US Alternatives Assessment Development

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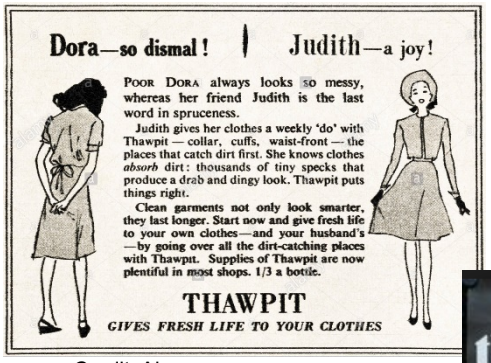
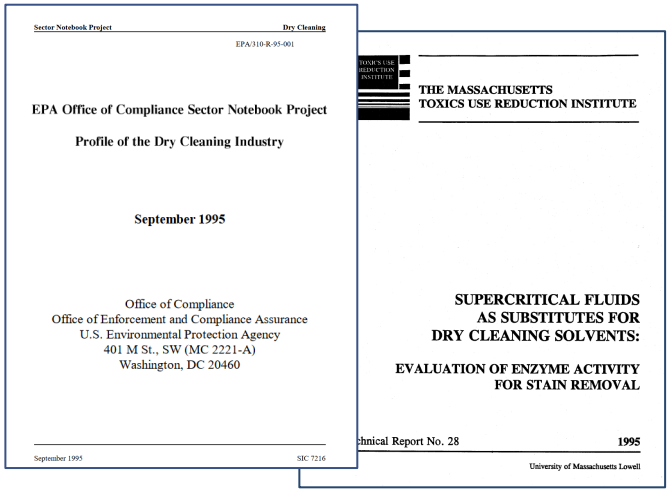
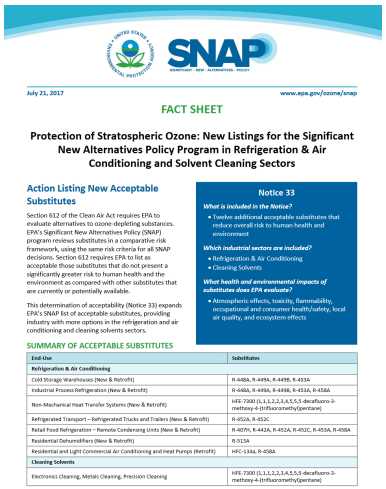


Credit: Alamy

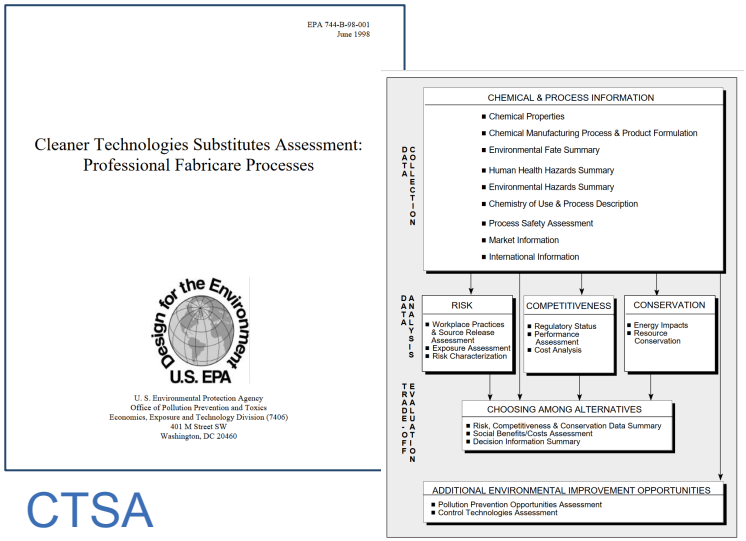
Non flammable substitute for Stoddard solvent



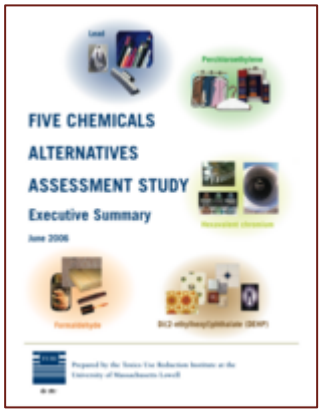
EPA Sector Notebooks, Source Reduction, P2/ TUR planning



Montreal protocol Ozone Depleting Substances



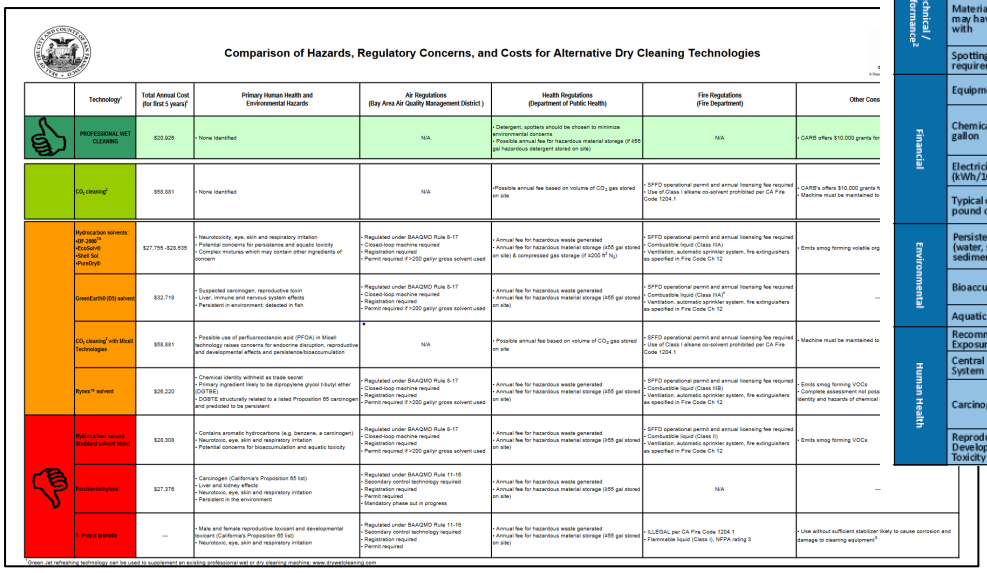
CTSA



Five chemicals Alt. Assess. Study

Table 5.4.1 L: Assessment Summary for Dry Cleaning Alternatives

Assessment Criteria		PCE reference	HC	VMS	SGE	Wet Cleaning	Carbon Dioxide
Technical Criteria	Time	45 min	-	-	-	-	+
	Load capacity	60 lbs	-	+	-	+/-	=
	# of Soils		-	-	=	-/=	=
	Clothing types		+	=	+	-	-
	Spotting requirements		-	-	=/-	-	+
Financial Criteria	Equipment		-	-	-	+	-
	Solvent		+	?	-	+	?
	Labor		-	?	=	-	?
	Operating		=	?	=	=	?
	Regulatory		+	=	+	+	+
Environmental Criteria	Water	60 days	+	+	+	+	+
	Soil	120 days	-	+	+	+	+
	Sediment	540 days	+	+	+	+	+
	Air	98 days	+	+	+	+	-
	BCF	83	-	+	+	+	+
Human Health Criteria	Exposure limits	100 ppm; 25 TLV	+	-	?	+	+
	Dermal/Oral/Respiratory	Irritant	?	+	=	=	+
	Mutagenicity	No	=	=	=	=	=
	Carcinogenicity	2A	+	+	+	+	+
	Repro/Develop Tox	No/?	=	=	=	=	=



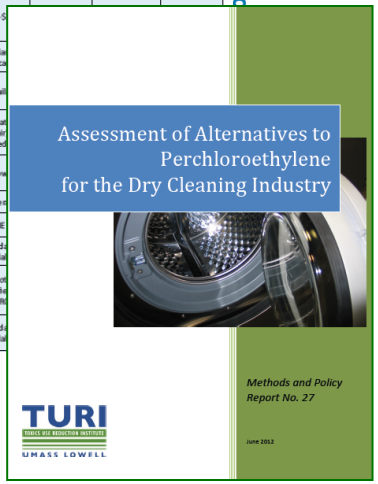
Comparison of Hazards, Regulatory Concerns, and Costs for Alternative Dry Cleaning Technologies

	Technology[1]	Total Annual Cost (for first 5 years)[2]	Primary Human Health and Environmental Hazards	Air Regulations (Bay Area Air Quality Management District)	Health Regulations (Department of Public Health)	Fire Regulations (Fire Department)	Other Cons
	PROFESSIONAL WET CLEANING	$20,926	• None Identified	N/A	• Detergent; spotters should be chosen to minimize environmental concerns • Possible annual fee for hazardous material storage (if >55 gal hazardous detergent stored on site)	N/A	• CARB offers $10,000 grants for
	CO_2 cleaning[3]	$58,881	• None Identified	N/A	•Possible annual fee based on volume of CO_2 gas stored on site	• SFFD operational permit and annual licensing fee required • Use of Class I aliane co-solvent prohibited per CA Fire Code 1204.1	• CARB's offers $10,000 grants fo • Machine must be maintained to
	Hydrocarbon solvents: -DF 2000™ -EcoSolv® -Shell Sol -PureDry®	$27,755 -$28,535	• Neurotoxicity, eye, skin and respiratory irritation • Potential concerns for persistence and aquatic toxicity • Complex mixtures which may contain other ingredients of concern	• Regulated under BAAQMD Rule 8-17 • Closed-loop machine required • Registration required • Permit required if >200 gal/yr gross solvent used	• Annual fee for hazardous waste generated • Annual fee for hazardous material storage (≥55 gal stored on site) & compressed gas storage (if ≥200 ft³ N_2)	• SFFD operational permit and annual licensing fee required • Combustible liquid (Class IIIA) • Ventilation, automatic sprinkler system, fire extinguishers as specified in Fire Code Ch 12	• Emits smog forming volatile org
	GreenEarth® (D5) solvent	$32,710	• Suspected carcinogen, reproductive toxin • Liver, immune and nervous system effects • Persistent in environment; detected in fish	• Regulated under BAAQMD Rule 8-17 • Closed-loop machine required • Registration required • Permit required if >200 gal/yr gross solvent used	• Annual fee for hazardous waste generated • Annual fee for hazardous material storage (≥55 gal stored on site)	• SFFD operational permit and annual licensing fee required • Combustible liquid (Class IIIA) • Ventilation, automatic sprinkler system, fire extinguishers as specified in Fire Code Ch 12	—
	CO_2 cleaning[3] with Micell Technologies	$58,881	• Possible use of perfluorooctanoic acid (PFOA) in Micell technology raises concerns for endocrine disruption, reproductive and developmental effects and persistence/bioaccumulation	N/A	• Possible annual fee based on volume of CO_2 gas stored on site	• SFFD operational permit and annual licensing fee required • Use of Class I aliane co-solvent prohibited per CA Fire Code 1204.1	• Machine must be maintained to
	Rynex™ solvent	$26,220	• Chemical identity withheld as trade secret • Primary ingredient likely to be dipropylene glycol t-butyl ether (DPTBE) • DPTBE structurally related to a listed Proposition 65 carcinogen and predicted to be persistent	• Regulated under BAAQMD Rule 8-17 • Closed-loop machine required • Registration required • Permit required if >200 gal/yr gross solvent used	• Annual fee for hazardous waste generated • Annual fee for hazardous material storage (≥55 gal stored on site)	• SFFD operational permit and annual licensing fee required • Combustible liquid (Class IIIB) • Ventilation, automatic sprinkler system, fire extinguishers as specified in Fire Code Ch 12	• Emits smog forming VOCs • Complete assessment not poss identity and hazards of chemical
	Hydrocarbon solvent Related solvent blend	$28,308	• Contains aromatic hydrocarbons (e.g. benzene, a carcinogen) • Neurotoxic, eye, skin and respiratory irritation • Potential concerns for bioaccumulation and aquatic toxicity	• Regulated under BAAQMD Rule 8-17 • Closed-loop machine required • Registration required • Permit required if >200 gal/yr gross solvent used	• Annual fee for hazardous waste generated • Annual fee for hazardous material storage (≥55 gal stored on site)	• SFFD operational permit and annual licensing fee required • Combustible liquid (Class II) • Ventilation, automatic sprinkler system, fire extinguishers as specified in Fire Code Ch 12	• Emits smog forming VOCs
	Perchloroethylene	$27,376	• Carcinogen (California's Proposition 65 list) • Liver and kidney effects • Neurotoxic, eye, skin and respiratory irritation • Persistent in the environment	• Regulated under BAAQMD Rule 11-16 • Secondary control technology required • Registration required • Permit required • Mandatory phase out in progress	• Annual fee for hazardous waste generated • Annual fee for hazardous material storage (≥55 gal stored on site)	N/A	—
	1-Propyl bromide	—	• Male and female reproductive toxicant and developmental toxicant (California's Proposition 65 list) • Neurotoxic, eye, skin and respiratory irritation	• Regulated under BAAQMD Rule 11-16 • Secondary control technology required • Registration required • Permit required	• Annual fee for hazardous waste generated • Annual fee for hazardous material storage (≥55 gal stored on site)	• ILLEGAL per CA Fire Code 1204.1 • Flammable liquid (Class I), NFPA rating 3	• Use without sufficient stabilizer likely to cause corrosion and damage to cleaning equipment[4]

[1]Green Jet refreshing technology can be used to supplement an existing professional wet or dry cleaning machine; www.drywetcleaning.com

Summary Table: Comparison of Perc

Key Assessment Criteria		Perc (reference)	Wet Cleaning[1]	Carbon Dioxide	High Flashpoint Hydrocarbons	Acetal	Propylene Glycol Ethers	Siloxane	n Propyl Bromide
Common Trade Names / Manufacturers of Equipment or Solvents			Wascomat, Miele, Continental, HwaSung, AquaSolo	Cool Clean Technologies, Solvair®	DF2000™ Fluid, EcoSolv®, ShellSol D60, Caled Hydroclene	Solvon K4	Solvair®, Rynex 3®, Impress®, Gen-X®	Green Earth® D5 solvent	Drysolv®, Fabrisolv™ XL
Solvent Chemical Identification [CAS#]		Perchloroethylene [127-184]	Solvent: Water Detergents: See full report[1]	Carbon Dioxide [124-38-9]	Naphtha (petroleum) hydrotreated heavy [64742-48-9]; C10-C13 Isoalkanes [68551-17-7]	1-(butoxy methoxy) butane (butylal) [2568-90-3]	dipropylene glycol tert-butyl ether, [132739-31-2]; di-propylene glycol n-butyl ether, [29911-28-2]	Decamethylcyclo-pen ta siloxane (D5) [541-02-6]	N Propyl Bromide (nPB) [106-94-5]
Technical / Performance[2]	Cycle time (min)	45	20-40	35-45	60-75	60-65	>45	53-58	45
	Load capacity (lb)	50	20-75	60	35-90	40-90	43	55	50
	Materials system may have difficulty with	Leather, suedes, beads, delicates	Leather, suede and fur	Triacetates, specially dyed acetates	Vinyl appliqués	Appliqués or decorations glued to fabric	None identified	None identified	Leather, suedes, beads, delicates
	Spotting requirements	Moderate	Low	High	Moderate	Low	Low	High	Low
Financial	Equipment	$40,000 - $65,000	$36,000 - $61,000	$100,000 - >$150,000	$38,000 - $75,000	$50,000 - $100,000	$56,000	$30,500 - $55,000	$40,000 - $60,000 or retrofit costs
	Chemical cost per gallon	$17	$0.007/gal (water); $25-$31/gal (detergent)	$0.18/lb ($CO_2$); $40/gal (detergent)	$14-$17	$28-$			
	Electricity usage[3] (kWh/100 lb)	26.6	9.3	30.9	35.5	Simila hydroca			
	Typical cost per pound cleaned[4]	$0.63-$1.94 avg. $1.02	$0.57-$1.32 avg. $1.10	$1.40	$0.73-$1.02 avg. $0.88	Unavail			
Environmental	Persistence[5] (water, soil, sediment, air)	M (water), H (soil, sed, air)	L (water, soil, air), M (sed)	NA	L (water, soil, air), M (sed)	L (wat soil, air (sed			
	Bioaccumulation[6]	Low	Low	NA	Moderate	Low			
	Aquatic Toxicity[7]	Moderate	Low to Moderate[8]	Low	High	Moder			
Human Health	Recommended Exposure limits[10]	25 ppm	NE	5000 ppm	100 ppm[11]	NE			
	Central Nervous System Effects	Yes	No[13]	No[14]	Yes	No da availa			
	Carcinogenicity	IARC Probable human carcinogen	Not classified by IARC	Not classified by IARC	Not classified by IARC	Not classifie IARC			
	Reproductive / Developmental Toxicity	Yes	Negligible[15]	No data available	No data available	No da availa			



GreenScreen® (v.1.2) Hazard Profile Summary Table – D5

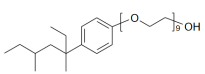
Group I Human					Group II and II* Human									Ecotox		Fate		Physical	
C	M	R	D	E	AT	ST		N		SnS*	SnR*	IrS	IrE	AA	CA	P	B	Rx	F
						single	repeated *	single	repeated *										
M	L	*L*	*M*	M	L	M	L	dg	L	L	dg	L	L	L	M	vH	*vH*	*L*	*M*

GreenScreen for dry clean solvent D5

Table 2-3 Screening Level Environmental Hazard Summary for Surfactants

This table contains information on the inherent hazards of surfactant chemicals and indicates whether a chemical meets the DfE Criteria for Safer Surfactants. Evaluations are based on DfE's Criteria for Safer Surfactants and Alternatives Assessment Criteria. See http://www.epa.gov/dfe/pubs/projects/gfcp/index.htm#Surfactants and http://www.epa.gov/dfe/alternatives_assessment_criteria_hazard_eval_nov2010_final_draft2.pdf

VL = Very low hazard L = Low hazard M = Moderate hazard H = High hazard VH = Very high hazard — Endpoints in colored text (VL, L, M, H, and VH) were assigned based on experimental data.
Endpoints in black italics *(VL, L, M, H,* and *VH)* were assigned using estimated values and professional judgment (Structure Activity Relationships).
Y=Yes…N=No

Chemical Class / Chemical	CASRN	Fate: Persistence	Fate: Degradates of concern[2]	Aquatic toxicity[1]: Acute	Aquatic toxicity[1]: Chronic	Aquatic toxicity[1]: Degradate Aquatic toxicity	Meets DfE Surfactant Criteria?	Synthesis
Nonylphenol ethoxylates (NPEs)								
Nonylphenol ethoxylate (9EO); NPE9 	127087-87-0	M	Y[3]	H	M	VH	N	Nonylphenol is prepared from phenol and tripropylene, yielding a highly branched, predominantly para-substituted alkylphenol. Reaction of nonylphenol with ethylene oxide yields NPE surfactants.
Octylphenol ethoxylates (OPEs)								
Octylphenol ethoxylate (10EO); OPE10	9036-19-5	H[4]	Y[5]	H	*H*	VH	N	Octylphenol is prepared from phenol and di-isobutylene, yielding a highly branched, predominantly para-substituted alkylphenol.

EPA DfE Alternatives Assessment