

**MASSACHUSETTS DEPARTMENT ENVIRONMENTAL PROTECTION
DRY CLEANERS ENVIRONMENTAL RESULTS PROGRAM
ALTERNATIVE DRY CLEANING TECHNOLOGIES COMPARATIVE ANALYSIS WORKSHEET**

This document contains a comparative analysis worksheet to assist you in considering alternatives to perchloroethylene. Various aspects such as cost, performance, capital and operating costs must be weighed to make a fully-informed decision. We have drawn on various sources to produce a worksheet that provides information needed for a full comparative analysis. The Comparative Analysis worksheet includes a column on the left for you to include the data from your current facility and one on the far right for you to record your comments and information specific to your needs and concerns for each data row. There are also summary rows at the bottom to record your conclusions about advantages or disadvantages, and remaining questions you may wish to pursue before making a decision. We have included symbols denoting "equal," "approximately equal to," "more than or less than," "greater than" and "less than," as quick summaries of what the information suggests. These are not strict mathematical quantities but represent the best estimate of how the burden or value of the alternative compares to that of perchloroethylene use.

Following the Comparative Analysis Worksheet we have also provided a summary of the information drawn from eight case studies of cleaners in Massachusetts using various alternatives to perc. We suggest that as you go through the Comparative Analysis Worksheet that you also consult the Case Study Summary, as it provides a slightly different way of weighing the various aspects, and is drawn from near-by real world examples. However, you should make careful note of the size of each of the case study facilities as they may vary greatly from your facility, and the numbers presented should be scaled accordingly as you make your comparisons. The Case Study Summary also includes columns for recording specific information about your shop, so that you can capture details that may be more or less important in your case, and tailor the exercise of comparing alternatives to your individual concerns and goals.

Finally, we have included a recent data set compiled by the Drycleaning & Laundry Institute from a panel discussion at the Clean '13 event held in New Orleans in June of 2013. The data is direct from the industry representatives on hand for each of the solvents compared. Note, however, that professional wet cleaning is not included in this data set. The data does include points about cycle length, wash time, costs, etc. This may be another helpful resource in comparing alternatives you are considering.

COMPARATIVE ANALYSIS WORKSHEET OF ECONOMICS, PERFORMANCE, ENVIRONMENTAL AND HEALTH CHARACTERISTICS OF ALTERNATIVE DRY CLEANING SOLVENTS

(July 31, 2013)

Based on case studies and research conducted by the Toxics Use Reduction Institute, to be updated in response to comments and as new information becomes available.

Note: All costs are approximate and have not been verified with vendors

FACTOR THAT MAY VARY WITH TYPE OF EQUIPMENT	Your perc data	Perc (Capital Costs for new machines are provided; fill in your operating costs for your existing perc machine)	Wet Cleaning	High Flash Point Hydrocarbon (e.g., DF2000)	Acetal (Solvon K4)	Propylene Glycol Ethers (Solvail, Rynex)	Siloxane (Green Earth)	nPB (DrySolv)	Your comparison
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COST CONSIDERATIONS									
Capital Costs									
Washing / Drying / Finishing Equipment (cost range depends on size and extra features; based on 2005 data)		\$40,000 to \$65,000	10% < perc \$36,000 to \$61,000	± 10% perc \$38,000 to \$75,000	25% - 50% > perc \$50,000 to \$100,000	≥ perc \$56,000 to \$90,000	20 -25% < perc \$30,500 to \$55,000	≈ perc \$40,000 to \$60,000	
(If No Public Sewer) Holding Tank or Wastewater Treatment System with Groundwater Discharge Permit		No cost	» perc, if no public sewer illegal to discharge cleaning wastewater to septic system	= perc no wastewater discharge	= perc no wastewater discharge	= perc no wastewater discharge	= perc no wastewater discharge	= perc no wastewater discharge	
Fire Code Compliance (if Class II or III solvent)		No cost: not a flammable liquid	= perc not combustible	>> perc Class III solvent*	>> perc Class III solvent*	>> perc Class III solvent*	>> perc Class III solvent*	= perc not combustible	
*Retrofit building to meet NFPA 32 code for Type III solvents (flame barriers, automatic sprinklers unless <330 gallons on site, and have specified fire protections in equipment). Local codes may apply as well.									

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Operating Costs									
Equipment Maintenance Costs									
Gaskets and Seals Replacement		Requirement to test weekly and fix identified leak within 24 hours	<< perc <i>Water does not break down gaskets and seals</i>	< perc	< perc	< perc	< perc	> perc <i>Causes need for frequent replacement of gaskets and seals; however there is not requirement for testing and replacement</i>	
Labor Costs									
Initial Staff Training			<i>Requires training on computer controlled equipment and tensioning machines</i>	<i>Training necessary for all new equipment</i>	<i>Training necessary for all new equipment</i>	<i>Training necessary for all new equipment</i>	<i>Training necessary for all new equipment</i>	<i>Training necessary for all new equipment</i>	
Finishing and Pressing			< perc <i>tensioning equipment needed (minimizes need to press clothes)</i>	= perc	≤ perc <i>manufacturer says less wrinkling during cleaning cycle</i>	≤ perc <i>manufacturer says less wrinkling during cleaning cycle</i>	= perc	= perc	
Pre Spotting			< perc	= perc	< perc	≈ perc	> perc	< perc	

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Regulatory Compliance: Air Pollution		Weekly leak detection & repair, equipment monitoring, recordkeeping per ERP Workbook because perc is a hazardous air pollutant. ALL co-residential and ALL co-located perc machines must cease operation on or by December 21, 2020.	< perc <i>no air pollutants</i>	none: unless use >2000 pounds per year <i>if > 2000 lb, Air VOC emissions permit required, would involve recordkeeping and controls</i>	none: unless use >2000 pounds per year <i>if > 2000 lb, Air VOC emissions permit required, would involve recordkeeping and controls</i>	none: unless use >2000 pounds per year <i>if > 2000 lb, Air VOC emissions permit required, would involve recordkeeping and controls</i>	none: unless use >2000 pounds per year <i>if > 2000 lb, Air VOC emissions permit required, would involve recordkeeping and controls</i>	none: unless use >2000 pounds per year <i>if > 2000 lb, Air VOC emissions permit required, would involve recordkeeping and controls</i>	
Regulatory Compliance: Hazardous Waste		Maintaining proper labeling, storage conditions, record keeping, shipping and disposal per ERP Workbook	<< perc <i>no hazardous or industrial waste</i>	= perc <i>maintaining proper labeling, storage conditions, recordkeeping, shipping and disposal</i>	< perc <i>no hazardous waste</i>	< perc <i>no hazardous waste</i>	< perc <i>no hazardous waste</i>	< perc <i>no hazardous waste</i>	
Materials and Resource Costs									
Water Use (Cleaning and Condensing / Chilling) and Sewer Discharge (if applicable)		Water used for condenser/chiller	≈ perc <i>no chilling/condensing, but water used for cleaning</i>	= perc	= perc	= perc	= perc	= perc	
Alternatives compared to refrigerated condenser chillers									
Cleaning Chemicals -- Detergent			> perc	= perc	= perc	= perc	= perc	= perc	
Solvent			<i>no cost</i>	= perc	> perc	> perc	> perc	>> perc	

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Energy (electricity for machine operation including solvent recovery)			<< perc <i>no distillation / solvent recovery</i>	<< perc if no distillation = perc if distillation	<< perc < other solvents <i>For distillation about 1/2 of other solvents</i>	= perc	> perc if distillation < perc if no distillation <i>high temperature required for distillation</i>	= perc	
Natural Gas / Oil (heating, pressing, steam, cooling)			< perc <i>less pressing</i>	= perc	= perc	= perc	= perc	= perc	
Fees									
Technology Licensing		no cost	= perc	= perc	= perc	= perc	\$2500/year for the first, \$1250/year for additional machines	= perc	
Regulatory Compliance Fees		\$250 annual ERP Compliance Fee + TURA fees for large users	<< perc	<< perc	<< perc	<< perc	<< perc	<< perc <i>TURA fee for very large users</i>	
Unquantifiable Costs									
Customer Acceptance / Good Will			>> perc <i>No loss of customers</i>	> perc <i>advertised as "green"</i>	> perc <i>advertised as "green"</i>	> perc <i>advertised as "green"</i>	> perc <i>advertised as "green"</i>	= perc	
Potential Liability from Spill or Accidental Release		Risk: highly toxic solvent that persists in air, and sediments, and groundwater	<<< perc	< perc	<< perc	<< perc	< perc	= perc	

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Risk of Fire		Minimal risk, not a flammable liquid	= perc <i>not a flammable liquid</i>	>> perc <i>Class III combustible solvent</i>	>> perc <i>Class III combustible solvent</i>	>> perc <i>Class III combustible solvent</i>	>> perc <i>Class III combustible solvent</i>	= perc <i>not a combustible liquid</i>	
Worker Health and Safety (See also Human Health Risk section below)		Risk: volatile toxic solvent; IARC carcinogen, and other adverse respiratory, neurological, and skin effects	<<< perc <i>no toxic solvents in washing – pre-spotting chemicals should be checked</i>	< perc <i>pre-spotting chemicals should be checked</i>	< perc <i>pre-spotting chemicals should be checked</i>	< perc <i>pre-spotting chemicals should be checked</i>	< perc <i>pre-spotting chemicals should be checked</i>	= perc <i>Volatile toxic solvent; National Toxicology Program has identified it as a likely carcinogen, with other adverse respiratory, neurological, and skin effects. pre-spotting chemicals should be checked</i>	
TECHNICAL CONSIDERATIONS									
Cycle Time			<< perc <i>20 - 40 minutes: washing and drying in separate machines so cycles can overlap</i>	>> perc <i>60-75 minutes</i>	>> perc <i>60-65 minutes</i>	> perc <i>> 45 minutes</i>	>> perc <i>53-58 minutes</i>	= perc <i>45 minutes</i>	
Materials does not handle well		Leather, suede, beads, delicates	Leather, suede and fur	Vinyl appliquéés	Appliquéés or decorations glued to fabric	None identified	None identified	Leather, suedes, beads, delicates	

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Aggressive-ness of solvent (roughness on clothes)		aggressive	< perc	< perc	< perc	unclassified	< perc	= perc	
ENVIRONMENTAL & HEALTH CONSIDERATIONS									
Environmental Risks		Persistence in soil, sediment, and air is an issue, as well as some aquatic toxicity. Hazardous Air Pollutant	<<< perc <i>no toxic solvents in washing – pre-spotters should be checked</i>	< perc <i>serious issues with aquatic toxicity, moderate issues in other areas. Volatile Organic Carbon that contributes to smog</i>	<< perc <i>based on current information, appears to be low to moderate issues. Volatile Organic Carbon that contributes to smog</i>	<< perc <i>based on current information, appears to be low to moderate issues. Volatile Organic Carbon that contributes to smog</i>	< perc <i>high issues with sediment and air as well as aquatic toxicity</i>	= perc <i>persistence in air, high aquatic toxicity, and a Volatile Organic Compound that contributes to smog</i>	

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Human Health Risks		IARC has identified this as a probable carcinogen and skin, eye and respiratory irritant; it is toxic to the liver, kidney, nervous, immune and hematological systems. Recommended occupational exposure limit 25 ppm	<<< perc <i>skin and eye irritant from detergent concentrate</i>	< perc <i>Skin, eye, respiratory irritant, and toxic to lungs, kidneys and nervous system. Recommended occupational exposure limit: 5000 ppm</i>	unknown <i>possible skin and eye irritant; no occupational exposure limit established</i>	<< perc <i>skin, eye, and respiratory irritant, toxic to the nervous system, liver and kidneys; no occupational exposure limit established</i>	< perc <i>Skin and eye irritant, toxic to liver and immune system, some evidence of carcinogenicity and toxicity to the reproductive/developmental and nervous systems. Recommended occupational exposure limit: 10 ppm</i>	= perc <i>Potent neurotoxin; National Toxicology Program has identified it as reasonably anticipated to be a human carcinogen; eye, skin, and respiratory irritant, toxic to liver and kidney and to the digestive, blood and nervous systems. Recommended occupational exposure limit: 10 ppm</i>	
WOULD YOU CONSIDER THIS OPTION?									
Advantages									

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Disadvantages									
Questions to ask Vendor, TURI, OTA, Trade Organization, Other Dry Cleaners, etc.									

CASE STUDY SUMMARY FOR DIFFERENT TYPES OF DRY CLEANING FACILITIES

July 31, 2013 (page 1 of 2)

(to be updated as additional information becomes available)

Cost Element		Perc	Perc	Wet Cleaning	Hydrocarbon	Acetal	PGE	Siloxane	nPB	How does your shop compare?
		Your Shop	Case Study Facilities							
Shop Sizing:	Pieces/day (DC)		60	100	TBD	650	~300	100	100	
	Pieces/day (Laundry)		50	500		600	350	100	30	
	lbs/day (DC)		-	-		-	260	-	-	
	lbs/day (Laundry)		-	-		-	-	-	-	
	FTEs		7	2.5		15+	4.5	4+	2.5	
	Square footage		1300	1,500		3600	4000	2800	1700	
Capital Costs:	Dry Cleaning		\$44,000	\$46,900		\$90,000	\$90,000	\$49,620	\$40,000	
	Other Investments		\$0	\$0		\$0	as needed	\$115,285	\$0	
Time Investments:	Load size (pounds)		30	30		50	60-70	40	40	
	Cycle time (mins/load)		40	12-25 washer; 8-15 dryer		65	120	60	35	
	ERP/DEP paperwork (average hours/year)		2	0		2 (for waste pick-ups)	10	5 hrs/week	0	
	Spotting time (average hours/day)			0.3		6	4	0.5	1.5	
	Finishing time (average hours/day)			5		6 pressers at 8 hrs/day	6	4	5	
	Training on new methods (hours/employee)		0	6 initial hours for tensioning equip; 3 initial hours for washer		4 hrs for spotter Also paid \$3600 for start-up solvent	0	?	1-2 days	
	OTHER							distiller in use		
Performance (items or \$/month)	Send-outs		0	0		0	13	0	0	
	Redos		0	0		0	27	1	3	
	Claims		\$65	0		0	2	0	0	

CASE STUDY SUMMARY FOR DIFFERENT TYPES OF DRY CLEANING FACILITIES

July 31, 2013 (page 2 of 2)

Cost Element	Perc	Perc	Wet Cleaning	Hydrocarbon	Acetal	PGE	Siloxane	nPB	How does your shop compare?
	Your Shop	Case Study Facilities							
Operation Costs (\$/month)	Machine Maintenance	\$0	\$32		\$0	\$1,200	\$206	\$42	
	Filters	\$34	0		\$0	\$100	\$26	\$0	
	Solvent	\$130	0		\$36	\$200	\$520	\$225	
	Detergent	\$74	\$180		\$326	\$0	\$24	\$10	
	Spotting agents	\$18	\$3		\$200	\$500	\$8	\$60	
	Waste disposal	\$125	0		\$92	\$54	\$49	\$21	
	Regulatory/permitting	\$11	0		\$0	\$54	\$8	\$0	
	Licensing fees	\$0	0		\$0	\$0	\$183	\$0	
Resource Use (Unit/month)	Electricity (kWh)	3027	1606		8284	625	2610	1962	
	Electricity (\$)	\$513	\$234		\$1,707	\$120	\$521	\$367	
	Natural Gas (therms)	98	0		1435	0	377	480	
	Natural Gas (\$)	\$90	0		\$1410	0	\$378	\$615	
	Oil (gallons)	0	424		0	675	0	0	
	Oil (\$)	0	\$1,086		\$0	\$2,360	\$0	\$0	
	Water (100cuft)	24	26		60	-	34	24	
	Water (\$)	\$66	\$142		\$275	\$230	\$160	\$107	
	Sewer (100 cuft)	24	26		60	-	34	24	
	Sewer (\$)	\$77	\$186		\$836	\$310	\$254	\$136	
Monthly total Operating Cost (w/out labor)		\$1,203	\$1,863		\$4,882	\$5,128	\$2,237	\$1,583	
Monthly per piece total operating cost (w/out labor)		(110/day or ~2640/month) \$0.46	(600/day or ~14,400/month) \$0.13		(1250/day or ~30,000/month) \$0.16	(650/day or ~15,600/month) \$0.33	(200/day or ~4800/month) \$0.47	(130/day or ~3120/month) \$0.50	

DRYCLEANING & LAUNDRY INSTITUTE CLEAN SHOW '13 PANEL DISCUSSION DATA COMPILATION
COMPARING THE SOLVENTS Source: <http://www.natclo.com/1308/solvents.htm>

Solvent/ Manufacturer	Perc Dow	Hydrocarbon R.R. Street & Co	Solvon K4 Kreussler	Rynex Adco	GenX Caled	GreenEarth GreenEarth Cleaning
Cycle length (minutes)	45	2 baths: 55-65 1 bath: 50-60	2 baths: 70 1 bath: 62	74	55-60	60
Wash time (minutes)	15-20	18-20	15-20	75	4-8	17
Drying time (minutes)	30-35	28	48 with cool down	60	25-30	35
Specific machine required?	Class IV	Class IIIA	Class IIIA with vacuum still	K Series Class IIIA	Class IIIA	Class IIIA
Fees/Licenses	No	No	No	No	No	\$2,500/year
Proprietary products required?	No	No products	Yes, Kreussler	Booster sizing	No	Many approved available, top brands
Average cost per gallon	\$25	\$13.95	\$30.70	\$36	\$29.41	\$21-\$34
Average solvent mileage (pounds cleaned per gallon)	750 to 1,000	1,500 to 1,800 4,000 in K series	4,500 Minimum of .5% of load	3,000+	800 to 1,100	1,500
Recommended waste disposal	Licensed waste hauler	Appropriate waste hauler	Licensed waste hauler	Regular waste hauler	Non-hazardous municipal waste	Licensed waste hauler
Number of machines in U.S.	36,000 U.S.	10,000+	200 U.S. 400 global	10 U.S. 13 global	800 U.S. 1,000 global	More than 900 U.S. 1,700 global
Any major issues?	Proper handling and disposal; restrictions on location; special reporting & permitting	None	None	Residual solvent temperature after drying	None	None
Rumors or misconceptions?	1. Banned 2. Unavailable 3. Stabilizer disappears when distilled	1. Doesn't clean	1. Odor of solvent will be a problem	None	1. Doesn't need detergent	1. Doesn't clean 2. Banned in Canada
Top 3 benefits	1. Safety 2. Proven performance 3. Economical	1. Cost effective 2. Virtually odorless 3. Ease of transition and ongoing operations	1. Exceptional cleaning performance 2. Unmatched solvent mileage 3. Environmental & occupational safety for clients, staff, landlords, and drycleaners	1. Better soil removal 2. Fewer reruns 3. Great solvent mileage	1. Better performance for oil & water stain removal 2. Cheaper spotting labor and chemical cost 3. Faster cleaning with no harsh smell	1. Favorable regulatory profile 2. Garment makers' recommendations 3. Landlord specified locations