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POLLUTION PREVENTION AS A REGULATORY TOOL IN CALIFORNIA: BREAKING BARRIERS AND BUILDING BRIDGES

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Traditional environmental regulation, which relies largely upon pollution control strategies to capture and treat pollution, is costly for government and business alike, and often simply transfers pollution from one environmental media to another (OTA, 1994). Pollution prevention is an alternative approach that attacks pollution at the source by minimizing or even eliminating the creation of pollution in the first instance¹ (Gottlieb, et al., 1995). One form of pollution prevention is the use of "clean technology," defined as a technology or process that generates less waste or emissions than the norm (Allen, 1995). The adoption of a clean technology requires at least two steps: the initial technological innovation followed by the diffusion of the new technology across the relevant industry sector or sectors (Stewart, 1981; Ashford, et al., 1985).

Progress in the development and diffusion of clean technologies across the nation has been relatively slow. Policymakers have generally not integrated pollution prevention into mainstream regulatory programs (Geiser, 1995). The dry cleaning industry is a particularly striking example of this phenomenon. Professional drycleaners currently use perchloroethylene (PCE), a toxic chemical, as the predominant cleaning solvent. One non-toxic alternative cleaning technology, known as "professional wet cleaning," has been demonstrated to be technically and financially viable. Yet cleaners have failed to adopt wet cleaning despite various voluntary incentive programs intended to encourage its diffusion. At present, there are three "dedicated" wet cleaners in the South Coast region (i.e., shops using wet cleaning as their sole cleaning technology), and less than 40 dedicated wet cleaners across the nation (USEPA, 1999). In Southern California, the South Coast Air Quality Management District (SCAQMD) appears to be moving toward a more aggressive strategy. SCAQMD staff is drafting proposed regulations that would phase out PCE dry cleaning within eighteen years.

This study uses the case of the dry cleaning sector in the South Coast region to explore how policymakers can encourage the diffusion of clean technologies. More specifically, it asks (1) what have been critical barriers to diffusion of wet cleaning and (2) what types policy tools could overcome those barriers? The dry cleaning case is useful because the technology in question--wet cleaning--has been demonstrated to be both technically viable and economically competitive with the dominant technology. This fact simplifies the analysis by essentially equalizing the two technologies from an economic perspective, and concentrating on "pure" issues of diffusion. The jurisdictional focus on the South Coast is appropriate because the sustained attention to the issue by regulators, commentators and industry actors in that region provides a rich source of information.

Technology choices of individual professional cleaners are influenced by other actors (such as suppliers, employees, customers, or competitors) and institutions (such as an existing regulatory system or a set of industry standards). Regulatory policy that is designed without this network or “system” of actors and institutions in mind will often ignore significant interests and influences of the relevant system, and consequently fail to produce the behavior it seeks.² We used a mixed methodology to collect and analyze empirical information concerning the dry cleaning sector, including a random sample survey of dry cleaners in Southern California, semi-structured interviews and participant observation.

Section II describes the conceptual model of the “professional cleaning” system developed from this information, and evaluates the operation of the system. Using the system model, Section III evaluates a series of policy tools that could be deployed to encourage diffusion, including increased enforcement of existing regulations, use of financial incentives, and a prohibition on PCE dry cleaning. Section IV sets forth a recommended strategy for accelerating diffusion of wet cleaning, and describes areas for further research concerning potential longer-term institutional changes.

System Model for the Professional Cleaning System

This section describes the system model for the professional cleaning system, set forth graphically in Figure 1 of Appendix B. There are three major components or “subsystems” within the system: the garment care industry itself; manufacturers and distributors of cleaning equipment and solvents; and government regulators.³ The section begins with a brief overview of the cleaning technologies in question.

Petroleum Dry Cleaning

Like penicillin and the telephone, dry cleaning was discovered by accident. In the early nineteenth century, Jean Baptiste Jolly noticed that some spilled kerosene dissolved a stain on his tablecloth. Hydrocarbon solvents dominated the dry cleaning market from that time through the 1950s. Concerns about flammability coupled with the availability of PCE as an alternative led to a sharp decline in petroleum dry cleaning beginning in the 1960s. More recently, increased regulation of PCE, improvements in equipment, and the introduction of less flammable petroleum solvents and synthetic petroleum solvents have led to increased interest in petroleum dry cleaning. Today, approximately 15% of dry cleaners use petroleum-based solvents (USEPA, 1998).

Petroleum dry cleaning causes air emissions, and generates wastewaters and hazardous and solid wastes for disposal. Petroleum solvents are not classified as toxic compounds, and thus do not raise concerns regarding cancer risks. They are volatile organic compounds, however, and thus contribute to the formation of ground level ozone (or “smog”), a substantial concern in the South Coast region. Like PCE dry cleaning, petroleum dry cleaning is subject to extensive environmental regulation.

PCE Dry Cleaning

In the 1940s, PCE was shown to be effective for garment cleaning. Because PCE was not considered a fire hazard, professional cleaners—mostly small neighborhood shops—sprang up in commercial and residential areas eventually dominating the industry. Currently in the United States, 85% of the more than 35,000 professional cleaners use PCE as their primary cleaning solvent (USEPA, 1998)

Dry cleaners can expose humans and the environment to PCE through releases of PCE and PCE-contaminated wastes to soil, groundwater and surface water, and through air emissions inside and outside of the cleaning facility from equipment vents and leaks. Effects of chronic exposure to PCE include dizziness, impaired judgment and perception, liver and kidney damage, respiratory disease, neurotoxicity, and reproductive and developmental toxicity (NIOSH, 1997). PCE has been classified as a probable human carcinogen by the International Agency for Research on Cancer (IARC, 1995) and as a potential human carcinogen by the National Institute of Occupational Safety & Health (NIOSH, 1997).

Professional Wet Cleaning

In the early 1990s, equipment vendors developed professional wet cleaning systems consisting of computer-controlled washers and dryers, specially formulated detergents, and specialized finishing equipment to create a cost-effective alternative to dry cleaning. Prior to 1995, shrinkage of wet-cleaned garments limited the variety and number of garments that could be wet cleaned. However, specialized tensioning pressing machines are now used to restore garments to their original form without harming them. Operation of these presses requires greater skill than conventional dry cleaning presses.

Beginning in the mid-1990s, various researchers performed a series of case studies of professional wet cleaning shops (Environment Canada, 1995; Patton & Eyring, 1996; PPERC, 1997; Sinsheimer, et al., 2000; Star & Ewing, 2000). In terms of performance (or cleaning abilities), professional wet cleaners were successfully able to clean the full range of garments normally taken to a dry cleaner. They also encountered few problem garments they were unable to clean successfully, and generated a high level of customer satisfaction with the cleaning process. In terms of financial viability, the cost of purchasing professional wet clean equipment was lower than for dry cleaning, while overall operating expenses were comparable. In terms of environmental impact, no environmental concerns were identified for dedicated wet cleaning operations, and a substantial benefit resulted from elimination of PCE use.

Liquid Carbon Dioxide Cleaning

Liquid carbon dioxide (CO₂) has also been introduced as an alternative solvent for garment cleaning. By placing gaseous CO₂ under pressure, the necessary equipment makes it a liquid with solvent properties (DeRosa, 2001).⁴ CO₂ machines are quite expensive. The typical cost estimate for the purchase and installation of a CO₂ machine is \$150,000. However, cleaners purchasing a machine from Micell, the leading manufacturer, must also pay costs associated with obtaining a franchise from Micell, which can raise capital costs to between \$500,000 to \$800,000 (U.S. House, Fisher Testimony, 2000). There is currently one plant in the South Coast utilizing a CO₂ machine (SCAQMD, 2001).

Silicone Solvent Cleaning

General Electric has introduced a new silicone-based dry cleaning solvent, marketed under the name Green Earth™. The distributor of Green Earth™ technology has tested it in forty sites across the country, and states that Green Earth™ shops are being established at a rate of 1-2 per week (Douglas, 2001). The Green Earth™ process uses a cyclopentasiloxane mixture, which is considered neither a volatile organic compound (VOC) nor a toxic air contaminant. However, these siloxanes have been identified by SCAQMD as compounds which "may be restricted in the future because they are either toxic, upper-atmosphere ozone depleters, or cause other environmental impacts" (SCAQMD Rule 102). General Electric is currently performing some form of toxicity testing, but has not yet released results of the testing (Douglas, 2001). Researchers have raised concerns about wastes potentially generated in the production of the siloxanes (dioxin and other organochlorine compounds) and from the breakdown of used solvent (formaldehyde) (DeRosa, 2001).

The Garment Care Industry Sector

The professional cleaning industry is a highly decentralized sector. There are approximately 36,000 dry cleaning shops nationwide, generating approximately \$7.2 billion in revenues each year (USEPA, 1998). Of these, approximately 2,618 operate in California (U.S. Census Bureau, 1997). The vast majority of cleaners in the United States and California are very small neighborhood businesses at which cleaning and finishing are performed on the premises. Most cleaners have fewer than 10 employees and report gross revenues of less than \$100,000 (USEPA, 1995). Individuals of Korean background represent a large portion of professional cleaners in the United States, especially prevalent in large cities like Los Angeles and Chicago. In California, as many as 50% of the shops are owned or operated by Koreans (Sinsheimer, et al., 2000).

There are national, state and regional dry cleaner trade organizations. The International Fabricare Institute (IFI) is the dominant national organization for the garment care industry, claiming a membership roster of 10,000. IFI employs 60 full-time staff and has an environmental staff of three. The California Cleaners Association has a membership of 1,000, and is affiliated with the Greater Los Angeles Dry Cleaning Association. Korean cleaning associations have also been formed as a consequence of increased ownership of facilities by Korean-Americans. The Korean Dry Cleaners and Launderers Association operates in the greater Los Angeles area.

Attitudes and Interactions of Sub-System Participants

We conducted a random sample survey of 202 dry cleaners located in the greater Los Angeles region in the Spring 2001. The results, which are reported below, are accurate to $\pm 3.5\%$ at a confidence interval of 95%. (See Appendix A for a discussion of the survey methodology design. A copy of the survey instrument can be obtained from the authors.)

Attitudes Towards Wet Cleaning Technology

To assess basic knowledge of professional wet cleaning, cleaners were first asked about their familiarity with different cleaning technologies. While almost all cleaners were stated they were very familiar with PCE machines (93%), significantly less were familiar with the other

technologies – 21% for wet cleaning, 19% for petroleum, 14% for carbon dioxide, and 9% for Green Earth™.

Cleaners were then read a list of different cleaning technologies and asked what machine they would purchase if they needed to replace their cleaning machine today. Over three-quarters (79%) selected a PCE machine as their first choice. The second most common response was from the 8% of cleaners who stated that they did not know. Wet cleaning and petroleum dry cleaning were the first choices of 5% and 4% of the cleaners, respectively. Wet cleaning and petroleum dry cleaning fare somewhat better as second choices. When asked to identify which technology would be their second choice, of those cleaners with a preference, 20% would select wet cleaning and 30% would choose petroleum dry cleaning.

Dry cleaners' concern about professional wet cleaning primarily centered on performance and operational issues. We asked cleaners to identify concerns or worries they had about wet cleaning. Combining the cleaners' biggest and second biggest concerns, the four leading issues were: shrinkage, damage, or harm to garments (72%), takes too long (27%), customers won't like it/lose business (11%), and expensive/cost too much (9%). Studies of professional wet cleaning shops indicate that these performance and operational issues do not prevent the use of wet cleaning as an effective, commercially viable substitute for dry cleaning. For example, it is clear very few wet cleaned garments have suffered irreparable shrinkage, damage or harm. (Patton & Eyring, 1996; Star & Ewing, 2000; PPERC, 1997; Sinsheimer, et al., 2000). Likewise, several demonstration projects have documented high customer retention of customers using a wet cleaning shop at least one time (Sinsheimer, 2000; Star & Ewing, 2000; PPERC, 1997).⁵

After initial attitudes towards professional wet cleaning were assessed, cleaners were provided both positive and negative facts about wet cleaning including: the ability to clean the full range of garments without damage, the increased processing time, the lack of regulation, the need for comprehensive training, and the availability of wet cleaning systems. After hearing this information, the percentage of cleaners that would probably or definitely consider wet cleaning machines as a replacement technology rose from 14% to 24%. The percentage of cleaners who would probably or definitely not consider wet cleaning dropped from 81% to 66%.

External Factors Influencing a Technology Shift

The survey addresses three factors external to the garment industry sub-system that could influence technology choice by dry cleaners: technical training, government regulation, and financial incentives.

Technical Training. Dry cleaners appear to view the availability of comprehensive training to be a critical factor in judging whether they can run a successful dry cleaning shop. In our survey, cleaners were asked about their degree of confidence in operating a successful wet cleaning facility *assuming they received proper training*. Three-quarters (75%) stated that with proper training they would be somewhat to very confident in operating a successful wet cleaning facility, with over half (51%) stated that they were very confident. Only 9% stated that they were not confident at all.

The centrality of comprehensive technical training to a successful switch to wet cleaning was echoed by dry cleaners who have toured wet cleaning facilities. In a survey of 29 dry cleaners who attended such tours in 1999-2000, 61% of the cleaners felt they needed more information about technical training before making a decision about wet cleaning. Moreover, 71% of the cleaners felt that free technical training would be extremely or very important in their decision to purchase wet cleaning equipment (Sinsheimer, et al., 2000).

Government regulation. Government regulation clearly plays a large role in many aspects of the cleaners' world. When asked what was the most important problem facing cleaners in the region, nearly half (48%) identified environmental regulation. This general concern with environmental regulation carries through to technology choice. Four in ten (42%) cleaners stated that, in the past, government regulations were extremely important in their decisions about purchasing dry cleaning equipment. Strict enforcement appears to increase the influence that regulation plays in technology choice. Seventy-five percent of the cleaners stated that increased enforcement was extremely important in their decision to purchase new equipment in the future.

Financial Incentives. Dry cleaners were asked about two financial incentive programs partially subsidizing the purchase of professional wet cleaning equipment. The first was a reimbursement program under which the cleaner would receive a cash rebate ranging from 10% to 50% of the cost of the wet cleaning system. The second was an income tax credit in the amount of 50% of the purchase price, valued at \$17,500. Cleaners were asked what difference each program would make in their purchasing decisions.

With respect to the reimbursement program, the number of cleaners who were more likely to purchase wet cleaning equipment increased as the size of the reimbursement rose. Only 10% of the cleaners were either much more or somewhat more likely to purchase wet cleaning equipment when a \$3,500 reimbursement was offered. When the reimbursement was changed to \$10,500 and then to \$17,500, that percentage rose to 15% and 28% respectively.⁶ A closer look at the \$17,500 rebate provides some interesting results. The possibility of a \$17,500 rebate made no difference to 50% of the cleaners, and for 13% of the cleaners made the purchase of wet cleaning equipment *less* likely.⁷

Results for the tax credit were similar. The question asked whether a tax credit of up to \$17,500 (which equals 50% of the cost of wet cleaning equipment) would make the respondents more likely to consider wet cleaning. Thirty percent of the cleaners were more likely to purchase wet cleaning systems when offered a \$17,500 tax credit.⁸ The tax credit would make no difference to 30% of the cleaners, more than 80% of whom previously stated that they would not consider wet cleaning as a purchase option. There was one notable difference between the \$17,500 tax credit and the \$17,500 rebate: for a significantly higher percentage of cleaners (37%) the tax credit made consideration of wet cleaning *less* likely.

The Market Structure

To understand the market structure for equipment and supply vendors in the sector, one must first understand what cleaners actually use in their process. Dry cleaners typically have two types of cleaning machines: commercial laundry machines (used for cotton shirts, linens and similar garments) and dry cleaning machines. The two types of cleaning machines are manufactured by two different sets of companies.

Because the garment care industry is dominated by PCE dry cleaners, until recently most professional cleaning equipment sold has been PCE dry cleaning systems. As new petroleum-based solvents and silicone-based solvents have emerged, manufacturers of PCE-based equipment have modified their equipment to create machines capable of using these newer solvents (Douglas, 2001).

Interestingly, none of the PCE machine manufacturers have developed wet cleaning systems. Rather, wet cleaning systems have a different pedigree than PCE and petroleum dry cleaning machines. Wet cleaning systems are produced by manufacturers of industrial and domestic laundry systems – including Miele, Electrolux (manufacturer of the Aqua Clean system), and IPSO (manufacturer of Aquatex system). In the United States, the two wet clean manufacturers (Unimac and Pellerin Milnor Corporation) are leading industrial laundry equipment manufacturers. With the exception of Miele, the vast majority of equipment sales for each of these firms are of industrial laundry systems (Eisenberg, 2000; Goldman 2000).

Six companies currently distribute wet cleaning systems in the United States. Each of these firms either manufactures or distributes other types of cleaning equipment. For example, Wascomat, the exclusive United States distributor of Aqua Clean systems, claims to be the world's largest manufacturer of industrial laundry equipment. Likewise, Bowe Permac, a distributor of Swiss-made Schulthess wet cleaning systems, manufactures and sells PCE, petroleum and silicone systems (Tipps, 2000; American Drycleaner, September 2001).

Attitudes and Interactions of Sub-System Participants

Fifty-one percent of the cleaners surveyed consider equipment suppliers to be very important source of information about cleaning technology. Thus, vendors are in a position to influence technology choice. One might expect that wet cleaning vendors would have a strong financial incentive to market their products to dry cleaners aggressively. Yet the market structure of this subsystem creates disincentives that may slow the diffusion of wet cleaning, and that could affect the outcomes flowing from several of the potential regulatory tools.

Wet cleaning equipment manufacturers and their distributors do not market wet cleaning equipment aggressively. In part, this may result from the position of wet cleaning within the manufacturing companies. In most of these companies, the production of industrial and, in some cases, domestic laundry systems dwarfs the production of wet cleaning equipment in terms of volume and importance to the company (Goldman, 2000; Trevigne, 2000). For another leading wet cleaning manufacturer, Bowe Permac, the vast majority of equipment sales are its dry cleaning systems (Tipps, 2000). Indeed, Miele, a German company without a strong presence in the United States market, is the only firm in which the majority of sales professional cleaning machines are for wet cleaning systems (Shaeffer, 2000)

Manufacturing or distributing more than one type of cleaning system (laundry or dry cleaning) appears to influence the extent to which firms promote their wet cleaning systems in the marketplace. For example, at Bowe Permac, which markets its equipment directly, sales agents are paid on commission, and are therefore more motivated to sell dry clean systems because such systems are both more expensive and easier to sell than the wet cleaning systems Bowe Permac distributes (Tipps, 2000). For firms distributing both wet cleaning and laundry equipment, only Wascomat (the U.S. distributor of Aqua Clean equipment) actively promotes the wet cleaning system (Goldman, 2000). Yet even Wascomat promotes its wet cleaning equipment as a "supplement" to dry cleaning, selling the majority of its Aqua Clean system to "mixed" shops that have both wet and dry cleaning machines (Goldman, 2000).

The Regulatory Sub-System

The dry cleaning industry is regulated by a variety of local, state and federal agencies under a number of programs. For purposes of this case study, the South Coast Air Quality Management District (SCAQMD) and its regulations covering PCE are the most influential. For that reason, the following section focuses on SCAQMD. The first part of this Section presents an overview of the relevant SCAQMD regulation and a brief description of the organizational structure of the agency, respectively. The third part uses results of interviews with SCAQMD staff to evaluate how interactions within SCAQMD and between SCAQMD and outside actors affect the diffusion of wet cleaning.

Overview of Agency and Regulations

SCAQMD is one of many regional air quality control agencies established by the California Health and Safety Code. It is directed by a Governing Board with support of a professional staff. Its staff functions are organized into a number of offices, including Science and Technology Advancement; Planning, Rule Development, and Area Sources; Engineering and Compliance; and District Prosecutor. Much of SCAQMD's work is directed at establishing and implementing rules governing the type and amount of air emissions that can be released by sources in the region. The rules are often incorporated into operating permits issued by SCAQMD, and enforced by its inspectors and prosecutors. SCAQMD also has a technology advancement function.

Rule 1421 is SCAQMD's source specific regulation for PCE dry cleaning.⁹ The rule sets forth design and performance standards for PCE machines, and supercedes both California's and Federal rules applicable to PCE dry cleaning.¹⁰ It essentially requires that cleaners use specific types of machines equipped with emissions controls. Rule 1421 also includes training, monitoring and record-keeping requirements intended to ensure that the emission controls are operated and maintained properly. For example, cleaners must check for PCE emissions from the cleaning equipment weekly using handheld monitoring equipment, and repair most leaks within twenty-four hours of detection. Likewise, cleaners must keep track of and record PCE usage, the amount of garments cleaned, maintenance performed on the machines, and other operating information.

Attitudes and Interactions of Sub-System Participants

Theoretically, there are several paths by which SCAQMD could accelerate the diffusion of wet cleaning. Commentators on innovation have identified the permitting, enforcement, and rule making functions as likely catalysts for diffusion of clean technology (Jaffe, et al., 2000; Blackman, 1999). However, our interviews and document review suggest that in the case of the dry cleaning sector, only the technology advancement and rule development functions have significant potential to act as diffusion catalysts.

The Science and Technology Advancement Office (TAO). TAO is charged with assisting in the development and demonstration of new technologies. It was formed by SCAQMD in 1988 in response to an ominous situation: air quality in the Los Angeles air basin was so bad that new emission reduction technologies would be needed to attain the National Ambient Air Quality Standards. Initially, TAO focused on spawning and demonstrating new technologies that reduced emissions of smog-forming compounds. More recently, TAO has expanded its efforts to include toxic-reducing technologies. (Liu, 2001).

In the case of process-changing technologies such as wet cleaning, TAO's mission includes developing acceptance of the technology within the affected industry. The focus on acceptance results from two related factors. First, the Governing Board applies a higher standard to technology demonstrations for process-changing technologies than to demonstrations for add-on control technologies. This closer scrutiny is further heightened where the technology affects small businesses. Second, TAO staff has less expertise in process-related technologies than in control technologies, a disquieting situation in light of the Governing Board's desire for more certainty that the technology will work on an industry-wide scale. Acceptance by the industry itself can provide the Governing Board with the assurance it requires (Liu, 2001).

TAO played a significant role in supporting studies of the viability and commercialization of wet cleaning. From 1995 to the present, TAO assisted in the funding of (1) the first professional wet cleaning demonstration facility in California, (2) a technical assistance project designed to educate cleaners in the South Coast region about professional wet cleaning, and (3) a grant program to assist eight dry cleaners interested in switching to professional wet cleaning (PPER, 1997; Sinsheimer, et al., 2000). However, our interviews revealed no formal mechanism by which the results of the studies are communicated to staff and management of other SCAQMD divisions. In addition, there appears to be no formal procedure within TAO by which technical advancements such as wet cleaning or other clean technologies are certified or otherwise declared to be commercially viable.

Permitting Division. Conceptually, the permitting division could encourage voluntary diffusion through dissemination of technical information during the permitting process. Permitting staff often use the pre-construction permitting process to provide potential permit applicants with technical information concerning new pollution control technologies (Mills, 2000). However, such a pre-application consultation procedure has not been consistently or aggressively used by staff to disseminate information concerning wet cleaning.

Permitting staff is directed not to get involved in business decisions of the permit applicants. Choices about process changes (as opposed to choices about pollution control

technology) are considered business decisions. As one manager put it, “It’s not really our place. We just make sure they comply with the rules” (Mills, 2001). Moreover, in the dry cleaning industry, the firms have often already purchased cleaning machines before they contact permitting staff (Pupka, 2000). In fact, in many cases, the application is prepared and submitted by the equipment vendor, and permitting staff may have no contact at all with the dry cleaner prior to the issuance of the permit (Mills, 2000). Thus, there would be no opportunity to discuss alternatives even if staff were inclined to do so.

The Enforcement Function. The enforcement function is performed by two separate offices: the compliance office (located in Engineering and Compliance) and the District Prosecutor’s Office. Conceptually, the enforcement function could encourage diffusion in two ways. First, stringent enforcement can increase the cost of using existing technology, either by imposing penalties directly for noncompliance or by increasing compliance expenditures by firms in response to the increased risk of detection (Jaffe, et al. 2000). In theory, the drive to maximize profits should trigger a cost-effective search for innovative technologies that minimize compliance costs. Second, enforcement personnel can increase diffusion by using settlement agreements known as “supplemental enforcement projects” (SEP) to reduce monetary penalties for those firms that agree to invest in an alternative clean technology (Strasser, 1997). In the case of the dry cleaning sector, neither of these two pathways has produced any increase in the use of wet cleaning.

In reality, the costs of compliance do not appear to be a significant driver of innovation among dry cleaners.¹¹ This is due in some measure to the fact that most cleaners do not actually incur the full amount of those costs. Compliance audits of drycleaners conducted in five urban areas between 1996 and 1999 revealed astonishing levels of noncompliance with Rule 1421 and similar rules in other jurisdictions. As Table 1 shows, non-compliance rates ranged between 79 and 98% percent, and the percentage of facilities that had PCE emissions or discharges was between 22% and 67%.

Table 1
Compliance Audit Results

Location and Year	Source	Number of Facilities Inspected	Number of Facilities in Compliance	Rate of Noncompliance	Percentage of Facilities with PCE Leaks
Sacramento 1996	(CARB, 1997)	30	4	87%	60%
South Coast 1997	SCAQMD, 1997)	208	21	90%	22%
South Coast 1999	(Pupka, 1999)	340	17	95%	35%
Bay Area 1998	(CARB, 1998)	41	9	79%	67%
New York 1998	(Drycleaner News,	200	3	98%	No measurements

Location and Year	Source	Number of Facilities Inspected	Number of Facilities in Compliance	Rate of Noncompliance	Percentage of Facilities with PCE Leaks
	1999)				
Massachusetts 1998	(Drycleaner News, 1998)	100	6	94%	No measurements

Historically, the low compliance rates in the South Coast can be traced to at least two factors. First, as a result of reductions in SCAQMD's enforcement budget, between 1994 and 2000 most of the South Coast's dry cleaners went for five years or more without an inspection (Pupka, 2000). Second, the consequences of noncompliance with Rule 1421 are often minimal.¹² Between October 2000 and March 2001, the penalties paid by individual dry cleaning facilities ranged between just \$50.00 and \$400.00.

The financial incentives associated with SEPs have been no more effective in encouraging the use of clean technologies. To date, SCAQMD has not used SEPs to encourage the diffusion of wet cleaning, or any other clean technology.¹³ (Mieras, 2000). (In fact, in the only case in which a penalty against a dry cleaner was reduced in recognition of a technology purchase, M&M Cleaners spent \$50,000 on a PCE machine (Sernel, 2001).) There are at least two factors that contribute to the dearth of clean technology SEPs. The first, most obvious factor is economic: even complete elimination of a penalty of between \$50 to \$400 does not financially justify the purchase of a \$35,000 wet cleaning system.

The second factor is organizational. Penalty negotiations are conducted on behalf of the SCAQMD by the District Prosecutor's office, a part of the agency that is largely unconnected with the agency's technology development and rule-making activities. Consequently, even though SCAQMD played a large role in demonstrating wet cleaning's viability, members of the District Prosecutor's Office were unaware of the potential use of wet cleaning in SEPs (Mieras, 2000; Sernel, 2001). Those personnel who are aware of wet cleaning obtained that information more by chance rather than design (Feldman, 2001).

The Rule Development Division. The Rule Development Division is scheduled to submit revisions of Rule 1421 to the SCAQMD Governing Board in January of 2002. The Rule Development Division considers the Rule 1421 revisions to be one of SCAQMD's highest priorities, and one of its most controversial proceedings (Broadbent, 2000). As of this writing, Rule Development is proposing to gradually phase out PCE cleaning systems by 2018 or later (SCAQMD, PAR 1421; SCAQMD, 2001a).

Prior to proposing the amendments to Rule 1421, Rule Development managers expected to encounter significant resistance to a phase out of PCE, both outside of and within SCAQMD. They believed that industry resistance would flow from a general distrust of SCAQMD statements concerning the cost-effectiveness of wet cleaning, and from general reluctance to accept change as profound as a switch of basic process equipment. Moreover, they felt that dry

cleaners simply were not convinced that wet cleaning actually works (Whynot, 2000). Their predictions were correct. At the first public meeting on the proposal, there was vehement opposition to the phase-out by individual cleaners and several of their trade organizations.

Rule Development managers traced resistance within SCAQMD to two factors. One factor is the pervasive view of rule-making among staff and the Governing Board as an exercise in risk management, which manifests itself as a search for cost-effective control equipment that can reduce risk to a defined level. Managers pointed to the recently promulgated diesel fleet rule as an example of the bias toward pollution control. In those proceedings, in the face of mounting scientific evidence of the dangerous nature of diesel truck and bus emissions and the availability of alternative clean technologies, SCAQMD still relied upon a traditional pollution control strategy rather than eliminating the use of diesel fuel (Broadbent, 2000). The organizational focus on pollution control is bolstered by a second related factor: a reluctance among SCAQMD staff and the Governing Board to directly affect the production processes of the regulated industries. (Whynot, 2000)

Evaluation of Policy Tools

Commentators on pollution prevention and innovation have identified a number of policy tools for encouraging diffusion of new technologies. Using the professional cleaning system model described in Section II as a guide, this section evaluates seven of these policy tools, and sets forth a recommended combination of policy tools for this case. Ultimately, the policy tool or tools selected by the policymakers should meet four minimum criteria:

- First and most obvious, the tool must actually cause cleaners to switch away from PCE use.
- The tool should also create a shift toward a clean technology. Eliminating the use of PCE in professional cleaning would not necessarily eradicate all undesirable impacts from the sector. For example, large numbers of cleaners could switch to petroleum dry cleaning, causing an increase in smog-forming hydrocarbon emissions.
- The tool should create the technology shift as soon as possible. PCE emissions from dry cleaning operations are a major source of toxic exposures in the urban environment. SCAQMD's Air Toxics Control Plan calls for a 95% reduction in PCE emissions by 2010 (SCAQMD, 2001).
- Subject to the criteria listed above, the social benefits of using the tool should outweigh the social costs of its use.

Natural Diffusion

Natural diffusion is a "no action" strategy under which policymakers would not intervene to assist in diffusion of wet cleaning. Existing permitting procedures and current enforcement efforts would remain unchanged. Based on the survey results and interviews, it is unlikely that broad adoption of wet cleaning will result from natural diffusion in the foreseeable future for several reasons.

It is doubtful that cleaners will adopt wet cleaning absent some external influences, either from vendors, regulators, or customers. The cleaning sector exhibits high levels of concern and misinformation concerning wet cleaning that are not overcome by the perceived benefits of the new technology. From the cleaner's perspective, the major benefits of wet cleaning (such as reduced toxic pollution) accrue to workers or the general public rather than to the cleaner. The economic value of other benefits (such as reduced regulation and lower capital costs) is in effect offset by increased labor costs and longer cleaning times. Moreover, the switch to wet cleaning involves potentially high one-time costs; namely, the risk of failure and cost of learning a new technology. Thus, the fact that wet cleaning can perform as well as the existing technology at similar operating and capital costs is not enough to cause a switch. Given these one-time costs, wet cleaning must either be significantly better in some way or must be supported by an external incentive of some form.

There is little evidence that the vendors of wet cleaning equipment and supplies will provide that external influence. Given the structure of the market for professional cleaning equipment, most vendors have no strong economic incentive to encourage the diffusion of wet cleaning. For many, wet cleaning is a small part of broader product lines that cater to dry cleaners. Indeed some actors within the vendor sector perceive their economic interest as linked to the continued dominance of dry cleaning. Moreover, government permitting and enforcement activities have led to virtually no growth in wet cleaning, a fact that is unlikely to change absent substantial revisions of current enforcement policies.¹⁴

Demonstration Projects/Education

Education, particularly in the form of technology demonstration projects, can assist policymakers and industry alike in resolving uncertainties about the commercial viability of a new technology. In the South Coast, such projects led SCAQMD's rule development staff to conclude that wet cleaning is a viable alternative to dry cleaning. The survey indicates that cleaners lack complete and accurate information concerning wet cleaning, and that they are skeptical about its technical and financial viability. Research in innovation suggests that demonstration projects and education campaigns can be effective tools in overcoming such barriers (Jaffe, et al, 2000; Blackman, 1999). However, the structure of the sector, the relationship between regulators and industry, and the adoption costs make it unlikely that demonstration projects alone can achieve widespread diffusion of wet cleaning at a reasonable cost.

The professional cleaning industry is highly decentralized and dominated by small, thinly staffed plants. This creates practical problems in disseminating the necessary information, both in reaching all the cleaners and assuring that they allocate some of their limited attention to the information. Moreover, cleaners may be highly skeptical of information disseminated by regulators or contractors hired by the regulators (OTA, 1994; Feldman, 2001). In our survey, only 23% of the cleaners considered information from government regulators concerning cleaning technologies to be very important. Almost 40% of the cleaners found such government information to be not important at all.¹⁵

Even if the information reaches the cleaners, the adoption costs of the new technology may prevent many of them from switching. As discussed above, switching to wet cleaning requires the cleaner to learn a new process, leaving behind the familiar and reliable routines and knowledge the cleaner relied upon to sustain the business. In our survey, the fact that a number of facilities are successfully wet cleaning made only 8% of the cleaners much more likely to consider wet cleaning in their next purchase.¹⁶ In a prior survey of dry cleaners who had toured a wet cleaning shop, only 28% of the respondents found the tour to be extremely or very influential in future decisions about whether to wet clean (Sinsheimer, et al. 2000).

Technical Training and Assistance

Like dry cleaning, quality wet cleaning requires both technical knowledge and acquired skills. Once a cleaner decides to (or is forced to) incur the burden and take the risk, comprehensive training and technical assistance are critical to a successful technology switch. However, standing alone, training and assistance simply provide no affirmative incentive to undertake the burden and risk in the first place. Training and technical support may be more useful when used in combination with other policy tools by minimizing the intangible adoption costs associated with wet cleaning. For example, training and technical support can reduce the cost of economic incentives; presumably the more secure cleaners feel about their ability to succeed with a new technology, the less financial persuasion they will need to switch to that technology.

Increased Enforcement

At least as currently structured, increased enforcement is not likely to result in increased diffusion of wet cleaning. For reasons quite apart from its effect on diffusion, it is also unlikely that SCAQMD would be willing to modify its existing enforcement approach.

The level of penalties typically imposed by SCAQMD is simply too low to create sufficient incentive to switch to wet cleaning for most cleaners. While penalty levels certainly could be increased so as to trigger greater diffusion, this would require a substantial change in SCAQMD policy and regulations.¹⁷ The low penalty numbers reflect the broader compliance assistance approach taken by SCAQMD towards *all* small businesses under which regulators attempt to educate operators about the existing rules, and gently "nudge" them into compliance (Pupka, 2000).

Second, even if the penalty levels were increased, the "paperwork-based," self-reporting nature of Rule 1421 itself is a barrier to the effective use of enforcement as diffusion catalyst. As written, Rule 1421 (and its state and federal counterparts) impose complicated maintenance and inspection requirements on the cleaners and then require extensive record-keeping and reporting to demonstrate compliance. Inspectors largely rely upon the cleaner's records to determine compliance with much of the regulations. It is extremely difficult and time-consuming for inspectors to determine if the reported maintenance and inspections were actually performed. For example, one experienced inspector noted that in nine years of inspecting dry cleaners, he had yet to see one facility that recorded a PCE leak from their equipment (Rascke, 2001). Since comprehensive inspection of cleaners' compliance with substantive emission limitations is costly and resource intensive, it is rarely done. Thus, when the self-reporting form of regulation is coupled with limited enforcement resources in this industry sector, it raises the

specter of widespread noncompliance and under-reporting, and ultimately excess emissions. The enforcement audits listed in Table 1 provide a glimpse of this problem, identifying a large number of facilities with PCE leaks.

Third, standing alone, increased enforcement provides no incentive for cleaners to adopt a clean technology such as wet cleaning. A cleaner seeking to reduce the risk of increased penalties could switch to petroleum or silicone solvents.

Solvent Taxes or Fees

Regulators could also attempt to raise the costs of dry cleaning through an excise tax or fee on the purchase of PCE, thus inducing a technology switch. At least ten states have adopted PCE taxes, ranging from \$3.50/gallon (Illinois) to \$10.00/gallon (Oregon) (State Coalition for Drycleaner Remediation, 2001). However, the fees are not designed to cause a technology shift, but rather to fund the cleanup of contaminated dry cleaner sites. In many of the states having such fees, the participating dry cleaners are released from cleanup liability in exchange for both paying the fee and using upgraded PCE dry cleaning equipment and procedures (State Coalition for Drycleaner Remediation, 2001). Thus, rather than encouraging a shift to alternative technologies, these programs may actually provide incentives for the *continued* use of dry cleaning processes.

Even an excise tax program that does not provide a liability waiver may be of very limited use as a catalyst for diffusion. The annual cost of purchasing PCE is relatively small for most dry cleaners. For a shop processing 200 garments per day (the median daily amount for cleaners in our survey), annual solvent costs would be approximately \$850.¹⁸ Even applying the largest existing tax of \$10/gallon to such a shop would raise total solvent costs by approximately \$1,300. The present value of such payments over a ten-year horizon is approximately \$9,200. This tax may simply be too small to cause a technology switch. In our survey, most cleaners found a rebate of almost \$11,000 insufficient enticement to consider wet cleaning.¹⁹

Of course, the tax could be raised until the cost of PCE overcomes the barriers to diffusion, but it appears that the level would have to be quite high. Between 1996 and 2001, the solvent tax in Oregon gradually rose from \$10 to almost \$27/gallon. Yet PCE continued to be the overwhelmingly dominant solvent; there is only one dedicated wet cleaner in Oregon (Glendening, 2001). Moreover, as the amount of the tax increases, so too do the problems of enforcing it. Rather than switching to alternative technologies, many cleaners may avoid the tax by obtaining “black market” PCE. (See Glendening, 2001; McClaren, 1998).²⁰ Indeed, professional cleaners and state officials report that in states with existing PCE taxes for remediation programs, black markets for PCE already exist (Douglas, 2001; Dry Cleaner Advisory Committee, 2000).

Increasing the tax also raises the costs to government. As the size of the tax and rates of noncompliance rise, the cost of enforcing the tax also increases (Dry Cleaner Advisory Committee, 2000). More importantly, significantly higher PCE taxes will face significant political challenges. In Oregon, a proposal to increase the PCE tax from approximately \$27 to \$30 caused a profound legislative reaction; the statute was changed to instead cap the tax at \$10/gallon (Glendening, 2001). There is reason to believe that there would be strong opposition in California as well. In 1995, a state dry cleaner trade group sponsored legislation creating a

\$20 gallon PCE tax with an associated liability waiver for cleaners. The group withdrew the legislation in the face of withering opposition from PCE manufacturers, environmentalists, and dry cleaners themselves (Wall Street Journal, 1996).

Thus, an excise tax on PCE is unlikely to cause a switch away from PCE. Moreover, even if it successfully moves cleaners away from PCE, a PCE tax provides no incentive for a move to clean technologies, unless the tax is linked with some other tool such as excise taxes on other solvents or a tax credit directed at a particular technology or set of technologies.²¹

Financial Incentives

Financial incentives such as direct subsidies, tax subsidies (including tax credits, sale tax exemptions, or accelerated depreciation), and low interest loans all attempt to encourage diffusion by decreasing the costs of the alternative technology (Lake, 1997; Catterall & Levin, 1982). Numerous states have adopted tax credit programs to encourage pollution prevention generally²² (Lake, 1997). Oregon had a pilot tax credit program intended to reduce dry cleaners' usage of PCE,²³ and similar tax credit bills have been proposed at the California state and federal level.²⁴ Given the prevalence of the tax credit as a financial incentive, this section will focus primarily on tax credits. It begins with an overview of the Oregon program, followed by analysis of (1) the need for a credit, and (2) the likely effectiveness of a credit.

Oregon Tax Credit Program

The Oregon Pollution Prevention Tax Credit Program was a four-year pilot program available to several industry sectors from 1996 through 1999.²⁵ A dry cleaner installing equipment that reduced annual PCE usage to less than 140 gallons/year was eligible for a credit against income or corporate excise tax equal to 50% of the equipment cost.

The Oregon credit was not widely used by any of the eligible business sectors. Although credits valued at \$2.6 million dollars were available, almost 2 million dollars remained unclaimed at the end of the program. Among dry cleaners, only 24 of the 330 eligible cleaners in Oregon took advantage of it. Of those 24 cleaners, only five purchased wet cleaning equipment. Most cleaners instead purchased either advanced PCE machines (12 cleaners) or petroleum machines (7 cleaners) (Oregon DEQ, 2001).

It does not appear that the tax credit played a significant role in the technology choices of most cleaners in Oregon, *including* those cleaners who took advantage of it. In responding to a question included in the tax credit application form, almost all of the applicants indicated that they would have made their purchase even absent the tax credit (Kauth, 2001). Nor did the credit appear to significantly affect technology choices of cleaners purchasing wet cleaning systems. During the four-year life of the credit program, nine cleaners purchased wet cleaning systems without seeking the benefits of the tax credit (Glendening, 2001).

Assessing the Need for a Tax Credit

Tax credits (and financial incentives in general) can serve at least three purposes. They may be used to temporarily offset a price advantage held by the existing technology until the alternative technology becomes more competitive.²⁶ (Hoerner, 1995). Alternatively, they may

provide an artificial cost advantage to a new technology. Lastly, such incentives are sometimes used to spread the cost of regulation more broadly across society, thus easing the financial burden imposed on regulated entities. None of these purposes justifies use of a tax credit for wet cleaning.

In the early stages of diffusion, new technologies are often more expensive than conventional technologies (Lake, 1997). Consequently, a tax credit can be used to offset the cost advantage of the dominant technology. For example, the proposed federal tax credit for dry cleaners was cast as a temporary measure designed to reduce costs of new technologies until economies of scale acted to permanently reduce those costs (U.S. House, 2000, statement of Rep. Camp). This justification is misapplied to wet cleaning because wet cleaning systems are already comparable to the dominant technology in cost. There is simply no need to use a tax credit to make wet cleaning more affordable for cleaners.²⁷

Of course, a tax credit could be used to give wet cleaning a clear cost advantage, so as to overcome obstacles other than the capital or operating costs of the technology. Although the lack of information, the risk of failure, and the burden of learning a new technology are not easily quantified, it is likely that some level of economic incentive could encourage a majority of cleaners to pay attention to and ultimately choose wet cleaning. Given the results of our survey, and the experience in Oregon, it appears that the incentive would have to be extremely large, making a tax credit quite expensive, perhaps prohibitively so. Both the survey and the Oregon pilot suggest that even a 50% tax credit for capital costs fails to generate significant diffusion of wet cleaning.

Tax credits can also serve to reallocate the social costs of regulation, spreading a portion of the financial burden of regulation otherwise borne by individual business across society more generally²⁸ (Barthold, 1994). For example, depending upon how quickly a prohibition takes effect, cleaners with fairly new PCE machines may suffer a significant financial burden if they are unable to recover some or all of their investment in the PCE machine. For these purposes, the usefulness a tax credit depends upon the type and extent of financial burdens imposed by the regulation upon the affected cleaners.

Assessing the Effectiveness of Tax Credits

Assuming that some form of financial incentive is desirable, is a tax credit an effective vehicle for delivering the incentive? Based on historical experience as well as surveys and interviews, tax credits are of uncertain value. Eligible businesses generally underutilize tax credits and other tax-related incentives concerning pollution prevention. In a study of tax subsidies in Germany, the Organization for Economic Cooperation and Development (OECD) found that firms typically apply for tax subsidies for environmental expenditures only when other regulations require the firms to undertake the expenditures (OECD, 1989). This finding is consistent with the results of Oregon's tax credit pilot program, in which the majority of cleaners applied for the credit in response to tightened regulations requiring replacement of their existing PCE machines (Kauth, 2001; Golden & Morlino, 1999).

The dry cleaning sector presents several challenges to the use of tax credits. First, as small, cash-basis businesses with thin margins, dry cleaners tend to report relatively low levels of

taxable income, which is directly related to their tax liability (Golden & Morlino, 1999; Glendening, 2001). A tax credit, even one spread over several years, is useless if the cleaner has no tax liability from which a tax credit can be subtracted (See Toder, 2000).²⁹

A credit may also exacerbate fears among cleaners who are cautious in their dealings with government regulators, and particularly with the revenue agencies. By claiming tax credits, cleaners are inviting government attention to their businesses, a potentially risky step for anyone who views regulators with distrust. In assessing the result of the Oregon program, one official believed the uneasy relationship with government regulators as one potential cause for the low usage of the program (Golden & Morlino, 1999). Cleaners who report low taxable income may be reluctant to call attention to themselves by claiming a tax credit.

Beyond the challenges created by the nature of dry cleaning industry sector, and need for information, the need for administrative simplicity also affects the efficacy of tax credits.³⁰ As typically implemented, a tax credit requires the filing of a form after the purchase and installation of the affected equipment. The mere obligation to complete and file the form can be a surprisingly powerful obstacle, particularly in an industry sector dominated by very small businesses often run by first generation immigrants. In addition, the actual cash benefit is received well after the cash expenditure is made, making it less attractive to businesses operating on a marginal cash flow.³¹

Prohibition on PCE Use

As discussed in Section I, regulators have traditionally relied upon pollution control and risk management rather than pollution prevention to address environmental and health concerns raised by industrial activities. Accordingly, product or process bans are fairly uncommon.³² Federal regulators have banned the use of a limited number of products, such as polychlorinated biphenols (PCBs), DDT, and CFCs for general use. Recently federal and state air quality regulators have prohibited the use of various toxic air contaminants for specific uses, and in each case identified alternative products that were available for the same use. For example, in 2000, the California Air Resources Board prohibited the use of PCE and two other toxic compounds in automotive consumer products after 2002 based on its judgment that non-chlorinated alternatives are widely available and are as equally effective (CARB, 2000).

A prohibition on PCE dry cleaning, if pursued by the SCAQMD staff and ultimately approved by the Governing Board, would be an effective tool to switch cleaners away from PCE. Unlike implementation and enforcement of the current operating, maintenance and inspection requirements in Rule 1421, enforcement of a prohibition would be relatively straightforward and inexpensive. Presumably, regulators can identify virtually all PCE cleaners through its permitting database. Inspectors need only check the shops after the effective dates to ensure that PCE machines or solvents are not in use. After the transition is complete, ongoing implementation costs will be low.

In concept, a prohibition could cause the technology shift to occur immediately. However, in most cases some period for a phase-out is provided. A phase-out period can play an equitable role, balancing the need to reduce health and environmental impacts against the social

costs of a ban.³³ The capital and operating costs of wet cleaning are comparable to those of PCE dry cleaning. Thus, for a new cleaner there is no significant capital cost associated with a ban. In contrast, existing dry cleaners may incur a substantial economic burden, depending upon whether or not they have recovered their investment in the PCE equipment at the time the prohibition takes effect. A phase-out allows temporary continued use of the PCE equipment, reducing that economic loss. A phase-out also can also reduce opposition to the prohibition within and outside government, making the measure more palatable and allowing additional time for the sector to grow more comfortable with the alternative technologies.³⁴

Successful implementation of a prohibition with a phase-out period may actually be in the economic interest of vendors of PCE equipment and supplies, with the exception of PCE solvent vendors. From an inventory perspective, PCE equipment vendors have a short-term interest in supporting a phase-out period during which inventory could be reduced. Moreover, many of the vendors also sell alternative equipment and supplies (including petroleum and wet cleaning systems). From the perspective of future sales growth, the prohibition would increase capital turnover rates among dry cleaners during and at the end of the phase-out period, and thus increase vendor sales. PCE solvent vendors have no similar long-term interests as they do not sell products that are compatible with the alternative technologies. Interestingly, at SCAQMD's public meeting on its proposal, a large PCE distributor and the PCE solvent manufacturers' trade group spoke out against the proposed prohibition. No PCE equipment manufacturers or distributors presented comments.

Standing alone, however, a prohibition on PCE equipment does not direct the industry towards clean technologies. For example, as drafted, the SCAQMD proposal specifically identifies petroleum dry cleaning as an approved alternative technology. Although existing petroleum and synthetic petroleum solvents do not contain any listed toxic air contaminants, they are sources of volatile organic compound (VOC) emissions and other wastes and industrial wastewaters.

Recommendations and Further Research

This section set forth short-term recommendations regarding the diffusion of wet cleaning in California, identifying a combination of policy tools that could fuel more general adoption of this zero emission technology. It also describes longer-term institutional changes for further study.

Short-Term Recommendations

Based upon the evaluation of the system model described above, we recommend using combination of policy tools, staged over a period of ten years, to increase the diffusion of wet cleaning and other clean alternatives to dry cleaning. The tools include: a phased-in prohibition on PCE dry cleaning, subsidized technical training, tracking of dry cleaner technology choices, and support of third party financial incentives.

1. Prohibition on PCE Dry Cleaning

A prohibition on the use of PCE dry cleaning is the most effective tool available to move cleaners away from that technology. Neither enforcement of existing regulations nor imposition of an excise tax would be effective. Standing alone, positive economic incentives such as tax

credits or subsidies would create a windfall for cleaners who would switch to wet cleaning even absent the incentive, and would likely have no or little influence on the vast majority of cleaners who view wet cleaning unfavorably.

The prohibition would apply immediately to all new facilities, and to any replacement machines purchased by existing cleaners after the effective date of the regulation. That regulation should contain a phase-out period for PCE machines currently operated by existing cleaners. Any existing cleaner would be required to replace its PCE machine within ten years from date the machine was first placed in service, or by 2011, whichever is sooner. The floating ten-year period should even out the rate of replacement across the phase-out period, preventing the “bunching” of replacements that might otherwise occur at the end of the period.

The ten-year period represents a reasonable estimate of the life span of typical dry cleaning systems. Commentators have identified a range of “average” life spans ranging from eight to fifteen years.³⁵ (See U.S. House, 2000, Fisher testimony; USEPA, 1998; PPERC, 1997). In identifying ten years, we focused on how long machines can be maintained and operated properly. It is likely that a facility, particularly a small one with limited cash flow, would attempt to keep a machine for as long as possible, putting off expensive repairs and using the machine even beyond the point that its emission controls will operate effectively. Based on interviews of PCE machine distributors, repair technicians, and a dry cleaner consultant performed by PPERC in 1997, it appears that ten years is an appropriate time period.³⁶

2. Training and Technical Assistance

Policymakers should also consider providing support for comprehensive training and ongoing technical assistance. The government obviously has an interest in ensuring proper training of wet cleaners. The widespread failure of wet cleaners would have serious implications for policy relating to PCE reduction, and for active promotion of clean technology in general. Moreover, training could encourage former PCE dry cleaners to select wet cleaning rather than petroleum cleaning. Our survey suggests that if PCE is removed as a choice, wet cleaning runs a close second to petroleum as the replacement technology among cleaners with a preference. Cleaners are cautious about wet cleaning because of, among other things, the need to learn a new technology. Guaranteed training and subsequent technical assistance could encourage cleaners to pursue an innovative technology, much as agricultural experimentation stations established by the federal government encouraged farmers to try new techniques and technologies (DeCanio, 1993).

Currently, training offered by manufacturers is generally limited, both in scope and duration, and there is little ongoing technical assistance offered. After a prohibition is in place, it is likely that manufacturers will eventually respond with broader training and technical assistance. Thus, policymakers may wish to limit the number of years that a training program is available, treating the program as a catalyst for creating technical assistance infrastructure within a region.

Training and technical assistance could be delivered by a variety of vehicles, including direct provision of services by the government, payment of a subsidy or tax benefit to the cleaner to cover the costs of training, or subsidization of vendors’ costs in providing enhanced training.

Given the general skepticism with which many regulated entities view government assistance, and the limited capacities of the regulatory agencies, the direct provision of training by the government is unlikely to succeed. As discussed in Section III, tax benefits raise issues concerning paperwork burdens and distrust of government. A subsidy, paid either to the cleaner directly or to the vendor in return for no-cost or reduced-cost training and technical assistance, is best suited for these purposes.

3. Tracking of Technology Choices

A prohibition on PCE use provides no direct incentive to choose a clean technology such as wet cleaning over petroleum dry cleaning, a polluting technology that directly contributes to the smog problem in Southern California. It is unclear just how many cleaners would choose petroleum cleaning over dry cleaning however. Regulators should track cleaners' technology choices over the first two years of the phase out. At the end of that period, SCAQMD can assess the impact of the prohibition on technology choice, and take further action if required. Petroleum dry cleaning systems require permits, making tracking them relatively straightforward.³⁷

4. Support of Third Party Financial Incentives

As noted above, a tax credit is of doubtful value in this sector for several reasons. At the margins, however, some form of financial incentive may be helpful to support movement to wet cleaning in response to a prohibition. Many of the problems with tax credits, such the administrative and paperwork requirements and distrust of government, could be avoided if the economic incentive comes from a third party. For example, there are two programs that could be used to provide financial benefits for cleaners choosing wet cleaning: rebates for use of energy-efficient equipment and reduced rates for workers' compensation insurance.

Public utilities currently offer rebates for businesses that purchase energy-efficient technology (Southern California Edison, 2001; Southern California Gas Company, 2001). Total energy use appears to be substantially lower for cleaners who have switched out from PCE dry cleaning to professional wet cleaning (Shaeffer, 2001). Two utility companies in southern California have expressed an interest in systematically evaluating the energy use in professional wet cleaning to create a rebate program (Williams, 2001; Becker, 2001). California law requires employers to have workers' compensation insurance for their employees. One factor that determines the employer's premium payment is industry classification, which factor is based on the occupational risk to workers (DWC, 2001). The National Institute for Occupational Safety and Health (NIOSH) have identified a number of health hazards associated with the use of PCE dry cleaning, and has suggested the use of PCE substitutes (including wet cleaning) as a means of reducing occupational exposure to PCE. Regulators could thus work with the California Workers Compensation Insurance Rate Board to develop a new, significantly cheaper classification for dedicated wet cleaning facilities.

Long-Term Recommendations for Further Study

At the time of this writing, SCAQMD has yet to make final decisions about the future of PCE dry cleaning in the South Coast basin. Yet the fact that the agency has so actively assisted the development and commercialization of a clean technology is notable, and has even proposed to ban PCE use in this sector is remarkable. Complete analysis of how the agency arrived at this

point and its ultimate result must await completion of the rulemaking. Yet, we can make some general observations about them, and identify potential institutional changes that could encourage greater diffusion of clean technologies.

1.Integration of Technology Advancement and Rule Development

First, policy makers should consider restructuring the relevant regulatory agencies to better coordinate research and demonstration of clean technologies with the planning, development and implementation of prospective rules. The integration of the technology advancement function with rule planning and development could provide regulators with a broader array of innovative technology options to consider in crafting major rules. Many state and federal agencies sponsor research and demonstrations of clean technologies, even in the dry cleaning sector (USEPA, 1998). For example, the California Air Resources Board's Innovative Clean Air Technologies office (ICAT) funds projects that can "demonstrate the commercial utility in California of technical innovations that will improve emission prevention and control." (CARB, 2001). Yet that office generally funds technologies relating to existing regulatory requirements, such as identifying more cost-effective NOx controls for currently regulated combustion devices. It does not support the development of new rules, but rather assists businesses in bringing products to market (Vincent, 2001). In contrast, TAO and its contractors used its dry cleaning work not only to assist and educate the industry, but also to support and educate the SCAQMD's rule making function.³⁸ The TAO approach is a good model.

Integration of the technical advancement and rule development functions would entail significant changes to existing agency structures. In particular, such a model would require provision of increased financial, personnel and organizational resources to the technology advancement function, and the creation of more formal, routine channels of communication between the technology office and other offices within the relevant agency. Even SCAQMD appears to lack clear, formal channels of communication between TAO and other offices, including the rule planning and development office. Such channels should be established.

2.Creation of a Preference For Clean Technology

Policy makers committed to pollution prevention as a regulatory model must deal with the risk management perspective held by many agency personnel. This perspective tends to favor pollution control rather than pollution prevention, a bias compounded by regulators' general reluctance to view process change as appropriate goal for regulation. These norms are a powerful part of agency culture, as seen in the case of the permitting, enforcement and rule development offices discussed in Section II. Even where existing statutes call for consideration of process changes along with control strategies, regulators expressly or by default often fail to give process change meaningful attention.

Policymakers can begin to break down the barriers against process change by requiring regulatory personnel to give priority to pollution prevention strategies in the rule making process. For example, the Health and Safety Code provisions regarding stationary sources of air emissions could be amended to establish an explicit, mandatory hierarchy of rule-making approaches with clean technologies heading the list. Coupled with a proactive technology advancement program, a statutory preference could break the existing barriers to the development and diffusion of clean technologies.

Each of the proposed institutional changes discussed above represent substantial shifts in policy. Given the limitation of our study to one industry sector and one regulatory agency, further research should be undertaken to evaluate the efficacy and impact of such changes across the broader population of industries and agencies in California, and to assess the tangible and intangible costs of the changes.

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Endnotes

¹ There is considerable debate over the precise scope of terms such as “pollution prevention” and clean technology, much of which centers on the question of how much prevention is enough. While some advocates argue that the terms are limited to measures and technologies that completely eliminate waste, emissions and other discharges from the process or activity, others read the terms more broadly to include any level of reduction. (Gottlieb, et al., 1995; Allen, 1995). Obviously, this is a debate over policy not linguistics, and one that we do not attempt to resolve in this study.

² For a description of the "systems/strategic approach", see LoPucki, 1997.

³ Obviously, there are many other actors and institutions within the system, such as environmental groups and dry cleaning customers. However, the interviews and other research suggest that the regulators, vendors and cleaners play the most significant roles with respect to diffusion of clean technologies in this sector.

⁴ While CO₂ is classified as a greenhouse gas contributing to global warming, the CO₂ used in garment cleaning comes from captured emissions from other industrial and agricultural processes, allowing manufacturers to promote this technology as a pollution prevention alternative. (SCAQMD, 2001). However, there are two potential problem areas for CO₂: a) waste from CO₂ garment cleaning machines is disposed of as hazardous waste, and b) VOC concentrations in the detergents used for CO₂ machines will require regulatory oversight.

⁵ Wet cleaning can require more time than dry cleaning. Longer cleaning time results in less garments cleaned per hour. However, with proper technical assistance, training and experience, total labor time for wet cleaning can be comparable to that for dry cleaning (Shaeffer, 2001). Moreover, while wet cleaners can provide “same day” service, they are unable to provide “one hour” cleaning.

⁶ Focusing just on cleaners who previously stated that they would probably not or definitely not consider wet cleaning, a \$17,500 rebate would make only 19% of those cleaners more likely to consider wet cleaning as a purchase option.

⁷ The fact that a rebate would make cleaners less likely to consider wet cleaning appears odd, and could reflect a misunderstanding of the question by those cleaners so responding. However, it could also reflect the operation of a phenomenon known as "motivational crowding," in which the encouragement of activity through positive or negative financial incentives actually decreases the rates of participation in that activity. (See Frey and Jegen, 2000).

⁸ That 30% drops to 17% when the population is limited to those cleaners who would probably not or definitely not consider wet cleaning.

⁹ SCAQMD also regulates petroleum dry cleaning under Rule 1102, which covers petroleum and siloxane solvents used by the GreenEarth™ process. The rule was amended in November 2000 to make it consistent with Rule 1421. Consequently, it establishes equipment and operating requirements, and in particular phases out the use of transfer machines (i.e., operations in which garments are washed in one machine and dried in another.) Like Rule 1421, it includes extensive leak detection, inspection, maintenance, and record-keeping obligations. At present, GreenEarth™ operators are exempt from all of the rule requirements, except for limited record-keeping requirements.

¹⁰ The California rule, "Air Toxic Control Measure (ATCM)—Emissions of Perchloroethylene from Dry Cleaning Operations," was issued by the California Air Resources Board and became effective in 1994. The Federal rule, promulgated by EPA under the Clean Air Act's National Emission Standards for Hazardous Air Pollutants (NESHAP) program, became effective in 1993. 55 Fed. Reg. 49354 (September 22, 1993), codified at 40 C.F.R. Part 63, Subpart M.

¹¹ Excluding the cost of the pollution control equipment (which is part of the capital cost of the dry cleaning machine), studies have estimated that annual compliance costs (including training, record-keeping, permit and emission fees, and hazardous waste disposal) range between \$5,483 and \$8,274 for an average dry cleaner (PPERCO, 1997; USEPA, 1998). Among process dependent expenses, only energy costs and pressing labor costs are higher (Sinsheimer, et al., 2000).

¹² The District's enforcement policy provides that an inspector can respond to an observed violation in one of two ways. First, for minor violations (i.e., administrative or procedural violations or violations that involve a de minimis amount of emissions) that are not immediately corrected, the inspector issues a notice to comply (NOC). If the facility responds by coming into compliance, no further action will be taken (SCAQMD Rule 112). For non-minor violations or for repeat violations, the inspector issues a Notice of Violation (NOV), which is forwarded to the SCAQMD District Prosecutor's Office. Depending upon the circumstances, the NOV may lead to administrative, civil or criminal proceedings seeking penalties and other relief.

¹³ In 1999, SCAQMD discovered that a large number of dry cleaners had allowed their permits to expire. Because those cleaners are treated as "new sources" under Rule 1401, their continued use of older machines violated Rule 1401. Under SCAQMD's conventional interpretation of Rule 1401, these cleaners were required to obtain new permits and purchase expensive advanced PCE machines, an expensive proposition. Most of the cleaners have entered into abatement orders with SCAQMD providing them with additional time in which to purchase complying equipment. (Mieras, 2001).

¹⁴ Natural diffusion may be an effective approach for spreading wet cleaning after a sufficiently large number of cleaners within a region already switch to wet cleaning. However, with only 3 professional wet cleaners operating in the South Coast, it appears that a tipping point has not yet been reached.

¹⁵ Indeed, some dry cleaners will simply throw out correspondence from regulators without opening it (Feldman, 2001). Government sources scored the worst on this question as compared to three other sources: vendors, trade

publications and shows, and other cleaners, each of which was found to be very important by almost half of the cleaners.

¹⁶ That figure drops to 6% when one considers only those cleaners who had previously stated that they would definitely not or probably not consider wet cleaning in the future. Thirty percent of the cleaners who previously expressed no interest in considering wet cleaning would be somewhat more likely to consider wet cleaning based on subsequent knowledge of that successful wet cleaners existed.

¹⁷ Section 42403 of the Health and Safety Code establishes factors to be considered in setting penalty amounts for civil action, and SCAQMD Regulation XXX sets forth similar factors for administrative penalties. Encouraging diffusion of alternative technologies does not easily fit within any of the factors.

¹⁸ This figure assumes that PCE cost is \$0.0136/garment. (PPEREC, 1997). EPA estimates annual solvent costs to be approximately \$1,400, based on a facility cleaning 53,333 pounds of clothes annually in a PCE machine with primary and secondary controls, using 210 gallons of solvent each year at a solvent cost \$6.83 dollars per gallon. (USEPA, 1998). At least in the South Coast region where many dry cleaners are subject to annual limitations on PCE usage, the usage rate of 210 gallons appears high. In our survey, when asked how much PCE they need to use to operate their business successfully, only 12% of the cleaners stated that they used more than 120 gallons per year, and only 8% used more than 150 gallons annually. The median usage was 65 gallons per year. Of course, solvent costs will vary depending on the type of machine used and other factors.

¹⁹ Cognitive psychology and behavioral economics suggest that the so-called “endowment effect” might make cleaners more concerned about a loss (payment of tax) than about a gain (receipt of rebate). (See Bazerman, 1998; Kahneman & Tversky, 1979).

²⁰ Such was the case with taxation of chlorofluorocarbons (CFCs); taxation during their phase-out led to the development of a black market for CFCs (U.S. Navy, 1994).

²¹ However, a PCE tax at lower levels may be a useful tool when used in combination with other policy tools. For example, the tax could be used to make other financial incentive programs, such as tax credits or subsidized training, revenue-neutral for the government.

²² Research has revealed no published data concerning the extent to which businesses have taken advantage of those generic tax credit programs. Rhode Island and New Jersey also have sales and use tax exemptions for purchases relating to recycling and alternative energy. (Lake, 1997).

²³ Beginning in 2000, North Carolina instituted an income tax credit equal to 20% of the cost of equipment that the State Department of Environment and Natural Resources (DENR) certifies to be “qualified dry-cleaning equipment.” (Section 105-129.16C). The statute defines qualified dry-cleaning equipment to mean equipment that is used to “dry-clean clothing or other fabric and does not use any hazardous solvent or any other substance that the [DENR] determines to pose a threat to human health or the environment.” DENR has yet to receive an application for certification of any equipment, although it anticipates that applications will be received shortly from cleaners proposing to use CO₂ equipment and Green Earth™ equipment (Nicholson, 2001). DENR has received no applications or queries from potential wet cleaners, and currently believes that the tax credit would not be available for wet cleaning equipment given the limitation in the statute to dry cleaning (Nicholson, 2001).

²⁴ In March of 2001, Representative Manzullo introduced the Small Business Pollution Prevention Opportunity Act (H. R. 978), which would provide a 20% tax credit to dry cleaners purchasing qualified dry or wet cleaning equipment. Hazardous solvents such as PCE and petroleum are specifically excluded from coverage. It is unclear whether silicone solvents such as Green Earth™ would be eligible for the credit. Sponsors and supporters of H. R. 978 hope to make alternative technologies such as wet cleaning and CO₂ systems competitive with PCE systems by bringing the cost of alternatives down (U.S. House, 2000, testimony of Camp). The bill did not move beyond committee. An earlier version of H.R. 978 was introduced in 2000, with strong support from Micell, a major manufacturer of CO₂ cleaning systems. Hearings on that earlier bill were held before a subcommittee of the House Committee on Small Business, but the bill ultimately failed to gain passage (U.S. House, 2000).

In 2001, California Assemblyman George Nakano introduced AB 845, which would provide a credit of 50% for the cost of using alternative dry or wet cleaning technology. The purpose of the bill, which was never acted upon by the Assembly, was to make alternative technologies economically feasible.

²⁵ It was designed to encourage businesses involved in dry cleaning, metal plating and halogenated solvent cleaning sectors to reduce, eliminate or avoid the use of certain toxic chemicals, including PCE.

²⁶ Tax credits and other financial incentives are also used to reduce the burden of government mandated pollution control on individual businesses, spreading the costs among taxpayers generally (See Barthold, 1994).

²⁷ Clearly, a tax credit would be more useful to promote the use of CO₂ technology, which costs as least three times as much as dry cleaning equipment. Analysis of the value and effectiveness of a tax credit for that purpose is beyond the scope of this report. However, it is worth noting two facts. First, even some supporters of CO₂ technology question whether CO₂ equipment will ever be competitive with PCE equipment on a cost basis (U.S. House, 2000, testimony of DeSimone). Second, even a 50% tax credit would only reduce the expected cost of a CO₂ system to \$75,000, a cost that most cleaners would not be willing to incur.

²⁸ For example, tax benefits have historically been available at the federal and state level for businesses required to install pollution control equipment (See Barthold, 1994).

²⁹ This problem can be overcome by creating a “refundable” tax credit, in which the taxpayer receives a direct payment equal to the excess of the available benefit over the taxpayer’s tax liability (Catteral & Levin, 1982). This is currently done at the federal level with the earned income tax credit (Steuerle, 1990). None of the existing or proposed dry cleaner tax credits are refundable. A refundable credit tends to be more expensive and more difficult to administer. It is more expensive simply because it will require more expenditures than a non-refundable credit. It is more difficult to administer because of increased paperwork and processing required to claim the credit by taxpayers and to issue it by the revenue agency. Moreover, it could require consideration by additional committees within the legislature due to its dual nature as both an expenditure (i.e., the credit portion) and a tax provision (Toder, 2000).

³⁰ A tax credit program will likely fail unless the responsible agency is provided adequate resources to promote the program. In its study of a German program, the OECD concluded that the program’s poor performance resulted in large part from a lack of information about it among targeted companies (OECD, 1989). A study of tax benefit programs available to New Jersey businesses identified lack of information about available incentives as a potentially significant barrier to their widespread implementation, particularly among smaller firms (Lake, 1997). In Oregon, cleaners were informed of the tax credit program at its start through mailings, but there was no active marketing or solicitation (Golden & Morlino, 1999). It also appears that neither vendors of equipment nor trade associations promoted the use of the tax credits in Oregon (Glendening, 2001).

³¹ The obstacles discussed above—lack of taxable income, concern over government intrusion, and administrative and timing barriers—could be addressed in large part by providing the tax incentive through a sales tax exemption implemented by the vendor rather than through an income tax credit. However, the relatively low level of sales tax liability associated with the purchase of wet cleaning equipment limits the size of this benefit.

³² A prohibition can take the form of a ban on existing products or processes, or the “culling” or screening of new ones in which the regulator has some type of prior approval authority (Stewart, 1981).

³³ A phase-out can also play a political role, buffering regulators from charges that the agency is moving precipitously, and focusing debate on the length of the phase-out rather than the underlying decision to ban the process.

³⁴ If not carefully structured, however, a phase-out could cause increased emissions during the phase-out period. For example, as currently proposed, the SCAQMD proposal has no mechanism for a gradual movement of existing dry cleaners to alternative technology, but rather simply provides a ten-year delay before the prohibition takes effect.

This ten-year period allows cleaners with old equipment to continue using it, even if absent the ban they would have replaced it with a new PCE machine. Faced with the immediate choice between buying a new wet cleaning machine or continuing to use an older PCE machine, it is likely that many cleaners will attempt to "get by" with the older machine. As compared to new PCE equipment, the older machines are less efficient in design and more likely to develop leaks. Consequently, they are significant sources of PCE emissions and the associated risks to human health. Likewise, if a substantial number of cleaners wait until the end of the phase-out period to switch to an alternative technology, there may be a shortage of equipment causing a rise in prices and uncertainty. That situation could result in delayed implementation of the prohibition. From a practical and political standpoint, the regulatory agency will be vulnerable if cleaners, vendors and trade associations seek an extension of the phase-out period until the equipment shortage eases.

³⁵ A representative of the International Fabricare Institute stated in Congressional testimony that depending upon the model and manufacturer, machines may last between "eight to twelve years to fourteen years." (U.S. House, Fisher testimony, 2000). PPERC uses a ten-year life span, while EPA assumes a 15 year life. (USEPA, 1998; PPERC, 1997). In our survey, based on the median age of existing machines and median amount of time cleaners expected to retain their existing machines, it appears that cleaners expect to replace machines after approximately fifteen years of use.

³⁶ Of the three distributors contacted, one said the expected life of a dry clean machine is 10 years (Bailey, 1997), one said 7-10 years for most machines (Karman, 1997), and one said 10-15 years (Korey, 1997). While two of the three repair technicians contacted said that a dry clean machine could last fifteen years, the operator usually would have to practice a significant amount of preventative maintenance, which is costly. Both said that rather than carry out preventative maintenance most cleaners wait until a problem occurs, which leads to more significant problems, more costly repairs, and greater overall deterioration of the machine (Centes, 1997; Khaiwara, 1997). One gave ten years as an average estimate (Centes, 1997). A third repair person said that dry clean machines are not designed to last longer than ten years. He said the maintenance cost of operating a dry clean machine is very low for the first five years, yet becomes very expensive for years five through ten and excessive afterwards (Trainer, 1997). The dry cleaning consultant said that ten years is the figure he used for the expected life of a dry clean machine (Barry, 1997).

³⁷ Given the fact that toxicity testing of GreenEarth™ systems has not been completed, regulators should also track usage of those systems. GreenEarth™ operators must maintain operating records under SCAQMD Rule 1102, but they need not obtain a permit or otherwise register with SCAQMD or other environmental agencies. Consequently, new registration requirements must be created in order to track GreenEarth™ usage

³⁸ Rule development personnel in some divisions of CARB perform proactive technology advancement of the sort done by TAO in the dry cleaning sector on an ad hoc basis, particularly those dealing with mobile sources such as automobiles. (Lui, 2001; Vincent 2001).

Appendix A
Survey Methodology

The telephone survey was designed to identify attitudes of dry cleaners towards technology choice in general and wet cleaning technology in particular. It also explores sources and accuracy of information regarding technology among cleaners, and the impact of various economic incentives. The sample of dry cleaners in the South Coast region was drawn from the South Coast Air Quality Management District's permitting records. Over 2400 facilities were identified as having current permits for the operation of PCE dry cleaning equipment.

The survey was designed in consultation with the UCLA School of Law Empirical Research Group, and administered by Fleischman Associates. It was pre-tested with three individuals, and revised to limit its length to approximately 15 minutes. Given the large proportion of shops operated by Koreans, the interview was translated into Korean, and Korean-speaking interviewers were available to administer the interview as needed.

The sample list was randomized, and the survey administered in accordance with standard protocols for telephone surveys. Reasonable efforts were made to obtain a response from each number before the next number was called. In the event that a telephone call was unanswered or busy, a maximum of three additional attempts were made to a contact the respondent. The interviews were performed between June 3 and June 27. The results of completed calls were recorded on survey questionnaires, and records were also kept for each attempt to reach a respondent.

A total of 202 surveys were completed, with a response rate of 57%:

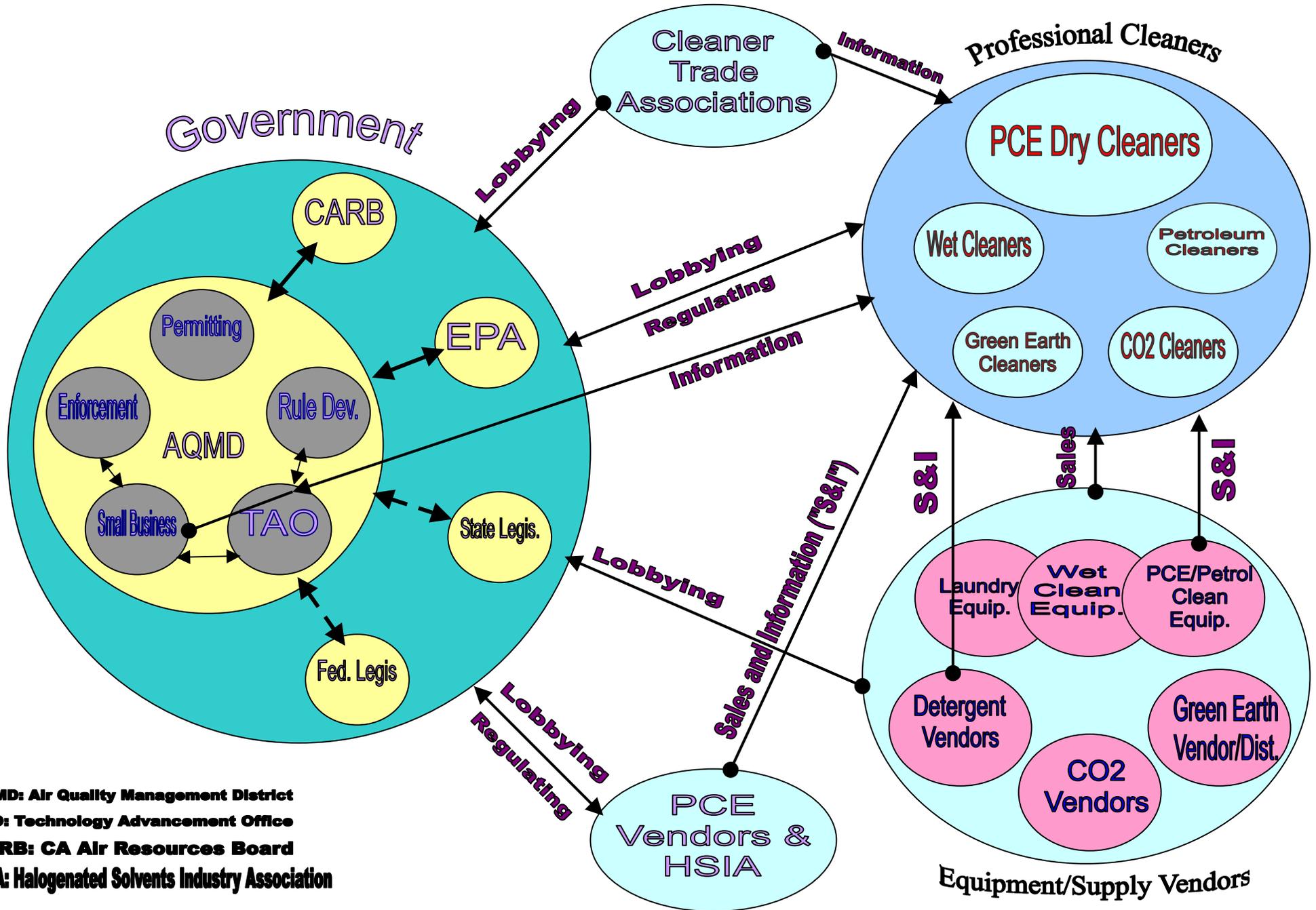
Table A1
Final Disposition of Calls

Disposition	Number	
1. Refusal	131	
2. Incomplete Survey	4	
3. Language Problem	17	
4. Subtotal		152
5. Completed surveys		202
6. Response rate (202/(152+202))		57%

Table A2
Unobtainable Sample

Disposition	Number
1. No answer/ answering machine	44
2. Call backs requested	185
3. Busy Signal	18
4. Wrong Number	75
5. Disconnected Number	351
6. Pager Number	7
7. Business Sold	6
Total	686

APPENDIX B: FIGURE 1
 DRY CLEANING SYSTEM MODEL



AQMD: Air Quality Management District
TAO: Technology Advancement Office
CARB: CA Air Resources Board
HSIA: Halogenated Solvents Industry Association