Assessment of Alternatives to Cleaners and Sanitizers for the Brewing Industry

Supplement 1:
P2OASys Raw Data Used in EHS Evaluations

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Contents

Baseline Cleaners

Category	Units	Powder Keg	Veracity Caustic Cleaner	Liquid Metal Safe
ACUTE HUMAN EFFECTS				
Inhalation Toxicity	LC50 ppm			
Inhalation Toxicity	Vapor GHS Category Level			
Inhalation Toxicity	mg/l gas/vapor			
Inhalation Toxicity	mg/l dust/mist/fume			
Inhalation Toxicity	Key Phrases	May cause breathing difficulties if inhaled	Harmful if inhaled	Not considered harmful
Inhalation Toxicity	Solid GHS Category Level	3		
Inhalation Toxicity	GHS H Phrases	H332, H305		
Oral Toxicity	LD50 mg/kg	2800	2000	
Oral Toxicity	Key Phrases	Harmful if swallowed	Harmful if swallowed	May be harmful if swallowed
Oral Toxicity	GHS H Phrases	H302		
Oral Toxicity	GHS Category Level	4		
Dermal Toxicity	LD50 mg/kg	1999	1350	
Dermal Toxicity	Key Phrases		Harmful in contact with skin	May be harmful
Dermal Toxicity	GHS H Phrases			
Dermal Toxicity	GHS Category Level			
Respiratory Irritation	Key Phrases	Evidence in humans and animals shows slight or minor reversible respiratory irritation effects	Evidence in humans or animals shows mild reversible respiratory irritation effects; Low to moderate frequency of occurrence	
Respiratory Irritation	GHS H Phrases	H335	H335	

Category	Units	Powder Keg	Veracity Caustic Cleaner	Liquid Metal Safe
Respiratory Irritation	GHS Category Level			
Dermal Irritation	Key Phrases	Reversible skin irritation effects; Irritant	Existing human and animal data, in vitro data or information from structurally related compounds shows irreversible skin burns; Corrosive	Existing human and animal data, in vitro data or information from structurally related compounds shows irreversible skin burns; Corrosive
Dermal Irritation	GHS Category Level	1C, 2	1A, 1	1A, 1
Dermal Irritation	GHS H Phrases	H315	H314	H314
Eye Irritation	Key Phrases	Reversible irritation effects on the eyes from single or repeated exposure; Irritating	Existing human and animal data, in vitro data or information from structurally related compounds shows irreversible eye damage; Irreversible	Existing human and animal data, in vitro data or information from structurally related compounds shows irreversible eye damage; Irreversible
Eye Irritation	GHS H Phrases	H319	H318, H314	H318, H314
Eye Irritation	GHS Category Level	2A	1	1
Exposure Limits	PEL/TLV ppm			
Exposure Limits	PEL/TLV (dusts/particles) mg/m3	2	2	2
Exposure Limits	GHS Category Level	1		
IDLH	ppm		10	
Health	NFPA/HMIS 0,1,2,3,4	1	3	2
CHRONIC HUMAN EFFECTS				
Carcinogen	IARC Category			
Carcinogen	EPA CLASS Category			
Carcinogen	ACGIH Category			
Carcinogen	OSHA Category		No components are listed as carcinogens by OSHA	No components are listed as carcinogens by OSHA
Carcinogen	Key Phrases		No component present at greater than or equal to 0.1% as probable, possible or confirmed human carcinogen	No component present at greater than or equal to 0.1% as probable, possible or confirmed human carcinogen
Carcinogen	GHS H Phrases			
Carcinogen	GHS Category			
Carcinogen	Prop 65 Category	No; not listed on prop 65		No; not listed on prop 65
Mutagen/ Teratogen	Key Phrases	Not expected to be mutagenic in humans	Not expected to be mutagenic in humans	Not expected to be mutagenic in humans
Mutagen/ Teratogen	GHS H Phrase			
Mutagen/ Teratogen	GHS Category			

Category	Units	Powder Keg	Veracity Caustic Cleaner	Liquid Metal Safe
Reproductive/ Developmental	Key Phrases		Not expected to have reproductive effects	Not expected to have reproductive effects
Reproductive/ Developmental	GHS H Phrases			
Reproductive/ Developmental	GHS Category			
Reproductive/ Developmental	Prop 65 Category	No; not listed on prop 65		No; not listed on prop 65
Neurotoxicity	GHS Category - STOT - Single Exposure			
Neurotoxicity	GHS Category - STOT - Repeated Exposure			
Neurotoxicity	Key Phrases			
Neurotoxicity	GHS H Phrase			
Respiratory Sensitivity/ Disease	Asthmagen Type (AOEC Database)		Rs; Rr; Rrs	
Respiratory Sensitivity/ Disease	Key Phrases		May cause allergy or asthma symptoms or breathing difficulties if inhaled; May cause sensitization by inhalation	
Respiratory Sensitivity/ Disease	GHS H Phrase	H335		
Respiratory Sensitivity/ Disease	GHS Category			
Endocrine System Effects	EU - Priority Endocrine Disruptor			
Endocrine System Effects	EU - SVHC			
Endocrine System Effects	ChemSec - SIN			
Endocrine System Effects	OSPAR			
Endocrine System Effects	TEDX		Yes	
Endocrine System Effects	Key Phrases			

Category	Units	Powder Keg	Veracity Caustic Cleaner	Liquid Metal Safe
Other Chronic Organ Effects	Key Phrases		May cause damage to organs; Possible risk of irreversible effects; May cause damage to organs through prolonged or repeated exposure	Causes damage to organs; Danger of very serious irreversible effects; Causes damage to organs through prolonged or repeated exposure; Danger of serious damage to health by prolonged exposure
Other Chronic Organ Effects	GHS H-Phrase - Single Exposure			
Other Chronic Organ Effects	GHS Category - STOT -Single Exposure	3		
Other Chronic Organ Effects	GHS H-Phrase - Repeated Exposure			
Other Chronic Organ Effects	GHS Category - STOT - Repeated Exposure			
ECOLOGICAL HAZARDS				
Acute Aquatic Toxicity	Acute Fish LC50 (mg/l)	300	45	
Acute Aquatic Toxicity	Acute Algae (or other aquatic plant) EC50 (mg/l)	242	34.6	
Acute Aquatic Toxicity	Key Phrases	No data, but some grounds for concern	Harmful to aquatic life	Not considered harmful to aquatic life
Acute Aquatic Toxicity	GHS H Phrases			
Acute Aquatic Toxicity	GHS Category level	Not Classified		
Chronic Aquatic Toxicity (fish, crustacea or algae) - Rapidly Degradable, with Adequate Data	NOEC (NOAEC) or ECx (mg/l)			
Chronic Aquatic Toxicity (fish, crustacea or algae) - Rapidly Degradable, with Adequate Data	ChV mg/l			
Chronic Aquatic Toxicity (fish, crustacea or algae) - Rapidly Degradable, with Adequate Data	Key Phrases		May be dangerous for the environment	Not expected to be harmful to aquatic life

Category	Units	Powder Keg	Veracity Caustic Cleaner	Liquid Metal Safe
Chronic Aquatic Toxicity (fish, crustacea or algae) - Rapidly Degradable, with Adequate Data	GHS H Phrases			
Chronic Aquatic Toxicity (fish, crustacea or algae) - Rapidly Degradable, with Adequate Data	GHS Category			
Chronic Aquatic Toxicity (fish, crustacea or algae) - NOT Rapidly Degradable, with Adequate Data	mg/l			
Chronic Aquatic Toxicity (fish, crustacea or algae) - NOT Rapidly Degradable, with Adequate Data	Key Phrases			
Chronic Aquatic Toxicity (fish, crustacea or algae) - NOT Rapidly Degradable, with Adequate Data	GHS Category level			
ENVIRONMENTAL FATE & TRANSPORT				
Persistence	Water t1/2 Days		8.7	
Persistence	Water Signal Words			
Persistence	Air t1/2 Days		0.89	
Persistence	Air Signal Words			
Persistence	Soil/Sediment t1/2 Days		17.6	
Persistence	Soil/Sediment Signal Words	GHS "rapid degradability"		
Persistence	Key Phrases			Not expected to be persistent
Rapid Degradability	28-day Study: % Breakdown Dissolved Organic Carbon			
Rapid Degradability	28-day Study: % Based on O2 or CO2			
Rapid Degradability	BOD Half-life (days)			
Rapid Degradability	Hydrolysis Half-life (days)			
Rapid Degradability	Key Phrases		Biodegradable	Not Determined

Category	Units	Powder Keg	Veracity Caustic Cleaner	Liquid Metal Safe
Bioconcentration/ Bioaccumulation	Log Kow / Pow	-6.9	-0.92	
Bioconcentration/ Bioaccumulation	BAF/BCF (l/kg)		0.9	
Bioconcentration/ Bioaccumulation	On Canada EPA Domestic Substances List			
Bioconcentration/ Bioaccumulation	Key Phrases	Not likely/expected to bioaccumulate	Will bioaccumulate	Not likely/expected to bioaccumulate
ATMOSPHERIC HAZARDS				
Greenhouse Gas	GWP Relative to CO2		0	0
Greenhouse Gas	Y/N	N	N	N
Ozone Depletor	ODP Units		0	0
Ozone Depletor	GHS H Phrase			
Ozone Depletor	Ozone Classification	Not Classified	Not Classified	Not Classified
Acid Rain Formation	Y/N	N	N	N
Acid Rain Formation	Key Phrases	Does not contain SO2 or NOx	Does not contain SO2 or NOx	Does not contain SO2 or NOx
NESHAP	Y/N		N	N
NESHAP	Key Phrases	Not listed as EPA hazardous air pollutant	Not listed as EPA hazardous air pollutant	Not listed as EPA hazardous air pollutant
PHYSICAL PROPERTIES				
Vapor Pressure	mm Hg		0.11	
Flammability: Liquid	NFPA/HMIS 0,1,2,3,4		0	0
Flammability: Liquid	GHS H Phrase			
Flammability: Liquid	GHS Category level			
Flash point: Liquid	deg C			
Flash point: Liquid	Key Phrases		No Flash point-will not burn	No Flash point-will not burn
Flammability: Gas	GHS H Phrase			
Flammability: Gas	GHS Category Level			
Reactivity	NFPA/HMIS 0,1,2,3,4		1	0
Reactivity	GHS H Phrase			
Reactivity	GHS Category Level			
pH	pH Units	2-5 or 9-11.5	1-2 or 11.5-14	1-2 or 11.5-14
pH	Key Phrases	Strong acid, caustic	Highly acidic, highly caustic	Strong acid, caustic
Corrosivity	Key Phrases	Corrosive	Highly Corrosive	Mildly corrosive
Corrosivity	GHS Category Level			
Odor	Key Phrases	Slight odor	Odorless	Odorless

Category	Units	Powder Keg	Veracity Caustic Cleaner	Liquid Metal Safe
Volatile Organic Compound	g/l		45	86
PROCESS FACTORS				
Heat	WBGT, deg C			
Noise Generation	dBA/hr			
Vibration	Class 1 Small Machine (mm/s)			
Vibration	Class 2 Medium Machine (mm/s)			
Vibration	Class 3 Large Rigid Foundation (mm/s)			
Vibration	Class 4 Large Soft Foundation (mm/s)			
Ergonomic Hazard	Occurence	Unlikely/ remote	Possible	Unlikely/ remote
Ergonomic Hazard	Hazard Level	Minor injury/illness, minor impact on time lost	Moderate injury, lost time	Moderate injury, lost time
Psychosocial Hazard	Work Overload and Pace: Work Load			
Psychosocial Hazard	Work Overload and Pace: Machine Pacing			
Psychosocial Hazard	Work Overload and Pace: Time Constraints			
Psychosocial Hazard	Work Schedule: Shift Work			
Psychosocial Hazard	Work Schedule: Work Isolation		Process requires restricted access	Process eliminates isolation work
Psychosocial Hazard	Control		Process provides worker with access to supervisor about needed changes	Process allows for minor changes in real-time by worker
Psychosocial Hazard	Work Environment & Equipment: Equipment Stability			
Psychosocial Hazard	Work Environment & Equipment: Work Space			
High Pressure System	Pressure (Delta % Change From Ambient)		0	0
High Temperature System	Temperature (Delta % Change From Ambient)		0	25
Water Use	% Water Change			
Water Use	Reuse			
Energy Use	% Energy Change	25% reduction		
Energy Use	% Renewable Energy			
Exposure Potential	Occurence: Near Certain			

Category	Units	Powder Keg	Veracity Caustic Cleaner	Liquid Metal Safe
Exposure Potential	Occurence: Highly Likely	Minor hazard		
Exposure Potential	Occurence: Likely		Critical hazard	Marginal hazard
Exposure Potential	Occurence: Unlikely			
Exposure Potential	Occurence: Remote			
LIFE CYCLE FACTORS				
Upstream Effects	Key Phrases		Process reduces suppliers use of hazardous materials, energy, water and other resources	Eliminates suppliers use of hazardous materials or reduces use of energy, water, and resources
Consumer Hazard	Key Phrases	Product contains hazardous components with no consumer exposure potential	Product contains hazardous components with low consumer exposure potential	Product contains hazardous components with low consumer exposure potential
Disposal Hazard (landfill, incineration)	Key Phrases	Prevents/ reduces amount of waste material being created	Creates concern for air, water or land and disposed of as hazardous waste	Creates concern for air, water or land and disposed of as hazardous waste
Reportable Quantity	Pounds			
Recycling	% Recyclable at End of Life			
Recycling	Uses Products With % Recycled Material			
Renewable to Nonrenewable Resource	% Renewable Materials			
Renewable to Nonrenewable Resource	Key Words			

Alternative Cleaners

Category	Units	Neutral CIP Detergent LFE	Force of Nature	Surface Cleanse 930	Micro A07	Ozone
ACUTE HUMAN EFFECTS						
Inhalation Toxicity	LC50 ppm					12.6
Inhalation Toxicity	Vapor GHS Category Level					
Inhalation Toxicity	mg/l gas/vapor					
Inhalation Toxicity	mg/l dust/mist/fume					
Inhalation Toxicity	Key Phrases		May cause breathing difficulties if inhaled	Not considered harmful	Not considered harmful	May cause breathing difficulties if inhaled
Inhalation Toxicity	Solid GHS Category Level					
Inhalation Toxicity	GHS H Phrases					
Oral Toxicity	LD50 mg/kg	20000	2000	2000	5000	
Oral Toxicity	Key Phrases	Not harmful if swallowed	May be harmful if swallowed	Not harmful if swallowed		May be harmful if swallowed
Oral Toxicity	GHS H Phrases					
Oral Toxicity	GHS Category Level					
Dermal Toxicity	LD50 mg/kg	20800				
Dermal Toxicity	Key Phrases	Not harmful if comes in contact with skin	May be harmful	Not harmful if comes in contact with skin	Not harmful if comes in contact with skin	May be harmful
Dermal Toxicity	GHS H Phrases					
Dermal Toxicity	GHS Category Level					
Respiratory Irritation	Key Phrases	Evidence in humans and animals shows slight or minor reversible respiratory irritation effects	Evidence in humans and animals shows slight or minor reversible respiratory irritation effects	Non-irritating; Adequate data available, and negative studies, no structural alerts, and GHS not classified.		
Respiratory Irritation	GHS H Phrases	H335				
Respiratory Irritation	GHS Category Level					1

Category	Units	Neutral CIP Detergent LFE	Force of Nature	Surface Cleanse 930	Micro A07	Ozone
Dermal Irritation	Key Phrases		Slight or minor reversible skin irritation effects	Non-irritating; Adequate data available, and negative studies, no structural alerts, and GHS not classified.	Non-irritating; Adequate data available, and negative studies, no structural alerts, and GHS not classified.	Slight or minor reversible skin irritation effects
Dermal Irritation	GHS Category Level					3
Dermal Irritation	GHS H Phrases					
Eye Irritation	Key Phrases	Mild reversible eye irritation effects; Mildly irritating	Slight or minor reversible eye irritation effects	Non-irritating; Adequate data available, and negative studies, no structural alerts, and GHS not classified.	Reversible irritation effects on the eyes from single or repeated exposure; Irritating	Mild reversible eye irritation effects; Mildly irritating
Eye Irritation	GHS H Phrases				H319	H320
Eye Irritation	GHS Category Level				2A	2, 2B
Exposure Limits	PEL/TLV ppm					0.1
Exposure Limits	PEL/TLV (dusts/particles) mg/m3					
Exposure Limits	GHS Category Level					
IDLH	ppm					5
Health	NFPA/HMIS 0,1,2,3,4	1	0	1	2	2
CHRONIC HUMAN EFFECTS						
Carcinogen	IARC Category					
Carcinogen	EPA CLASS Category					
Carcinogen	ACGIH Category					
Carcinogen	OSHA Category	No components are listed as carcinogens by OSHA	No components are listed as carcinogens by OSHA	No components are listed as carcinogens by OSHA		No components are listed as carcinogens by OSHA

Category	Units	Neutral CIP Detergent LFE	Force of Nature	Surface Cleanse 930	Micro A07	Ozone
Carcinogen	Key Phrases	No component present at greater than or equal to 0.1% as probable, possible or confirmed human carcinogen	No component present at greater than or equal to 0.1% as probable, possible or confirmed human carcinogen	No component present at greater than or equal to 0.1% as probable, possible or confirmed human carcinogen	No component present at greater than or equal to 0.1% as probable, possible or confirmed human carcinogen	No component present at greater than or equal to 0.1% as probable, possible or confirmed human carcinogen
Carcinogen	GHS H Phrases					
Carcinogen	GHS Category					
Carcinogen	Prop 65 Category					
Mutagen/ Teratogen	Key Phrases	Not expected to be mutagenic in humans	Tested with no signs of mutagenicity		Not expected to be mutagenic in humans	
Mutagen/ Teratogen	GHS H Phrase					
Mutagen/ Teratogen	GHS Category					
Reproductive/ Developmental	Key Phrases	Not expected to have reproductive effects	Tested with no signs of reproductive/ development toxicity		Not expected to have reproductive effects	
Reproductive/ Developmental	GHS H Phrases					
Reproductive/ Developmental	GHS Category					
Reproductive/ Developmental	Prop 65 Category					
Neurotoxicity	GHS Category - STOT - Single Exposure					
Neurotoxicity	GHS Category - STOT - Repeated Exposure					
Neurotoxicity	Key Phrases					
Neurotoxicity	GHS H Phrase					
Respiratory Sensitivity/ Disease	Asthmagen Type (AOEC Database)					

Category	Units	Neutral CIP Detergent LFE	Force of Nature	Surface Cleanse 930	Micro A07	Ozone
Respiratory Sensitivity/ Disease	Key Phrases	May cause respiratory irritation	May cause respiratory irritation	Known to not cause respiratory sensitization; Only negative test results		May cause respiratory irritation
Respiratory Sensitivity/ Disease	GHS H Phrase	H335				
Respiratory Sensitivity/ Disease	GHS Category					
Endocrine System Effects	EU - Priority Endocrine Disruptor					
Endocrine System Effects	EU - SVHC					
Endocrine System Effects	ChemSec - SIN					
Endocrine System Effects	OSPAR					
Endocrine System Effects	TEDX	Yes				
Endocrine System Effects	Key Phrases					
Other Chronic Organ Effects	Key Phrases					
Other Chronic Organ Effects	GHS H-Phrase - Single Exposure					
Other Chronic Organ Effects	GHS Category - STOT - Single Exposure	Substance/mixture not classified as STOT, single exposure.	Substance/mixture not classified as STOT, single exposure.	Substance/mixture not classified as STOT, single exposure.		
Other Chronic Organ Effects	GHS H-Phrase - Repeated Exposure					
Other Chronic Organ Effects	GHS Category - STOT - Repeated Exposure	Substance/mixture not classified as STOT, repeated exposure.	Substance/mixture not classified as STOT, repeated exposure.	Substance/mixture not classified as STOT, repeated exposure.		
ECOLOGICAL HAZARDS						
Acute Aquatic Toxicity	Acute Fish LC50 (mg/l)	45	597		31400	

Category	Units	Neutral CIP Detergent LFE	Force of Nature	Surface Cleanse 930	Micro A07	Ozone
Acute Aquatic Toxicity	Acute Algae (or other aquatic plant) EC50 (mg/l)	19000	126		23300	
Acute Aquatic Toxicity	Key Phrases	Harmful to aquatic life	Not considered harmful to aquatic life	Not considered harmful to aquatic life	Not considered harmful to aquatic life	Very toxic to aquatic life
Acute Aquatic Toxicity	GHS H Phrases					H400
Acute Aquatic Toxicity	GHS Category level					Acute 1
Chronic Aquatic Toxicity (fish, crustacea or algae) - Rapidly Degradable, with Adequate Data	NOEC (NOAEC) or ECx (mg/l)					
Chronic Aquatic Toxicity (fish, crustacea or algae) - Rapidly Degradable, with Adequate Data	ChV mg/l	1.44	24.51		28660	235
Chronic Aquatic Toxicity (fish, crustacea or algae) - Rapidly Degradable, with Adequate Data	Key Phrases	May be dangerous for the environment	Not harmful to aquatic life	Not expected to be harmful to aquatic life	Not harmful to aquatic life	Not expected to be harmful to aquatic life
Chronic Aquatic Toxicity (fish, crustacea or algae) - Rapidly Degradable, with Adequate Data	GHS H Phrases					
Chronic Aquatic Toxicity (fish, crustacea or algae) - Rapidly Degradable, with Adequate Data	GHS Category					
Chronic Aquatic Toxicity (fish, crustacea or algae) - NOT Rapidly Degradable, with Adequate Data	mg/l					
Chronic Aquatic Toxicity (fish, crustacea or algae) - NOT Rapidly Degradable, with Adequate Data	Key Phrases					

Category	Units	Neutral CIP Detergent LFE	Force of Nature	Surface Cleanse 930	Micro A07	Ozone
Chronic Aquatic Toxicity (fish, crustacea or algae) - NOT Rapidly Degradable, with Adequate Data	GHS Category level					
ENVIRONMENTAL FATE & TRANSPORT						
Persistence	Water t1/2 Days	15			8.7	15
Persistence	Water Signal Words					
Persistence	Air t1/2 Days	0.89			1.25	0.15
Persistence	Air Signal Words					
Persistence	Soil/Sediment t1/2 Days	30			17.4	30
Persistence	Soil/Sediment Signal Words					
Persistence	Key Phrases	Not expected to be persistent	Not expected to be persistent	Not persistent		Not persistent
Rapid Degradability	28-day Study: % Breakdown Dissolved Organic Carbon					
Rapid Degradability	28-day Study: % Based on O2 or CO2					
Rapid Degradability	BOD Half-life (days)					
Rapid Degradability	Hydrolysis Half-life (days)					
Rapid Degradability	Key Phrases	Biodegradable	Biodegradable	Biodegradable	Biodegradable	Readily degradable
Bioconcentration/ Bioaccumulation	Log Kow / Pow	3.01	-0.46		-1.64	-0.87
Bioconcentration/ Bioaccumulation	BAF/BCF (l/kg)	71.36	1.09		0.89	0.9
Bioconcentration/ Bioaccumulation	On Canada EPA Domestic Substances List					
Bioconcentration/ Bioaccumulation	Key Phrases	Not likely/expected to bioaccumulate	Will not bioaccumulate	Not likely/expected to bioaccumulate		Will not bioaccumulate
ATMOSPHERIC HAZARD						
Greenhouse Gas	GWP Relative to CO2	0	0	0	0	0
Greenhouse Gas	Y/N	N	N	N	N	N

Category	Units	Neutral CIP Detergent LFE	Force of Nature	Surface Cleanse 930	Micro A07	Ozone
Ozone Depletor	ODP Units	0	0	0	0	0
Ozone Depletor	GHS H Phrase					
Ozone Depletor	Ozone Classification	Not Classified	Not Classified	Not Classified	Not Classified	Not Classified
Acid Rain Formation	Y/N	N	N	N		N
Acid Rain Formation	Key Phrases	Does not contain SO2 or NOx	Does not contain SO2 or NOx	Does not contain SO2 or NOx	Product may form SO2 or NOx upon combustion	Does not contain SO2 or NOx
NESHAP	Y/N	N	N	N	N	Y
NESHAP	Key Phrases	Not listed as EPA hazardous air pollutant	Not listed as EPA hazardous air pollutant	Not listed as EPA hazardous air pollutant	Not listed as EPA hazardous air pollutant	Listed as EPA hazardous air pollutant
PHYSICAL PROPERTIES						
Vapor Pressure	mm Hg	6.99			0.01	
Flammability: Liquid	NFPA/HMIS 0,1,2,3,4	0	0	0	0	0
Flammability: Liquid	GHS H Phrase					
Flammability: Liquid	GHS Category level					
Flash point: Liquid	deg C					
Flash point: Liquid	Key Phrases	No Flash point-will not burn	No Flash point-will not burn	No Flash point-will not burn	No Flash point-will not burn	No Flash point-will not burn
Flammability: Gas	GHS H Phrase					
Flammability: Gas	GHS Category Level					
Reactivity	NFPA/HMIS 0,1,2,3,4	0	0	0	0	3
Reactivity	GHS H Phrase					
Reactivity	GHS Category Level					
pH	pH Units	2-5 or 9-11.5	5-6 or 8-9	6-7 or 7-8	2-5 or 9-11.5	2-5 or 9-11.5
pH	Key Phrases	Acidic, alkaline	Mildly acidic, mildly alkaline	Mildly acidic, mildly alkaline	Acidic, alkaline	
Corrosivity	Key Phrases	Not corrosive	Not corrosive	Not corrosive	Mildly corrosive	
Corrosivity	GHS Category Level					
Odor	Key Phrases	Odorless	Slight odor	Mild odor	Mild odor	Pungent or irritating odor
Volatile Organic Compound	g/l	45	0		25	
PROCESS FACTORS						
Heat	WBGT, deg C					
Noise Generation	dBA/hr		80/no limit			

Category	Units	Neutral CIP Detergent LFE	Force of Nature	Surface Cleanse 930	Micro A07	Ozone
Vibration	Class 1 Small Machine (mm/s)		1			
Vibration	Class 2 Medium Machine (mm/s)					
Vibration	Class 3 Large Rigid Foundation (mm/s)					
Vibration	Class 4 Large Soft Foundation (mm/s)					
Ergonomic Hazard	Occurence	Unlikely/ remote	Possible	Unlikely/ remote	Unlikely/ remote	Possible
Ergonomic Hazard	Hazard Level	Minor injury/illness, minor impact on time lost	Minor injury/illness, minor impact on time lost	Insignificant, no injury, no impact on time	Minor injury/illness, minor impact on time lost	Minor injury/illness, minor impact on time lost
Psychosocial Hazard	Work Overload and Pace: Work Load					
Psychosocial Hazard	Work Overload and Pace: Machine Pacing					
Psychosocial Hazard	Work Overload and Pace: Time Constraints					
Psychosocial Hazard	Work Schedule: Shift Work					
Psychosocial Hazard	Work Schedule: Work Isolation	Process eliminates isolation work	Process eliminates isolation work	Process eliminates isolation work	Process eliminates isolation work	Process requires restricted access
Psychosocial Hazard	Control	Process allows for minor changes in real-time by worker	Process includes worker input	Process allows for minor changes in real-time by worker	Process allows for minor changes in real-time by worker	Process provides worker with access to supervisor about needed changes
Psychosocial Hazard	Work Environment & Equipment: Equipment Stability		Improved equipment quality and suitability			
Psychosocial Hazard	Work Environment & Equipment: Work Space					
High Pressure System	Pressure (Delta % Change From Ambient)	0	0	0	0	0
High Temperature System	Temperature (Delta % Change From Ambient)	0	0	15	15	0

Category	Units	Neutral CIP Detergent LFE	Force of Nature	Surface Cleanse 930	Micro A07	Ozone
Water Use	% Water Change					
Water Use	Reuse					
Energy Use	% Energy Change		25% increase			
Energy Use	% Renewable Energy					
Exposure Potential	Occurence: Near Certain					
Exposure Potential	Occurence: Highly Likely					
Exposure Potential	Occurence: Likely	Marginal hazard	Minor hazard	Minor hazard	Marginal hazard	Marginal hazard
Exposure Potential	Occurence: Unlikely					
Exposure Potential	Occurence: Remote					
LIFE CYCLE FACTORS						
Upstream Effects	Key Phrases	Eliminates suppliers use of hazardous materials or reduces use of energy, water, and resources	Eliminates suppliers use of hazardous materials or reduces use of energy, water, and resources	Eliminates suppliers use of hazardous materials and reduces use of energy, water, and resources	Eliminates suppliers use of hazardous materials and reduces use of energy, water, and resources	Process reduces suppliers use of hazardous materials, energy, water and other resources
Consumer Hazard	Key Phrases	Product contains hazardous components with no consumer exposure potential	Product contains hazardous components with no consumer exposure potential	Product contains no hazardous components	Product contains no hazardous components	Product contains hazardous components with low consumer exposure potential
Disposal Hazard (landfill, incineration)	Key Phrases	Creates some concern for air, water or land	Prevents/ reduces amount of waste material being created	Creates some concern for air, water or land	Prevents/ reduces amount of waste material being created	Creates some concern for air, water or land
Reportable Quantity	Pounds					100
Recycling	% Recyclable at End of Life					
Recycling	Uses Products With % Recycled Material					
Renewable to Nonrenewable Resource	% Renewable Materials					
Renewable to Nonrenewable Resource	Key Words					

Baseline & Alternative Sanitizers

Category	Units	Star San	Spartan PAA SANITIZER FP	ECA Device	Lactic acid	Caprylic Acid	NaDCC Tablets	Ozone
ACUTE HUMAN EFFECTS								
Inhalation Toxicity	LC50 ppm							12.6
Inhalation Toxicity	Vapor GHS Category Level							
Inhalation Toxicity	mg/l gas/vapor		0.3					
Inhalation Toxicity	mg/l dust/mist/fume							
Inhalation Toxicity	Key Phrases	Harmful if inhaled	Harmful if inhaled	May cause breathing difficulties if inhaled	Not considered harmful	May cause breathing difficulties if inhaled	May cause breathing difficulties if inhaled	May cause breathing difficulties if inhaled
Inhalation Toxicity	Solid GHS Category Level							
Inhalation Toxicity	GHS H Phrases							
Oral Toxicity	LD50 mg/kg		263	2000	3730	10000		
Oral Toxicity	Key Phrases	Harmful if swallowed	Harmful if swallowed	May be harmful if swallowed		Harmful if swallowed	Harmful if swallowed	May be harmful if swallowed
Oral Toxicity	GHS H Phrases						H302	
Oral Toxicity	GHS Category Level						4	
Dermal Toxicity	LD50 mg/kg		1060		2000	2000		
Dermal Toxicity	Key Phrases	Harmful in contact with skin		May be harmful		May be harmful	Harmful in contact with skin	May be harmful
Dermal Toxicity	GHS H Phrases							
Dermal Toxicity	GHS Category Level						1	

Category	Units	Star San	Spartan PAA SANITIZER FP	ECA Device	Lactic acid	Caprylic Acid	NaDCC Tablets	Ozone
Respiratory Irritation	Key Phrases	Evidence in humans or animals shows mild reversible respiratory irritation effects; Low to moderate frequency of occurrence	Evidence in humans or animals shows mild reversible respiratory irritation effects; Low to moderate frequency of occurrence	Evidence in humans and animals shows slight or minor reversible respiratory irritation effects	Non-irritating; Adequate data available, and negative studies, no structural alerts, and GHS not classified.	Evidence in humans and animals shows slight or minor reversible respiratory irritation effects	Evidence in humans and animals shows slight or minor reversible respiratory irritation effects	
Respiratory Irritation	GHS H Phrases	H335						
Respiratory Irritation	GHS Category Level							1
Dermal Irritation	Key Phrases	Reversible skin irritation effects; Irritant	Existing human and animal data, in vitro data or information from structurally related compounds shows irreversible skin burns; Corrosive	Slight or minor reversible skin irritation effects	Reversible skin irritation effects; Irritant	Reversible skin irritation effects; Irritant	Reversible skin irritation effects; Irritant	Slight or minor reversible skin irritation effects
Dermal Irritation	GHS Category Level		1A, 1		1C, 2	1B	1A, 1	3
Dermal Irritation	GHS H Phrases	H315	H314		H315	H315	H314	

Category	Units	Star San	Spartan PAA SANITIZER FP	ECA Device	Lactic acid	Caprylic Acid	NaDCC Tablets	Ozone
Eye Irritation	Key Phrases	Reversible irritation effects on the eyes from single or repeated exposure; Irritating	Existing human and animal data, in vitro data or information from structurally related compounds shows irreversible eye damage; Irreversible	Slight or minor reversible eye irritation effects	Reversible irritation effects on the eyes from single or repeated exposure; Irritating	Reversible irritation effects on the eyes from single or repeated exposure; Irritating	Existing human and animal data, in vitro data or information from structurally related compounds shows irreversible eye damage; Irreversible	Mild reversible eye irritation effects; Mildly irritating
Eye Irritation	GHS H Phrases	H319	H318, H314		H319	H318, H314	H318, H314	H320
Eye Irritation	GHS Category Level	2A	1		1	1	1	2, 2B
Exposure Limits	PEL/TLV ppm		1					0.1
Exposure Limits	PEL/TLV (dusts/particles) mg/m3	1	1					
Exposure Limits	GHS Category Level							
IDLH	ppm		50					5
Health	NFPA/HMIS 0,1,2,3,4	3	3	0	3	3		2
CHRONIC HUMAN EFFECTS								
Carcinogen	IARC Category	4	4				4	
Carcinogen	EPA CLASS Category						E	
Carcinogen	ACGIH Category		A5				A5	
Carcinogen	OSHA Category	No components are listed as carcinogens by OSHA	No components are listed as carcinogens by OSHA	No components are listed as carcinogens by OSHA	No components are listed as carcinogens by OSHA	No components are listed as carcinogens by OSHA	No components are listed as carcinogens by OSHA	No components are listed as carcinogens by OSHA

Category	Units	Star San	Spartan PAA SANITIZER FP	ECA Device	Lactic acid	Caprylic Acid	NaDCC Tablets	Ozone
Carcinogen	Key Phrases	No component present at greater than or equal to 0.1% as probable, possible or confirmed human carcinogen	No component present at greater than or equal to 0.1% as probable, possible or confirmed human carcinogen	No component present at greater than or equal to 0.1% as probable, possible or confirmed human carcinogen	No component present at greater than or equal to 0.1% as probable, possible or confirmed human carcinogen	No component present at greater than or equal to 0.1% as probable, possible or confirmed human carcinogen	No component present at greater than or equal to 0.1% as probable, possible or confirmed human carcinogen	No component present at greater than or equal to 0.1% as probable, possible or confirmed human carcinogen
Carcinogen	GHS H Phrases							
Carcinogen	GHS Category							
Carcinogen	Prop 65 Category						No; not listed on prop 65	
Mutagen/ Teratogen	Key Phrases	Not expected to be mutagenic in humans		Tested with no signs of mutagenicity				
Mutagen/ Teratogen	GHS H Phrase							
Mutagen/ Teratogen	GHS Category							
Reproductive/ Developmental	Key Phrases	Not expected to have reproductive effects		Tested with no signs of reproductive/ development toxicity				
Reproductive/ Developmental	GHS H Phrases							
Reproductive/ Developmental	GHS Category							
Reproductive/ Developmental	Prop 65 Category						No; not listed on prop 65	

Category	Units	Star San	Spartan PAA SANITIZER FP	ECA Device	Lactic acid	Caprylic Acid	NaDCC Tablets	Ozone
Neurotoxicity	GHS Category - STOT - Single Exposure							
Neurotoxicity	GHS Category - STOT - Repeated Exposure							
Neurotoxicity	Key Phrases							
Neurotoxicity	GHS H Phrase							
Respiratory Sensitivity/ Disease	Asthmagen Type (AOEC Database)		Rs; Rr; Rrs					
Respiratory Sensitivity/ Disease	Key Phrases	May cause respiratory irritation	Sensitizer; Asthmagen; Substances showing a high frequency of occurrence in humans; probability of occurrence of a high sensitization rate in humans based on animals or other tests	May cause respiratory irritation		May cause respiratory irritation		May cause respiratory irritation
Respiratory Sensitivity/ Disease	GHS H Phrase							
Respiratory Sensitivity/ Disease	GHS Category							
Endocrine System Effects	EU - Priority Endocrine Disruptor							
Endocrine System Effects	EU - SVHC							

Category	Units	Star San	Spartan PAA SANITIZER FP	ECA Device	Lactic acid	Caprylic Acid	NaDCC Tablets	Ozone
Endocrine System Effects	ChemSec - SIN							
Endocrine System Effects	OSPAR							
Endocrine System Effects	TEDX							
Endocrine System Effects	Key Phrases							
Other Chronic Organ Effects	Key Phrases	May cause damage to organs; Possible risk of irreversible effects; May cause damage to organs through prolonged or repeated exposure						
Other Chronic Organ Effects	GHS H-Phrase - Single Exposure							
Other Chronic Organ Effects	GHS Category - STOT -Single Exposure		3	Substance/mixture not classified as STOT, single exposure.				
Other Chronic Organ Effects	GHS H-Phrase - Repeated Exposure							
Other Chronic Organ Effects	GHS Category - STOT - Repeated Exposure			Substance/mixture not classified as STOT, repeated exposure.				
ECOLOGICAL HAZARDS								
Acute Aquatic Toxicity	Acute Fish LC50 (mg/l)	8.47	16.4	597	160	110	0.28	

Category	Units	Star San	Spartan PAA SANITIZER FP	ECA Device	Lactic acid	Caprylic Acid	NaDCC Tablets	Ozone
Acute Aquatic Toxicity	Acute Algae (or other aquatic plant) EC50 (mg/l)	13.41	2.5	126	3500		0.88	
Acute Aquatic Toxicity	Key Phrases	Harmful to aquatic life		Not considered harmful to aquatic life	Not considered harmful to aquatic life	Not considered harmful to aquatic life	Very toxic to aquatic life	Very toxic to aquatic life
Acute Aquatic Toxicity	GHS H Phrases						H400	H400
Acute Aquatic Toxicity	GHS Category level						Acute 1	Acute 1
Chronic Aquatic Toxicity (fish, crustacea or algae) - Rapidly Degradable, with Adequate Data	NOEC (NOAEC) or ECx (mg/l)							
Chronic Aquatic Toxicity (fish, crustacea or algae) - Rapidly Degradable, with Adequate Data	ChV mg/l	1.12	493	24.51			48.9	235
Chronic Aquatic Toxicity (fish, crustacea or algae) - Rapidly Degradable, with Adequate Data	Key Phrases	May be dangerous for the environment		Not harmful to aquatic life	Not harmful to aquatic life	Toxic to aquatic life with long lasting effects	Toxic to aquatic life with long lasting effects	Not expected to be harmful to aquatic life
Chronic Aquatic Toxicity (fish, crustacea or algae) - Rapidly Degradable, with Adequate Data	GHS H Phrases						H410	
Chronic Aquatic Toxicity (fish, crustacea or algae) - Rapidly Degradable, with Adequate Data	GHS Category						Chronic 1	

Category	Units	Star San	Spartan PAA SANITIZER FP	ECA Device	Lactic acid	Caprylic Acid	NaDCC Tablets	Ozone
Chronic Aquatic Toxicity (fish, crustacea or algae) - NOT Rapidly Degradable, with Adequate Data	mg/l							
Chronic Aquatic Toxicity (fish, crustacea or algae) - NOT Rapidly Degradable, with Adequate Data	Key Phrases							
Chronic Aquatic Toxicity (fish, crustacea or algae) - NOT Rapidly Degradable, with Adequate Data	GHS Category level							
ENVIRONMENTAL FATE & TRANSPORT								
Persistence	Water t1/2 Days	15	15		8.7	8.7	15	15
Persistence	Water Signal Words							
Persistence	Air t1/2 Days	0.65	14.5		2.7	1.9	3.55	0.15
Persistence	Air Signal Words							
Persistence	Soil/Sediment t1/2 Days	30	30		17	17	30	30
Persistence	Soil/Sediment Signal Words							
Persistence	Key Phrases			Not expected to be persistent	Not expected to be persistent	Not expected to be persistent	Slow environ-mental degradation/ hazardous degradation products form	Not persistent

Category	Units	Star San	Spartan PAA SANITIZER FP	ECA Device	Lactic acid	Caprylic Acid	NaDCC Tablets	Ozone
Rapid Degradability	28-day Study: % Breakdown Dissolved Organic Carbon					88		
Rapid Degradability	28-day Study: % Based on O2 or CO2							
Rapid Degradability	BOD Half-life (days)							
Rapid Degradability	Hydrolysis Half-life (days)							
Rapid Degradability	Key Phrases	Biodegradable	Biodegradable	Biodegradable	Readily degradable	Readily degradable	Not Determined	Readily degradable
Bioconcentration/ Bioaccumulation	Log Kow / Pow	4.78	-0.17	-0.46	-0.62	3.05	-0.06	-0.87
Bioconcentration/ Bioaccumulation	BAF/BCF (l/kg)	508.9	0.95	1.09	3.2	3.2	1.28	0.9
Bioconcentration/ Bioaccumulation	On Canada EPA Domestic Substances List							
Bioconcentration/ Bioaccumulation	Key Phrases	Potential to bioaccumulate		Will not bioaccumulate	Will not bioaccumulate	Not likely/expected to bioaccumulate	Will not bioaccumulate	Will not bioaccumulate
ATMOSPHERIC HAZARD								
Greenhouse Gas	GWP Relative to CO2	0	0	0	0	0	0	0
Greenhouse Gas	Y/N	N	N	N	N	N	N	N
Ozone Depletor	ODP Units	0	0	0	0	0	0	0
Ozone Depletor	GHS H Phrase							
Ozone Depletor	Ozone Classification	Not Classified	Not Classified	Not Classified	Not Classified	Not Classified	Not Classified	Not Classified
Acid Rain Formation	Y/N		N	N	N	N	N	N

Category	Units	Star San	Spartan PAA SANITIZER FP	ECA Device	Lactic acid	Caprylic Acid	NaDCC Tablets	Ozone
Acid Rain Formation	Key Phrases	Product may form SO2 or NOx upon combustion	Does not contain SO2 or NOx	Does not contain SO2 or NOx	Does not contain SO2 or NOx	Does not contain SO2 or NOx	Does not contain SO2 or NOx	Does not contain SO2 or NOx
NESHAP	Y/N	N	N	N	N	N	N	Y
NESHAP	Key Phrases	Not listed as EPA hazardous air pollutant	Not listed as EPA hazardous air pollutant	Not listed as EPA hazardous air pollutant	Not listed as EPA hazardous air pollutant	Not listed as EPA hazardous air pollutant	Not listed as EPA hazardous air pollutant	Listed as EPA hazardous air pollutant
PHYSICAL PROPERTIES								
Vapor Pressure	mm Hg				0.08	0		
Flammability: Liquid	NFPA/HMIS 0,1,2,3,4	1	1	0	0	0		0
Flammability: Liquid	GHS H Phrase							
Flammability: Liquid	GHS Category level	3						
Flash point: Liquid	deg C	49			110	133		
Flash point: Liquid	Key Phrases	Combustible liquid	Flammable liquid	No Flash point-will not burn				No Flash point-will not burn
Flammability: Gas	GHS H Phrase							
Flammability: Gas	GHS Category Level							
Reactivity	NFPA/HMIS 0,1,2,3,4	1	2	0	1	1		3
Reactivity	GHS H Phrase		H201, H202, H250, H251, H261, H270				H204, H205, H290, H252, H272	
Reactivity	GHS Category Level							
pH	pH Units	1-2 or 11.5-14	1-2 or 11.5-14	5-6 or 8-9	1-2 or 11.5-14	2-5 or 9-11.5	6-7 or 7-8	2-5 or 9-11.5
pH	Key Phrases	Highly acidic, highly caustic	Highly acidic, highly caustic	Mildly acidic, mildly alkaline	Acidic, alkaline	Acidic, alkaline	Mildly acidic, mildly alkaline	
Corrosivity	Key Phrases	Highly Corrosive	Corrosive	Not corrosive	Not corrosive			
Corrosivity	GHS Category Level							

Category	Units	Star San	Spartan PAA SANITIZER FP	ECA Device	Lactic acid	Caprylic Acid	NaDCC Tablets	Ozone
Odor	Key Phrases	Slight odor	Mild odor	Slight odor	Odorless	Pungent or irritating odor		Pungent or irritating odor
Volatile Organic Compound	g/l	0		0				
PROCESS FACTORS								
Heat	WBGT, deg C							
Noise Generation	dBA/hr			80/no limit				
Vibration	Class 1 Small Machine (mm/s)			1				
Vibration	Class 2 Medium Machine (mm/s)							
Vibration	Class 3 Large Rigid Foundation (mm/s)							
Vibration	Class 4 Large Soft Foundation (mm/s)							
Ergonomic Hazard	Occurence	Unlikely/ remote	Possible	Possible	Unlikely/ remote	Possible	Unlikely/ remote	Possible
Ergonomic Hazard	Hazard Level	Minor injury/illness, minor impact on time lost	Moderate injury, lost time	Minor injury/illness, minor impact on time lost	Minor injury/illness, minor impact on time lost	Minor injury/illness, minor impact on time lost	Minor injury/illness, minor impact on time lost	Minor injury/illness, minor impact on time lost
Psychosocial Hazard	Work Overload and Pace: Work Load						Process improves workload	
Psychosocial Hazard	Work Overload and Pace: Machine Pacing						Adequate machine pacing	

Category	Units	Star San	Spartan PAA SANITIZER FP	ECA Device	Lactic acid	Caprylic Acid	NaDCC Tablets	Ozone
Psychosocial Hazard	Work Overload and Pace: Time Constraints						Process improves time constraints/ deadlines	
Psychosocial Hazard	Work Schedule: Shift Work						Process normalizes shift work	
Psychosocial Hazard	Work Schedule: Work Isolation	Process requires restricted access	Process requires restricted access	Process eliminates isolation work	Process eliminates isolation work	Process requires restricted access	Process requires restricted access	Process requires restricted access
Psychosocial Hazard	Control	Process provides worker with access to supervisor about needed changes	Process doesn't allow for workers to participate in decision process	Process includes worker input	Process allows for minor changes in real-time by worker	Process allows for minor changes in real-time by worker	Process allows for minor changes in real-time by worker	Process provides worker with access to supervisor about needed changes
Psychosocial Hazard	Work Environment & Equipment: Equipment Stability			Improved equipment quality and suitability			Improved equipment quality and suitability	
Psychosocial Hazard	Work Environment & Equipment: Work Space						Improves work space and surrounding conditions	
High Pressure System	Pressure (Delta % Change From Ambient)	0	0	0	0	0		0
High Temperature System	Temperature (Delta % Change From Ambient)	0	0	0	0	0		0
Water Use	% Water Change							

Category	Units	Star San	Spartan PAA SANITIZER FP	ECA Device	Lactic acid	Caprylic Acid	NaDCC Tablets	Ozone
Water Use	Reuse							
Energy Use	% Energy Change			25% increase				
Energy Use	% Renewable Energy							
Exposure Potential	Occurence: Near Certain							
Exposure Potential	Occurence: Highly Likely						Minor hazard	
Exposure Potential	Occurence: Likely	Critical hazard	Catastrophic hazard	Minor hazard	Marginal hazard	Marginal hazard		Marginal hazard
Exposure Potential	Occurence: Unlikely							
Exposure Potential	Occurence: Remote						Catastrophic hazard	
LIFE CYCLE FACTORS								
Upstream Effects	Key Phrases	Process reduces suppliers use of hazardous materials, energy, water and other resources	Process requires suppliers to use hazardous materials or excess energy, water, and other resources	Eliminates suppliers use of hazardous materials or reduces use of energy, water, and resources	Eliminates suppliers use of hazardous materials and reduces use of energy, water, and resources	Process reduces suppliers use of hazardous materials, energy, water and other resources	Process reduces suppliers use of hazardous materials, energy, water and other resources	Process reduces suppliers use of hazardous materials, energy, water and other resources
Consumer Hazard	Key Phrases	Product contains hazardous components with low consumer exposure potential	Product contains hazardous components with consumer exposure potential	Product contains hazardous components with no consumer exposure potential	Product contains no hazardous components	Product contains hazardous components with low consumer exposure potential	Product contains hazardous components with no consumer exposure potential	Product contains hazardous components with low consumer exposure potential

Category	Units	Star San	Spartan PAA SANITIZER FP	ECA Device	Lactic acid	Caprylic Acid	NaDCC Tablets	Ozone
Disposal Hazard (landfill, incineration)	Key Phrases	Creates concern for air, water or land and disposed of as hazardous waste	Creates concern for air, water or land and disposed of as hazardous waste	Prevents/ reduces amount of waste material being created	Prevents/ reduces amount of waste material being created	Creates concern for air, water or land and disposed of as hazardous waste	Creates concern for air, water or land and disposed of as hazardous waste	Creates some concern for air, water or land
Reportable Quantity	Pounds							100
Recycling	% Recyclable at End of Life							
Recycling	Uses Products With % Recycled Material							
Renewable to Nonrenewable Resource	% Renewable Materials							
Renewable to Nonrenewable Resource	Key Words							

The P2OASys evaluations were performed using Safety Data Sheets for each product which can be found in Supplement 2. EPA's Estimation Programs Interface, (EPI) Suite™ software was used to assess environmental fate and transport and ecological toxicity data for each product.[i]

[i] EPI Suite (2020). US EPA Estimation Programs Interface (EPI) Suite™ for Microsoft® Windows, v 4.11. United States Environmental Protection Agency, Washington, DC, USA.