroyed the cells completely

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mutation test	**Open Literature**	Purity: Not Reported	
870.5300 In Vitro cell transformation	***MRID No. 43498427*** K. Inoue et al (1980) Food Cosmetic Toxicol. 18:289-296 *Acceptable* **Open Literature**	Duplicate primary cultures of embryonic SHE and Salmonella typhimurium strain TA 98 and TA 100 cells were exposed to SDDBS and positive and negative controls for 8 days.	SDDBS was negative for transformation up to cytotoxic levels and did not induce mutation in either strains of Salmonalla when allplied up to cytotoxic levels or limit concentration of 2000-3000 ug/plate. SDDBS was tested negative at cytotoxic levels or limit concentrations (both with and without S-9 metabolic activation) of 2,000-30,000 ug/plate for 2 days (Salmonella) or 8 days (SHE)
870.5385 Mammalian bone marrow chomosomal aberration test	Inoue K, et al. (1979) In vivo Cytogenetic Tests of Some Synthetic Detergents in Mice, Ann. Rep. Osaka Perfect. Inst. Public Health 8: 17-24 (in Japanese), See: IPCS, 1996. (HERA) **Open Literature**	LAS was administered at doses of 200, 400, and 800 mg/kg bw/d by gavage for 1 and 5 days M Mouse Purity: Not Reported	There was no significant difference in the incidence of chromosomal aberrations between any of the groups
870.5385 Mammalian bone marrow chomosomal aberration test	Inoue, K. et al. (1977) In Vivo Cytogenetic Tests of Some Synthetic Detergents in Mice. Ann Rep Osaka Prefect Inst Public Health, 8: 17-24. (HERA) **Open Literature**	LAS was administered at a dose of 200, 400, and 800 mg/kg bw/d by gavage for 5 days. One commercial preparation containing 19.0% LAS was also given, at a dose of 800, 1600, or 3200 mg/kg bw, and another containing 17.1% LAS at a dose of 1000, 2000, or 4000 mg/kg bw once only by gavage. M ICR:JCL Mouse Purity: Not Reported	There was no significant difference between any of the groups given LAS and the negative control group in the incidence of chromosomal aberrations
870.5385 Mammalian bone marrow chomosomal aberration test	**MRID 43498428** J. Hope (1977) Absence of Chromosome Damage in the Bone Marrow of Rats Fed Detergent Actives for 90 Days. Mutation Research, 56: 47-50. **Acceptable** Guideline	SDDBS was administered in the diet for 90 days at 0, 280, and 565 mg/kg bw/d Colworth/Wistar Weanling Rat (6/sex/dose) Purity: Not Reported	All test preparations were negative for increased chromosomal damage over controls.
870.5385 Mammalian bone marrow chomosomal aberration test	Masabuchi et al. (1976) Cytogenetic Studies and Dominant Lethal Tests with Long Term Administration of Butylated Hydroxytoluene (BHT) and LAS in Mice and Rats, Ann. Rep.	LAS was administered in the diet for 9 months at a dose of 0.9% in rats (450 mg/kg bw/d) and in mice (1170 mg/kg bw/d) Male Rat and Male Mouse Purity: Not Reported	There were no significant differences in the incidences of chromosomal aberrations between the experimental and control groups

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	Tokyo Metrop. Res. Lab. Public Health 27(2): 100-104. (HERA) **Open Literature**		
870.5395 Mammalian erthrocyte micronucleus test	Kishi et al. (1984) Effects of Surfactants on Bone Marrow Cells, Bull. Kanagawa Public Health Lab. 14: 57-58. (HERA) **Open Literature**	LAS was administered as a single intraperitoneal injection at a dose of 100 mg/kg bw 3 M ddY Mice Purity: Not Reported	There were no differences in the incidences of polychromatic erythrocytes with micronuclei in the bone marrow cells between the treated group and the control group
870.5395 Mammalian erthrocyte micronucleus test	Koizumi et al. (1985) Implantation Disturbance Studies with LAS in Mice, Arch. Environ. Contam. Toxicol. 14: 73-81. (HERA) **Open Literature**	LAS were administered as a single oral dose of 2 mg to pregnant mice on day 3 of gestation. On day 17 of gestation, each animal received a subcutaneous dose of 1, 2, or 10 mg and were killed 24 h later. Pregnant ICR Mice Purity: Not Reported	There was no difference among treated groups in the incidence of polychromatic erythrocytes with micronuclei in maternal bone marrow or fetal liver or blood. No mutagenetic effect was found in any of the groups.
870.5450 Rodent dominant lethal assay	Masubuchi MA et al. (1976) Cytogenetic Studies and Dominant Lethal Tests with Long Term Administration of Butylated Hydroxytoluene (BHT) and Linear Alkylbenzene Sulfonate (LAS) in Mice and Rats. Ann Rep Tokyo Metrop Res Lab Public Heath, 27(2): 100-104. (HERA) **Open Literature**	A diet containing 0.6% LAS at 300 mg/kg bw/d was administered to mice for 9 months. Each of the male mice was then mated with two female mice that had not been given LAS, and 11 of the 14 females became pregnant. The pregnant mice were laparotomized on day 13 of gestation 7 M ICR:JCL Mice Purity: Not Reported	There were no significant differences in fertility, mortality of ova and embryos, the number of surviving fetuses, or the index of dominant lethal induction (Roehrborn) between the experimental and control groups.
Metabolism			
870.7485 General Metabolism	**MRID 43498410** Creswell et al. (1978) Toxicology Studies of Linear Alkylbenzene Sulphonate (LAS) in Rhesus Monkeys II. The Disposition of C14-LAS After Oral or	Single oral doses of C14-LAS (SDDBS; 25 ucuries) were administered to each animal, following 2-3 weeks between dose levels, at levels of 30, 150, and 300 mg/kg. Following 2-3 weeks	After single 30 mg/kg doses the radioactivity was rapidly excreted, mostly during the first 24 hours. Feces and urine contained 23.1% and 71.2%, respectively, in the first 5 days after oral dosing. Plasma concentrations were comparable after the oral doses and averaged 34, 41, and 36 u/ml, respectively. Peak plasma concentrations increased proportional to the dose and were 0.16, 0.72, 1.13 u/ml, respectively. In urine samples

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	Subcutaneous Administration. Toxicology, 11: 5-17. **Acceptable** Guideline	after the last single oral dose, each monkey received 7 consecutive daily oral doses of 30 mg/kg/d of C14-LAS. 2 M/2 F Rhesus Monkeys Purity: Not Reported	analyzed for metabolites, there was no unchanged SDDBS and the 5 metabolites detected were polar, but were not sulphate or glucuronide conjugates.
870.7485 General Metabolism	Lay JP, et al. (1983) Toxicol. Letters 17 (1-2): 187-192 **Open Literature**	(14)C-labeled sodium dodecylbenzenesulfonate was administered daily in the diet at a concentration of 1.4 mg/kg for 5 weeks M Rat Purity: not reported	From a total uptake of 1.213 + or - 0.08 mg/animal of DBS, 81.8% was excreted during the dosing period: 52.4% in feces and 29.4% in urine. Low levels of (14)C-DBS-derived residues were detected in all tissues analyzed on day 35 of the study. Following 1 week on a normal diet, only 7.8% of the nominally stored amount of (14)C was found in the excreta.
870.7485 General Metabolism	Sunakawa et al. (1979) Yakuzaigaku 39 (2): 59-68 **Open Literature**	Sodium-para-dodecylbenzenesulfonate Rat Purity: Not Reported	Blood levels were max at 2 hr, negligible at 48 hr Excretion rate of radioactive label was 99.4% after 48 hr
870.7485 General Metabolism	The Royal Society of Chemistry. (1981) Foreign Compound Metabolism in Mammals. Volume 6: A Review of the Literature Published during 1978 and 1979. London: The Royal Society of Chemistry, p.354. **Open Literature**	(35)S-labeled sodium dodecylbenzenesulfonate was administered as a single oral dose Rat Purity: Not Reported	Rats excreted 64% and 24% of the dose in urine and feces, respectively
870.7485 General Metabolism	The Royal Society of Chemistry. (1981) Foreign Compound Metabolism in Mammals. Volume 6: A Review of the Literature Published during 1978 and 1979. London: The Royal Society of Chemistry, p.354.	Repeated doses of (14)C-labeled alkylbenzenesulfonate were orally administered Rhesus Monkey Purity: Not Reported	Radioactivity did not accumulate in the tissues
870.7485 General Metabolism	**MRID 43498431** W. Michael (1968) Metabolism of Linear Alkylate Sulfonate and Alkyl Benzene Sulfonate. Toxicol. Appl. Pharmacol. 12: 473-485. **Acceptable** Guideline	LAS-S35 was administered orally to fasted rats at doses of 0.6, 1.2, 8, and 40 mg Charles River CD M Rat Purity: Not Reported	The rate and distribution of the excreted dose was independent of concentration. Similar levels of radioactivity were found in urine and feces and within 3 days, 85.2% - 96.6% of the label was recovered. In the high dose rats, no detectable radioactivity was found in the carcasses after 3 days. Following methylation, one urinary metabolite was

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			identified as 4-(4'-methylsulfophenyl) pentanoate. LAS-S35 in the feces remained unmetabolized.
Special Studies			
870.3700a Developmental Toxicity (rodent)	Koizumi et al. (1985) Implantation Disturbance Studies with LAS in Mice, Arch. Environ. Contam. Toxicol. 14: 73-81. (HERA) **Open Literature**	LAS was administered as a single oral dose of 350 mg/kg bw on day 3 of gestation Pregnant ICR Mice Purity: Not Reported	LAS was not detected in the uterus
Other	Inoue K, T Sunakawa. (1979) Mutagenicity Tests of Surfactants, Jpn. Fragr. J. 38: 67-75, (in Japanese), See: IPCS, 1996. (HERA) **Open Literature**	LAS tested in a recombination assay at concentrations up to 50 ug/plate Bacillus subtilis Purity: 99.5%	Negative results with and without metabolic activation
Other	Fujise, H. and Aoyama, M. (1984) Nagoya Med J, 28 (3-4): 211-5 **Open Literature**	The proliferation rate of the connective tissue was examined by measuring the activity of proline hydroxylase. The dorsal neck skin of rats was coated with sodium laurylbenzenesulfonate for 4 days, and on the 5th day, the enzyme activity in the skin was measured. Rat Purity: Not Reported	The proline hydroxylase in the part of the skin coated with the irritants showed clearly higher activity than normal skin, although it was still lower than the injured skin region prepared as a positive control.
Other	**MRID 43498430 and 43498408** Kimura et al. (1982) Mechanisms of Toxicities of Some Detergents Added to a Diet and the Ameliorating Effects of Dietary Fiber in the Rat. J. Nutrit. Science and Science and Vitaminology, 28: 483-489. Kimura et al. (1982) Toxicity for Detergent Feeding and Effect of the Concurrent Feeding of Dietary Fiber in the Rat. Nutrition Reports International, 26(2): 271-279.	Ringer's bicarbonate (containing sodium lauryl benzene sulfonate) at 0.5 ml/min was used to perfuse a 10 cm length of jejunal segment for 150 minutes; equilibrated for 30 minutes and then the perfusates were collected in 30 minute aliqouts for 120 minutes M Wistar Rat Purity: 0.5%	Alkaline phosphatase was released by an increase of 15-fold in comparison to Ringer's alone (controls without added sodium lauryl benzene sulfonate) and 3-7 times greater than other surfactants tested in Ringer's. The authors conclude that SDDBS has an exfoliative effect on the intestinal brush border

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	Acceptable Guideline		
Other	Oba et al. (1968) Biochemical Studies of n-alpha-olefin sulfonates: (II) Acute Toxicity, Skin and Eye Irritation, and Some Other Physiological Properties. J Jpn Oil Chem Soc, 17 (11): 628-634. (EHC 169) **Open Literature**	Solutions of various concentrations of LAS were mixed with red blood cells from rabbits at room temperature for 3 hours Rabbit Red Blood Cell Purity: Not Reported	The 50% haemolytic concentration of LAS was 9 mg/litre
Other	Samejima Y (1991) Effects of Synthetic Surfactants and Natural Soap on the Development of Mouse Embryos In Vitro and the Fertilizing Capacity of Mouse and Human Sperm. J Osaka Univ Med Sch, 3 (12): 675-682. (EHC 169) **Open Literature**	Eggs were fertilized in vitro and incubated in culture medium containing LAS at concentrations between 0.015 and 0.03%. F B6C3F1 Mouse Egg Purity: Not Reported	Concentrations of LAS less than 0.025%: Eggs exposed for 1 hr, washed, and then cultured for 5 days developed normally to the blastocyst stage Concentrations of LAS higher than 0.03%: The eggs did not develop beyond the one-cell stage With continuous exposure to LAS for five days, a concentration of 0.01% slightly impaired development to the blastocyst stage, and 0.025% prevented development to the one-cell stage
Other	Takahashi et al. (1974) Inhibition of Thrombin by Linear Alkylbenzene Sulfonate (LAS). Ann Rep Tokyo Metrop Res Lab Public Health, 25: 637-645. (HERA) **Open Literature**	Purified LAS at various concentrations were added to 10 ul of plasma from rats and prothrombin time was determined M Rat Purity: Not Reported	Prothrombin time was prolonged; the 50% inhibitory concentration was about 0.6 mmol/litre. When LAS at various concentrations were added to a mixture of 1% fibrinogen and thrombin, the time of formation of a mass of fibrin was prolonged by inhibition of thrombin activity. The 50% inhibitory concentration was about 0.05 mmol/litre.
Other	Yanagisawa et al. (1964) Biochemical Studies of Dodecylbenzene Sulfonates; Differences Between Soft and Hard Detergents. Jpn. J Public Health, 11(13): 859-864. (EHC 169) **Open Literature**	The haemolytic action of LAS was investigated by mixing red blood cells from rabbits with solutions of LAS at concentrations of 1-1000 mg/litre at 38 C for 30 min Rabbit Red Blood Cell Purity: Not Reported	Haemolysis occurred at concentrations >= 5 mg/litre.