

## Human Health Hazard, Environmental Hazard/Impact, and Physical Hazard of Different Professional Apparel Cleaning Technologies

### Perchloroethylene Dry Cleaning

#### *Human Health Hazard*

- Possible carcinogen<sup>1</sup>
- Liver toxin<sup>2</sup>
- Kidney toxin<sup>3</sup>
- Neuro toxin<sup>4</sup>
- Developmental toxin<sup>5</sup>
- Reproductive toxin<sup>6</sup>
- Effluent Guidelines: Toxic Pollutant<sup>7</sup>
- Water Quality Criteria: Priority Pollutant<sup>8</sup>
- Classification in California as a Toxic Air Contaminant<sup>9</sup>
- Classification in the US Federal Clean Air Act as a Hazardous Air Pollutants<sup>10</sup>







#### *Environmental Hazard/Impact*

- Persistent in water, soils, air, sediments<sup>11</sup>
- Moderate aquatic toxicity<sup>12</sup>
- Energy intensive<sup>13</sup>

#### Physical Hazard/Regulations

- N/A

#### *Overall Health/Environment/Physical Hazard Ranking*

- TURI: Perc Dry Cleaning = 5 (1=best & 5=worst) /  (  =best &  =worst)<sup>14</sup>
- SFDE: Perc Dry Cleaning = 4 (1=best & 4=worst) /  (  =best&  =worst)<sup>15</sup>

#### *Non-Toxic/Non Smog-Forming Classification*

- California Air Resources Board regulation of perchloroethylene as a Toxic Air Contaminant phased out use as dry clean solvent by 2023.<sup>16</sup>

## Petroleum/Hydrocarbon Dry Cleaning (e.g. DF2000™)

### *Human Health Hazard*<sup>17</sup>

- Hazardous material (OSHA)<sup>18</sup>
- Neuro toxin<sup>19</sup>
- Possible reproductive toxin<sup>20</sup>
- Eye irritant<sup>21</sup>
- Skin irritant<sup>22</sup>
- Respiratory irritant<sup>23</sup>
- Respiratory irritation (from ozone)<sup>24</sup>
- Asthma (from ozone)<sup>25</sup>
- Premature death (from ozone)<sup>26</sup>
- Hazardous classification -- OSHA<sup>27</sup>







### *Environmental Hazard/Impact*

- Smog forming<sup>28</sup>
- Global warming potential<sup>29</sup>
- Moderately persistent in sediment<sup>30</sup>
- Moderate bioaccumulation<sup>31</sup>
- Highly toxic to the aquatic environment<sup>32</sup>
- Energy intensive<sup>33</sup>

### *Physical Hazard/Regulations*

- Flammable/Combustible Liquid<sup>34</sup>
- Fire Hazard<sup>35</sup>

### *Overall Health/Environment/Physical Hazard Ranking*

- TURI: Petroleum/Hydrocarbon Dry Cleaning = 3 (1=best & 5=worst) /  (  =best &  =worst)<sup>36</sup>
- SFDE: Petroleum/Hydrocarbon Dry Cleaning = 3 (1=best & 4=worst) /  (  =best &  = worst)<sup>37</sup>

### *Non-Toxic/Non Smog-Forming Classification*

- "A detrimental and secondary health effect of the alternative solvents is that all hydrocarbon solvents are considered volatile organic compounds (VOC). VOCs contribute to the formation of ozone which is linked to many ill-health effects including respiratory irritation, asthma, and premature death. VOC emitting systems require air permits."<sup>38</sup>
- Decision by the California Air Resources Board for hydrocarbon solvents to be excluded from list of *Approved Non-toxic and Non-smog-forming Dry Cleaning Technologies*<sup>39</sup>

## Siloxane D5 (Decamethylcyclopentasiloxane) Dry Cleaning (Green Earth™)

### *Human Health Hazard*

- “Concerns for potential carcinogenicity relevant to humans”<sup>40</sup>
- “Some evidence of potential effects of D5 on the reproductive system”<sup>41</sup>
- “Effects on the liver, immune, and nervous systems”<sup>42</sup>
- “Disruption of dopaminergic pathways by D5 could have adverse health impacts on the nervous system (e.g., possible psychological imbalance).”<sup>43</sup>
- “The substance may be toxic to liver.”<sup>44</sup>
- “Repeated or prolonged exposure to the substance can produce target organs damage.”<sup>45</sup>
- “Prolonged or repeated ingestion may affect the liver (changes in liver weight, increase in liver metabolizing enzymes, transient increase in the number of normal cells (hyperplasia), increase in cell size (hypertrophy). blood (changes in spleen).”<sup>46</sup>
- “This product contains methylpolysiloxanes which can generate formaldehyde at approximately 300 degrees Fahrenheit (150°C) and above, in atmospheres which contain oxygen. Formaldehyde is a skin and respiratory sensitizer, eye and throat irritant, acute toxicant, and potential cancer hazard.”<sup>47</sup> (Note: In dry cleaning, to evaporate the solvent during each dry cycle and during each distillation cycle, D5 is heated to its boiling point of 410 °F in the presence of oxygen, which is above the 300 °F threshold where formaldehyde is created).<sup>48</sup>
- Hazardous classification – OSHA<sup>49</sup>
- Recommended exposure limit of 10 ppm TWA<sup>50</sup>
- “Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value.”<sup>51</sup>
- “Use a vapor respirator under conditions where exposure to the substance is apparent (e.g. generation of high concentrations of mist or vapor, inadequate ventilation, development of respiratory tract irritation), and engineering controls are not feasible.”<sup>52</sup>
- “Widespread exposure to D5, a dopamine agonist, has potential public health impacts”<sup>53</sup>
- Skin irritant<sup>54</sup>
- Eye irritant<sup>55</sup>
- Respiratory irritant<sup>56</sup>
- Ingestion irritant<sup>57</sup>







### *Environmental Hazard/Impact*

- Priority Chemical listed in California Environmental Contaminant Biomonitoring Program<sup>58</sup>
- Persistence<sup>59</sup>
- Bioaccumulation<sup>60</sup>
- Toxicity in fish<sup>61</sup>
- Energy intensive<sup>62</sup>

### *Physical Hazard*

- Flammable/Combustible Liquid<sup>63</sup>
- Fire Hazard<sup>64</sup>

### *Overall Health/Environment/Physical Hazard Ranking*

- TURI: Green Earth™ (D5) Dry Cleaning =4 (1=best & 5=worst) /  (  =best &  = worst)<sup>65</sup>
- SFDE: Green Earth™ (D5) Dry Cleaning =3 (1=best & 4=worst) /  (  =best &  = worst)<sup>66</sup>

*Non-Toxic Classification*

- “OEHHA cannot make a finding at this time that D5 is non-toxic”<sup>67</sup>
- Decision by the California Air Resources Board for D5 to be excluded from list of *Approved Non-toxic and Non-smog-forming Dry Cleaning Technologies*<sup>68</sup>
- “SEHSC does not disagree with CARB’s decision on D5 under AB998....”<sup>69</sup>

## N-Propyl Bromide Dry Cleaning

### *Human Health Hazard*

- “Reasonably anticipated to be a human carcinogen.”<sup>70</sup>
- Neuro toxin<sup>71</sup>
- Reproductive toxin<sup>72</sup>
- Eye irritant<sup>73</sup>
- Skin irritant<sup>74</sup>
- Respiratory irritant<sup>75</sup>
- “The substance may be toxic to blood, liver, central nervous system (CNS).”<sup>76</sup>
- “Repeated or prolonged exposure to the substance can produce target organs damage.”<sup>77</sup>
- Listed under Proposition 65 as a reproductive toxicant<sup>78</sup>







### *Environmental Hazard/Impact*

- Energy intensive<sup>79</sup>

### *Physical Hazard/Regulations*

- Flammable<sup>80</sup>
- Fire Hazard<sup>81</sup>

### *Overall Health/Environment/Physical Hazard Ranking*

- TURI: n-PB Dry Cleaning =5 (1=best & 5=worst)/  (  = best &  = worst)<sup>82</sup>
- SFDE: n-PB Dry Cleaning=4 (1=best & 4=worst)/  (  = best &  = worst)<sup>83</sup>

### *Non-Toxic Classification*

- Decision by the California Air Resources Board for n-propyl bromide to be excluded from list of *Approved Non-toxic and Non-smog-forming Dry Cleaning Technologies*<sup>84</sup>

## Professional Wet Cleaning

### *Human Health Hazard*

- “The United States Environmental Protection Agency examined the human health and environmental hazards of the primary components of detergents and found no expected health risks to the general public.”<sup>85</sup>







### *Environmental Hazard/Impact*

- “The United States Environmental Protection Agency examined the human health and environmental hazards of the primary components of detergents and found no expected health risks to the general public.”<sup>86</sup>
- Energy-efficient.<sup>87</sup>

### *Physical Hazard/Regulations*

- N/A

### *Overall Health/Environment/Physical Hazard Ranking*

- TURI: Professional Wet Cleaning =1 (1=best & 5=worst) /  (  = best &  =worst) <sup>88</sup>
- SFDE: Professional Wet Cleaning =1 (1=best & 4=worst) /  (  = best &  = worst) <sup>89</sup>

### *Non-Toxic Classification*

- Decision by CARB to be included on list of *Approved Non-toxic and Non-smog-forming Dry Cleaning Technologies*<sup>90</sup>
- “These systems qualify for grant money under California’s Non-Toxic Dry Cleaning Incentive Program, established by Assembly Bill (AB) 998.”<sup>91</sup>

## CO<sub>2</sub> Dry Cleaning

### *Human Health Hazard*

- “There is no expected health risk to the general public from these processes.”<sup>92</sup>







### *Environmental Hazard/Impact*

- “Questions have been raised because CO<sub>2</sub> is a greenhouse gas which contributes to global warming. Although the amount of emissions from dry cleaning processes have not been studied, the CO<sub>2</sub> used in the dry cleaning processes is a by-product from industrial operations and therefore does not contribute to the greenhouse gas inventory.”<sup>93</sup>

### *Physical Hazard/Regulations*

- Fire Permit

### *Overall Health/Environment/Physical Hazard Ranking*

- TURI: CO<sub>2</sub> Dry Cleaning =2 (1=best & 5=worst) /  (  = best &  = worst)<sup>94</sup>
- SFDE: CO<sub>2</sub> Dry Cleaning =2 (1=best & 4=worst) /  (  = best &  = worst)<sup>95</sup>

### *Non-Toxic Classification*

- Decision by CARB to be included on list of *Approved Non-toxic and Non-smog-forming Dry Cleaning Technologies*<sup>96</sup>
- “These systems qualify for grant money under California’s Non-Toxic Dry Cleaning Incentive Program, established by Assembly Bill (AB) 998.”<sup>97</sup>

Toxic Use Reduction Institute: Summary Table Comparison of Perc and Seven Garment Cleaning Alternatives<sup>98</sup>

| Key Assessment Criteria |  | Perc (reference)              | Wet Cleaning                  | Carbon Dioxide         | High Flash point Hydro-carbons | Acetal                        | Propylene Glycol Ethers        | D5 Siloxane                       | n-Propyl Bromide                                   |
|-------------------------|--|-------------------------------|-------------------------------|------------------------|--------------------------------|-------------------------------|--------------------------------|-----------------------------------|--|
| Environmental           | Persistence (water, soil, sediment and/or 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                                | Low                           | Low                           | NA                     | Moderate                       | Low                           | Low                            | Moderate                          | Low  |
|                         | Aquatic toxicity                               | Moderate                      | Low to Moderate               | Low                    | High                           | Moderate                      | Low                            | High                              | High   |
| Human Health            | Recommended exposure limits                    | 25 ppm                        | NE                            | 5000 ppm               | 100 ppm                        | NE                            | NE                             | 10 ppm                            | 10 ppm   |
|                         | Central nervous system effects                 | Yes                           | No                            | No                     | Yes                            | No data available             | Yes                            | Some Evidence                     | Yes  |
|                         | Carcinogenicity                                | 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            |
|                         | Reproductive/developmental toxicity            | Yes                           | Negligible                    | No data available      | No data available              | No data available             | No                             | Studies indicate concern          | Yes  |
| Physical Safety         | 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 or 72°F (Flammability dependent on test method) |





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



|  | Technology <sup>1</sup>  | Total Annual Cost (for first 5 years) <sup>2</sup> | 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 Considerations  |
|--|--|--|---|---|---|--|---|
|  | PROFESSIONAL WET CLEANING  | \$20,926   | • None identified   | N/A   | • Detergent, spotters should be chosen to minimize environmental concerns<br>• Possible annual fee for hazardous material storage (if >55 gal hazardous detergent stored on site)     | N/A  | • CARB offers \$10,000 grants for conversion (AB 998)   |
|  | CO <sub>2</sub> cleaning <sup>3</sup>  | \$58,881   | • None identified   | N/A   | • Possible annual fee based on volume of CO <sub>2</sub> gas stored on site   | • SFFD operational permit and annual licensing fee required<br>• Use of Class I alkane co-solvent prohibited per CA Fire Code 1204.1   | • CARB's offers \$10,000 grants for conversion (AB 998)<br>• Machine must be maintained to avoid CO <sub>2</sub> leaks              |
|  | Hydrocarbon solvents:<br>• DF-2000™<br>• EcoSolv®<br>• Shell Sol<br>• PureDry® | \$27,755 - \$28,535                                | • Neurotoxicity, eye, skin and respiratory irritation<br>• Potential concerns for persistence and aquatic toxicity<br>• Complex mixtures which may contain other ingredients of concern   | • Regulated under BAAQMD Rule 8-17<br>• Closed-loop machine required<br>• Registration required<br>• Permit required if >200 gal/yr gross solvent used              | • Annual fee for hazardous waste generated<br>• Annual fee for hazardous material storage (>55 gal stored on site) & compressed gas storage (if >200 ft <sup>3</sup> N <sub>2</sub> ) | • SFFD operational permit and annual licensing fee required<br>• Combustible liquid (Class IIIA)<br>• Ventilation, automatic sprinkler system, fire extinguishers as specified in Fire Code Ch 12              | • Emits smog forming volatile organic compounds (VOCs)  |
|  | GreenEarth® (DE) solvent   | \$32,718   | • Suspected carcinogen, reproductive toxin<br>• Liver, immune and nervous system effects<br>• Persistent in environment, detected in fish   | • Regulated under BAAQMD Rule 8-17<br>• Closed-loop machine required<br>• Registration required<br>• Permit required if >200 gal/yr gross solvent used              | • Annual fee for hazardous waste generated<br>• Annual fee for hazardous material storage (>55 gal stored on site)  | • SFFD operational permit and annual licensing fee required<br>• Combustible liquid (Class IIIA) <sup>4</sup><br>• Ventilation, automatic sprinkler system, fire extinguishers as specified in Fire Code Ch 12 | —   |
|  | CO <sub>2</sub> cleaning <sup>3</sup> 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 <sub>2</sub> gas stored on site   | • SFFD operational permit and annual licensing fee required<br>• Use of Class I alkane co-solvent prohibited per CA Fire Code 1204.1   | • Machine must be maintained to avoid CO <sub>2</sub> leaks   |
|  | Rynes™ solvent   | \$26,220   | • Chemical identity withheld as trade secret<br>• Primary ingredient likely to be dipropylene glycol t-butyl ether (DGBTBE)<br>• DGBTBE structurally related to a listed Proposition 65 carcinogen and predicted to be persistent | • Regulated under BAAQMD Rule 8-17<br>• Closed-loop machine required<br>• Registration required<br>• Permit required if >200 gal/yr gross solvent used              | • Annual fee for hazardous waste generated<br>• Annual fee for hazardous material storage (>55 gal stored on site)  | • SFFD operational permit and annual licensing fee required<br>• Combustible liquid (Class IIIB)<br>• Ventilation, automatic sprinkler system, fire extinguishers as specified in Fire Code Ch 12              | • Emits smog forming VOCs<br>• Complete assessment not possible without information on identity and hazards of chemical ingredients |
|  | Hydrocarbon solvent:<br>Stoddard solvent blend                                 | \$28,308   | • Contains aromatic hydrocarbons (e.g. benzene, a carcinogen)<br>• Neurotoxic, eye, skin and respiratory irritation<br>• Potential concerns for bioaccumulation and aquatic toxicity  | • Regulated under BAAQMD Rule 8-17<br>• Closed-loop machine required<br>• Registration required<br>• Permit required if >200 gal/yr gross solvent used              | • Annual fee for hazardous waste generated<br>• Annual fee for hazardous material storage (>55 gal stored on site)  | • SFFD operational permit and annual licensing fee required<br>• Combustible liquid (Class II)<br>• 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)<br>• Liver and kidney effects<br>• Neurotoxic, eye, skin and respiratory irritation<br>• Persistent in the environment  | • Regulated under BAAQMD Rule 11-16<br>• Secondary control technology required<br>• Registration required<br>• Permit required<br>• Mandatory phase out in progress | • Annual fee for hazardous waste generated<br>• Annual fee for hazardous material storage (>55 gal stored on site)  | N/A  | —   |
|  | t-Propyl bromide   | —  | • Male and female reproductive toxicant and developmental toxicant (California's Proposition 65 list)<br>• Neurotoxic, eye, skin and respiratory irritation   | • Regulated under BAAQMD Rule 11-16<br>• Secondary control technology required<br>• Registration required<br>• Permit required                                      | • Annual fee for hazardous waste generated<br>• Annual fee for hazardous material storage (>55 gal stored on site)  | • ILLEGAL per CA Fire Code 1204.1<br>• Flammable liquid (Class I), NFPA rating 3   | • Use without sufficient stabilizer likely to cause corrosion and damage to cleaning equipment <sup>5</sup>                         |

<sup>1</sup>Green Jet refreshing technology can be used to supplement an existing professional wet or dry cleaning machine: [www.drywetcleaning.com](http://www.drywetcleaning.com)

<sup>2</sup>This technology uses reclaimed CO<sub>2</sub>, so no new greenhouse gases are generated.

<sup>3</sup>Cost/year for first 5 yrs based on machine, solvent, detergent, spotting agent, electricity, natural gas, waste disposal, filter/gasket, maintenance costs (CARB, 2006)

<sup>4</sup>Class determined based on flash point listed in MSDS for each solvent

<sup>5</sup>Wotr, Katy. 2006. n-Propyl Bromide Destroys Equipment in Dry Cleaning Plant. <http://irta.us/>

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- <sup>1</sup> EPA. Integrated Risk Information System (IRIS): Toxicological Review of Tetrachloroethylene (Perchloroethylene). (February 2012) (EPA/635/R-08/011F); EPA Cleaner Technologies Substitute Assessment: Professional Fabricare Processes.(June 1998) (EPA-744-B-001)
- <sup>2</sup> EPA IRIS (February 2012); EPA CTSA (June 1998)
- <sup>3</sup> EPA IRIS (February 2012); EPA CTSA (June 1998)
- <sup>4</sup> EPA IRIS (February 2012); EPA CTSA (June 1998)
- <sup>5</sup> EPA IRIS (February 2012); EPA CTSA (June 1998)
- <sup>6</sup> EPA IRIS (February 2012); EPA CTSA (June 1998)
- <sup>7</sup> Toxic Use Reduction Institute (TURI). Assessment of Alternatives to Perchloroethylene for the Dry Cleaning Industry: Methods and Policy Report No. 27. (June 2012)
- <sup>8</sup> TURI (June 2012), p.8.
- <sup>9</sup> California Toxic Air Contaminant Program (Assembly Bill 1807: HSC sections 39660-39662).
- <sup>10</sup> Federal Clean Air Act (42 U.S.C. 7412).
- <sup>11</sup> EPA CTSA (June 1998), p.8-22; TURI (June 2012), USEPA PBT 2006; EU RA 2005, European Chemicals Bureau. EU Risk Assessment Report: Tetrachloroethylene, Part 1: Environment, Vo 57, 2005.
- <sup>12</sup> Shubat, P. J., et al. "Acute toxicity of tetrachloroethylene and tetrachloroethylene with dimethylformamide to rainbow trout (*Salmo gairdneri*)." *Bulletin of environmental contamination and toxicology* 28.1 (1982): 7-10.
- <sup>13</sup> Sinsheimer, Peter. (February 19, 2009). *Comparison of Electricity and Natural Gas Use of Five Garment Care Technologies* (ET 05.01 Final Report). Design and Engineering Series.
- <sup>14</sup> TURI (June 2012), p. 43-44.
- <sup>15</sup> San Francisco Department of the Environment (2007). Comparison of Hazards, Regulatory Concerns, and Costs for Alternative Dry Cleaning Technologies. [https://sfenvironment.org/sites/default/files/fliers/files/sfe\\_th\\_dry\\_cleaning\\_alternatives\\_assessment.pdf](https://sfenvironment.org/sites/default/files/fliers/files/sfe_th_dry_cleaning_alternatives_assessment.pdf) (access August 15, 2017)
- <sup>16</sup> California Code of Regulation: Airborne Toxic Control Measure (ATCM) for Emissions of Perchloroethylene from Dry Cleaning and Water-Repelling Operations Amendment to Section 93109, Titles 17 (December 27, 2007). entitled See <https://www.arb.ca.gov/toxics/dryclean/reginfo.htm>; ARB Regulatory Advisory: Perc Dry Cleaning (January 2008) <https://www.arb.ca.gov/toxics/dryclean/PercadvisJan08E.pdf>
- <sup>17</sup> TURI (June 2012) used the following CAS number for the environmental health and safety assessment: 68551-17-7 (C10-13 Isoparaffin) (Chevron 2011) and 64742-48-9 (Naphtha (petroleum), hydrotreated heavy) (Exxon-Mobil 2010)
- <sup>18</sup> DF2000 Material Data Safety Sheet. This material is considered hazardous in accordance with OSHA HazCom 2012, 29 CFR 1910.1200. (May 30, 2017)
- <sup>19</sup> EPA CTSA (June 1998), p. 3-3; TURI (2012), p.19,
- <sup>20</sup> ECHA, August 1, 2017 Access date: August 1, 2017. <https://echa.europa.eu/registration-dossier/-/registered-dossier/15475/2/1>
- <sup>21</sup> EPA CTSA (June 1998)
- <sup>22</sup> EPA CTSA (June 1998)
- <sup>23</sup> EPA CTSA (June 1998)
- <sup>24</sup> California Air Resources Board (September 4, 2015). *Alternative Solvents: Health and Environmental Impacts*. ([https://www.arb.ca.gov/toxics/dryclean/notice2015\\_alt\\_solvents.pdf](https://www.arb.ca.gov/toxics/dryclean/notice2015_alt_solvents.pdf))
- <sup>25</sup> California Air Resources Board (September 4, 2015). *Alternative Solvents: Health and Environmental Impacts*. ([https://www.arb.ca.gov/toxics/dryclean/notice2015\\_alt\\_solvents.pdf](https://www.arb.ca.gov/toxics/dryclean/notice2015_alt_solvents.pdf))
- <sup>26</sup> California Air Resources Board (September 4, 2015). *Alternative Solvents: Health and Environmental Impacts*. ([https://www.arb.ca.gov/toxics/dryclean/notice2015\\_alt\\_solvents.pdf](https://www.arb.ca.gov/toxics/dryclean/notice2015_alt_solvents.pdf))
- <sup>27</sup> DF2000 Material Data Safety Sheet. This material is considered hazardous in accordance with OSHA HazCom 2012, 29 CFR 1910.1200. (May 30, 2017)
- <sup>28</sup> EPA CTSA (June 1998), p. 5-35
- <sup>29</sup> EPA CTSA (June 1998), p. 5-35

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- <sup>30</sup> TURI (June 2012), USEPA PBT Profiler 68551-17-7 (C10-13 Isoparaffin), last updated on August 1, 2017, accessed at <http://www.pbtprofiler.net/Results.asp>
- <sup>31</sup> TURI (June 2012), USEPA PBT Profiler 68551-17-7 (C10-13 Isoparaffin), last updated on August 1, 2017, accessed at <http://www.pbtprofiler.net/Results.asp>
- <sup>32</sup> TURI (June 2012), USEPA PBT Profiler 68551-17-7 (C10-13 Isoparaffin), last updated on August 1, 2017, accessed at <http://www.pbtprofiler.net/Results.asp>
- <sup>33</sup> Sinsheimer, Peter. (February 19, 2009). *Comparison of Electricity and Natural Gas Use of Five Garment Care Technologies* (ET 05.01 Final Report). Design and Engineering Series.
- <sup>34</sup> ExxonMobil (May 30, 2017) DF2000 Safety Data Sheet. (from <http://www.msds.exxonmobil.com/IntApps/psims/SearchResults.aspx> (August 15, 2017 access))
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