



# Alternatives to Perchloroethylene In Garment Care

NEWMOA

## Regional Multi-Program Meeting on Promoting Safer Garment Cleaning

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### What is Perc and Why is it a Problem?

Able to dissolve most organic materials, perchloroethylene (PCE or perc) is the most widely used dry cleaning solvent in Massachusetts and nationally.

A typical dry cleaning machine...



generates hazardous waste

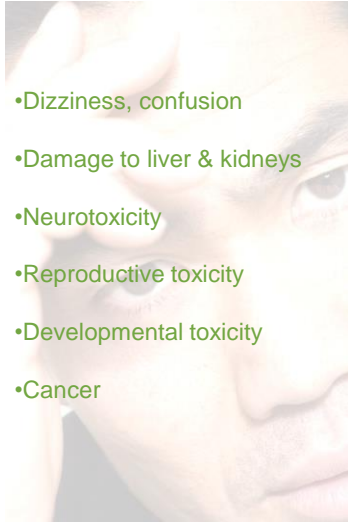


and has fugitive emissions

Though perc machines have improved emissions over time, there is still exposure to workers and even co-located residences and clothes taken home.



Short and long term health effects linked to use of perc include:



- Dizziness, confusion
- Damage to liver & kidneys
- Neurotoxicity
- Reproductive toxicity
- Developmental toxicity
- Cancer



Misuse of perc can lead to soil and groundwater contamination.

75% of drycleaner sites in the US are contaminated.

Many are Superfund sites.

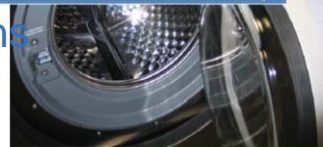


## Alternatives Studied

- Wet cleaning
- CO<sub>2</sub>
- High flash point hydrocarbons
- Acetals
- Propylene-glycol ethers
- Volatile methyl siloxanes
- n-Propyl bromide

2012

Assessment of Alternatives to Perchloroethylene for the Professional Garment Care Industry



Methods and Policy Report No. 27

April 2012



## Key Criteria: 1<sup>st</sup> set

### Technical/Performance

Cycle time and load capacity

Difficult materials

Pretreatment and finishing requirements

### Economic

Equipment costs

Chemical costs

Energy costs



Key Assessment Criteria		Perc (reference)	Wet Cleaning <sup>2</sup>	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®, Fabrisol™ XL
Solvent Chemical Identification [CAS#]		Perchloroethylene [127-18-4]	Solvent: Water Detergents: See full report <sup>2</sup>	Carbon Dioxide [124-38-9]	Naphtha (petroleum) hydrotreated heavy [64742-48-9]; C10-C13 Isoalkanes [68551-17-7]	1-(butoxy methoxy) butane (butylal) [2588-90-3]	dipropylene glycol tert-butyl ether, [132759- 31-2]; di- propylene glycol n-butyl ether, [29911-28-2]	Decamethylcyclo- penta siloxane [D5] [541-02-4]	N Propyl Bromide (nPB) [106-94-5]
Technical / Performance <sup>2</sup>	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 appliqué	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 <sub>2</sub> ); \$40/gal (detergent)	\$14-\$17	\$28-\$34	\$25-\$30	\$22-\$28	\$40-\$64
	Electricity usage <sup>3</sup> (kWh/100 lb)	26.6	9.3	30.9	35.5	Similar to hydrocarbon	Unavailable	54.2	Unavailable
	Typical cost per pound cleaned <sup>4</sup>	\$0.63-\$1.94 avg. \$1.02	\$0.57-\$1.32 avg. \$1.10	\$1.40	\$0.73-\$1.02 avg. \$0.88	Unavailable	\$1.14	\$1.08-\$2.33 avg. \$1.71	Unavailable

## Are Alternatives Effective and Affordable?

**All** options are technically feasible  
Some may have impact on throughput  
Some have limitations on the fabrics they can handle

**Most** options are affordable  
CO<sub>2</sub>-based options not economically feasible (for majority of smaller MA shops)



## Key Criteria – 2<sup>nd</sup> set

### Environmental

- Persistence
- Bioaccumulation
- Aquatic Toxicity

### Health and Safety

- Exposure limits
- CNS effects
- Carcinogenicity
- Repro/developmental toxicity
- Flammability



Key Assessment Criteria		Perc (reference)	Wet Cleaning <sup>1</sup>	Carbon Dioxide	High Flashpoint Hydrocarbons	Acetal	Propylene Glycol Ethers	Siloxane	n Propyl Bromide
Environmental	Persistence <sup>5</sup> (water, soil, sediment, air)	M (water), H (soil, sed, air)	L (water, soil, air), M (sed)	NA	L (water, soil, air), M (sed)	L (water, soil, air), M (sed)	L (water, soil, air), M (sed)	L (water), M (soil), H (sed, air)	L (water, soil), M (sed), H (air)
	Bioaccumulation <sup>6</sup>	Low	Low	NA	Moderate	Low	Low	Moderate	Low
	Aquatic Toxicity <sup>7</sup>	Moderate	Low to Moderate <sup>8</sup>	Low	High	Moderate <sup>9</sup>	Low	High	High
Human Health	Recommended Exposure limits <sup>10</sup>	25 ppm	NE	5000 ppm	100 ppm <sup>11</sup>	NE	NE	10 ppm <sup>12</sup>	10 ppm
	Central Nervous System Effects	Yes	No <sup>13</sup>	No <sup>14</sup>	Yes	No data available	Yes	Some evidence	Yes
	Carcinogenicity	IARC Probable human carcinogen	Not classified by IARC	Not classified by IARC	Not classified by IARC	Not classified by IARC	Not classified by IARC	Some evidence	Clear evidence in animal studies by NTP
Safety	Reproductive / Developmental Toxicity	Yes	Negligible <sup>15</sup>	No data available	No data available	No data available	No <sup>16</sup>	Studies indicate concern	Yes
	Flash Point/ Flammability	NA / Not Flammable	NA / Not Flammable	NA / Not Flammable	140-145°F / Combustible liquid	144°F / Combustible liquid	160-212°F / Combustible liquid	171°F / Combustible liquid	NA <sup>17</sup>

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## Are the Alternatives Safer than Perc?

All are less persistent; HC and Siloxanes are more bioaccumulative and toxic in aquatic environment

Most are safer to humans ... **EXCEPT ...**

- nPB is carcinogenic, reproductive toxic and neurotoxic – **NOT** a safer alternative
- **Data gaps** present concern for alternatives that are new to the market (e.g., Solvon K4 acetals)

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# Key Criteria – 3<sup>rd</sup> set: Applicable Regulations

Hazardous Air Pollutants

Designated VOCs

Massachusetts regulations

- Listed toxics under TURA
- Environmental Results Program

Hazardous waste disposal issues

Wastewater discharge restrictions



Key Assessment Criteria		Perce (reference)	Wet Cleaning <sup>1</sup>	Carbon Dioxide	High Flashpoint Hydrocarbons	Acetal	Propylene Glycol Ethers	Siloxane	n-Propyl Bromide
Applicable Regulations	Clean Air Act Hazardous Air Pollutant (HAP)	Yes, HAP	No	No	No	No	No	No	No
	Clean Air Act NAAQS VOC <sup>18</sup>	No, Exempt <sup>19</sup>	No <sup>20</sup>	No	VOC	VOC	VOC	No, Exempt <sup>19</sup>	VOC
	Massachusetts regulated (TURA, ERP)	TURA Higher Hazard Substance, ERP	No	No	No	No	No	No	TURA
	Hazardous waste disposal required	Yes - Listed hazardous waste	No	No	Yes Waste Oil = Hazardous Waste in MA	No	No	No	No; monitor for residual perc if using retrofitted machine
	Wastewater discharge restrictions	No	Discharge to sewer or holding tank <sup>21</sup>	No	No	No	No	No	No



## Are the Alternatives More Regulated than Perc?

**Most** options are combustibile or flammable, requiring additional control for safety

**Several** options are VOCs

**Most** options involve industrial waste disposal, though not hazardous waste disposal

**Wet Cleaning** poses issues for facilities on septic

**nPB** newly regulated under TURA and now... HHS is coming!



## Have you seen something like this...



## “Green Washing: Site Visit Data Summary

35 Cleaners visited

13 did not have “green” claims

- Drop store (1)
- Green Earth (8)
- Solvon K4 (3)
- Hydrocarbon (1)

22 did have “green” claims

- Drop store (2)
- Green Earth (13)
- Solvon K4 (5)
- Hydrocarbon & Wet Cleaning (2)



**Wet Cleaning and CO2 are considered the most environmentally friendly options. Wet Cleaning technology is the more affordable of the two.**

Washer and dryer use biodegradable detergents, and conditioners

Finishing equipment re-shapes and dries the slightly damp clothes





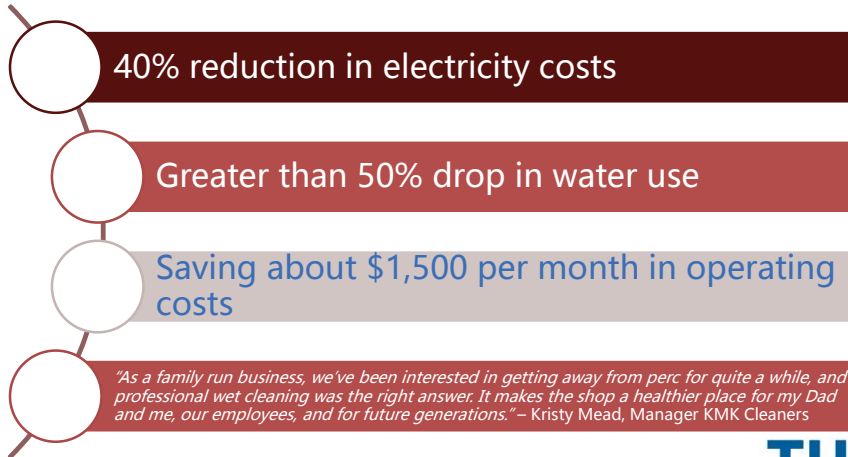
## MA Conversions to Wet Cleaning

From 2008 through 2014 TURI has given 10 grants to dry cleaners to eliminate the use of perc and switch to dedicated professional wet cleaning

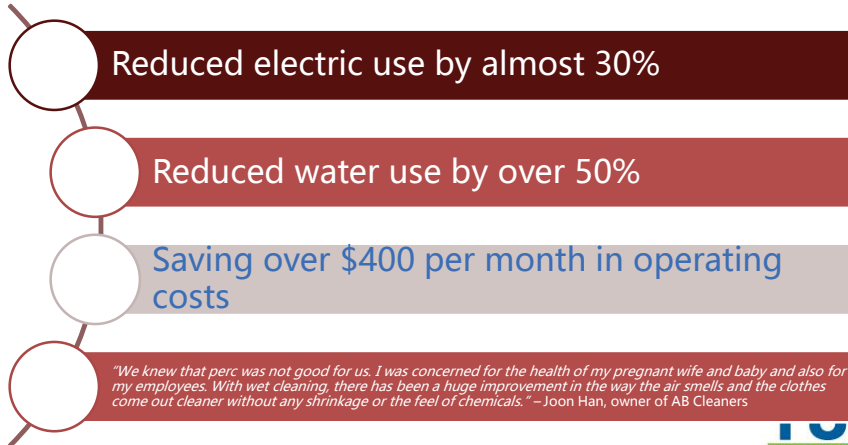
- Cleaners save money on solvent, waste, water, and electricity
- Cleaners are fully satisfied with the process and product; there is less regulatory oversight and risk of contamination
- The work environment is greatly improved
- Customers are very pleased with quality



## KMK Cleaners in Walpole Creates Healthier Workplace



## AB Cleaners in Westwood Creates Safer Work Environment with Improved Quality



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