Integrating Pollution Prevention Technology into Public Policy: The Case of Professional Wet Cleaning

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This paper discusses opportunities to promote pollution prevention technologies through public policy, describing the case of dry cleaning. The crisis in dry cleaning is associated with the industry's reliance on perchloroethylene (PCE), the chemical cleaning solvent used by the vast majority of cleaners. The limits to the current pollution control or end-of-pipe system of laws and regulations and the search for nontoxic alternatives are analyzed in light of the environmental and occupational hazards associated with PCE use. Criteria to evaluate those alternatives are then described, including their application to professional wet cleaning, a commercially available pollution prevention alternative to PCE. The article concludes with an evaluation of several public policy instruments that could be used to promote the diffusion of professional wet cleaning as a potential solution to this regulatory crisis. These include environmental and occupational regulations designed to reduce or eliminate risk from exposure to toxic substances as well as incentive-based programs. Both barriers and opportunities for the use of each instrument are identified. This review reveals that, while the pollution control approach to public policy has deepened the regulatory crisis in the garment care industry, policy instruments are currently available to create an effective transition toward a pollution prevention outcome.

Introduction

Pollution prevention emerged in the 1990s as an alternative method to pollution control for reducing hazards characterized as harmful to public health and the environment. While pollution control focuses on controlling hazards from a source after they are created, pollution prevention focuses on eliminating those hazards through changes in the production process itself.

Much of the contemporary environmental regulatory system continues to be based on the pollution control approach. Such an approach requires that public policy makers classify a specific pollutant as harmful, identify at what level a specific pollutant may cause harm, and then identify and implement a strategy for reducing those hazards to a safe or acceptable level. Each of these components has been fraught with problems. The scientific basis for characterizing a pollutant as harmful is often uncertain and can be challenged, and the cost-effectiveness of pollution control strategies may also be problematic. Even when pollution control regulations have been implemented, the target level of reduction may prove to be difficult to reach, given the lack of compliance by industry as well as the lack of regulatory enforcement.

Pollution prevention has been seen as an effective way to avoid problems inherent in the pollution control approach. By focusing on technologies that eliminate the production of harmful pollutants, pollution prevention avoids the problems associated with quantifying and setting safe or acceptable levels of exposure, identifying end-of-pipe control technologies, and establishing a workable monitoring, compliance, and enforcement approach. The challenge for pollution prevention has been its ability to identify a pollution prevention technology that constitutes a commercially viable substitute for an existing polluting process and how to integrate the knowledge about viable pollution prevention technologies into public policy to promote their diffusion.

This paper focuses on the application of a pollution prevention approach to dry cleaning, including an evaluation of one pollution prevention technology, professional wet cleaning. In the United States, the vast majority of dry cleaners use the toxic chemical perchloroethylene (PCE) as their primary cleaning solvent. Exposure to PCE from dry cleaning represents a significant risk to workers, customers, and the surrounding community. Efforts to regulate these risks, primarily designed to minimize exposure to PCE from dry cleaning rather than eliminate its use, have been limited and inadequate.

The increased regulatory pressure associated with PCE use in dry cleaning helped stimulate interest in a number of alternative technologies. The first pollution prevention technology introduced commercially was professional wet cleaning, a nontoxic water-based cleaning process which uses computer-controlled washers and dryers, specially formulated detergents, and specialized finishing equipment to facilitate the cleaning of delicate garments in water. By removing PCE from the cleaning process, professional wet cleaning appears capable of eliminating the associated risks and, therefore, the need to develop, enforce, and comply with PCE-based regulations. Evaluation of professional wet cleaning (and any other pollution prevention technology) is also seen as crucial for its acceptance by cleaners and regulators alike. A series of case study evaluations commissioned by government agencies during the mid- and late 1990s are described, including the results of the evaluations. These results have further stimulated an interest in developing new policies and regulations for PCE use in dry cleaning that, in turn, have the potential to shift professional cleaners away from their dependence on PCE by integrating a pollution prevention approach into the development of public policy.

PERC Use in Dry Cleaning and Its Hazards

The identity of the garment care industry has long been associated with its cleaning solvents. The term "dry cleaning"

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was first derived from a mid-19th century discovery that camphene, a fuel for oil lamps, could clean oily stains on garments. Petroleum solvents became the first "dry" cleaning agents for an industry that distinguished itself from the "wet" processes used by commercial laundries. Commercial dry cleaning operations, which took root in the early 20th century, tended to be centralized plants located in industrial zones or at the urban edge, because of the fire hazards associated with use of petroleum as a solvent. In the 1940s, a number of chlorine-based chemicals were shown to be effective for garment cleaning, including carbon tetrachloride, trichloroethylene, and perchloroethylene (PCE). Because these chlorine-based chemicals were not considered fire hazards, professional cleaners were able to move into commercial and residential areas of cities. Small neighborhood cleaners began to dominate the industry, with PCE becoming the solvent of choice. Currently in the United States, 85% of the more than 35 000 professional cleaners use PCE as their primary cleaning solvent.

Just as dry cleaners became ubiquitous in cities and even small towns, increasing evidence began to emerge in the 1970s of the adverse health and environmental impacts associated with PCE use in dry cleaning (*1*−*3*). Effects of chronic exposure to PCE include dizziness, impaired judgment and perception, damage to the liver and kidneys, and respiratory disease (*4*). Other risks include neurotoxicity and reproductive and developmental toxicity as well as various forms of cancer such as bladder, stomach, esophageal, intestinal, and pancreatic (*5*). PCE has been classified as a Group 2A carcinogen (i.e., a probable human carcinogen) by the International Agency for Research on Cancer and as a potential human carcinogen by the National Institute of Occupational Safety and Health (NIOSH) (*6*).

Knowledge of the adverse effects of PCE came precisely at a time when significant new national environmental and occupational regulations were being developed. Workplace exposure limits were first placed on PCE in 1970 by the Occupational Safety and Health Administration (OSHA). In the 1980s, the EPA as well as state and regional agencies began establishing standards to regulate PCE as a water, land, and air contaminant (*7*). Solid waste contaminated with PCE must be disposed of as hazardous waste. Discharge of water contaminated with PCE is highly regulated. Soil and groundwater contaminated with PCE is subject to Superfund designation and cleanup requirements. Regulatory oversight of PCE as an air contaminant increased substantially with the passage and subsequent implementation of the 1990 Clean Air Act Amendments.

The 1990 amendments classified 189 chemicals (including PCE) as hazardous air pollutants (HAPs) and developed administrative procedures to establish emissions standards, or National Emissions Standard for Hazardous Air Pollutants (NESHAPs), for each classified chemical (*8*). PCE dry cleaning was the first NESHAP promulgated by the EPA after the 1990 legislation took effect. Issued in 1993, the rule focused on the use of pollution control ("add on" or "end-of-pipe") equipment to achieve emissions reductions as well as operator monitoring requirements to ensure compliance with emission reduction goals (*9*). All new dry clean machines were required to install PCE vapor recovery systems (refrigerated condenser or carbon adsorber), with large facilities required to install vapor recovery for existing machines. Good housekeeping requirements included monitoring, recordkeeping, reporting, and leak detection and repair.

At first, implementation of these environmental regulations appeared to create a relative degree of certainty within the garment care industry that PCE use could remain viable for years to come. However, recent revelations concerning the lack of regulatory compliance as well as questions regarding population exposure to PCE from dry cleaning (even when facilities are in compliance) have created a crisis both within the regulatory community as well as within the garment care industry. Enforcement evaluation audits in the late 1990s revealed that few cleaners were in compliance with federal, state, or regional rules (*10*−*14*).

Finding Substitutes: Professional Wet Cleaning as a Pollution Prevention Technology

As regulation of PCE dry cleaning intensified in the 1990s, so did interest in the development of alternatives to PCE, including reformulated petroleum solvents, silicone-based solvents, liquid carbon dioxide, and professional wet cleaning. This search for alternatives in the garment care industry occurred precisely at the time when the concept of pollution prevention was gaining prominence as a solution to the shortcomings of a pollution control approach to regulation. The dry cleaning industry provided a clear example of the problems with the pollution control approach; end-of-pipe controls such as vapor recovery technology have proven to be costly to purchase and maintain, difficult to monitor and enforce, and ultimately ineffective in fully addressing the problems of exposure. However, could such a pollution prevention alternative be found and, even more significantly, could it be judged as a viable substitute?

It became apparent, in relation to garment care, that not all such alternative technologies could be characterized as pollution prevention technologies. For example, as regulations concerning PCE dry cleaning began to intensify in the 1990s, Exxon and ARCO reintroduced a new generation of petroleum solvents. These reformulated solvents, designed to overcome petroleum's long-standing problems with flammability, nevertheless continued to pose a number of environmental and occupational problems. Petroleum emissions are classified as a volatile organic compound (VOC), contributing to the formation of smog; waste from petroleum dry clean facilities is classified as hazardous, and fire risk, while minimized, cannot be eliminated (*15*).

General Electric (GE) has introduced a new silicone-based dry cleaning solvent, marketed under the name GreenEarth. While GreenEarth has been promoted as a clean alternative to conventional dry cleaning solvents, because it is neither classified as a VOC nor (as of yet) as a toxic compound, concerns, both inside and outside the garment care industry, have been raised about its toxicity. In the MSDS, GE has identified a maximum exposure limit of 10 parts per million time-weighted average, which itself constitutes a very stringent standard (*16*). In addition, waste from cleaners using GreenEarth is classified as hazardous.

Liquid carbon dioxide (CO_2) has also been introduced as an alternative solvent for garment cleaning. While CO_2 is classified as a greenhouse gas contributing to global warming, the CO_2 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. However, there are two potential problem areas for CO_2: (a) waste from CO_2 garment cleaning machines is disposed of as hazardous waste, and (b) VOC concentrations in the detergents used for CO_2 machines will require regulatory oversite. Finally, the capital cost of CO_2 machines, about double the cost of convention dry cleaning equipment, raises questions about the financial viability of this alternative. Nevertheless, in addition to professional wet cleaning (in the following discussion), CO_2 could emerge as an important environmentally preferable substitute for PCE-based dry cleaning.

The first clearly identifiable pollution prevention technology in the garment care industry to emerge has been an aqueous-based alternative known as professional wet cleaning. Wet cleaning, a process of hand-laundering delicate garments, had long been practiced by cleaners (*17*). Professional wet cleaning industrialized this practice by using computer-controlled washers and dryers, specially formulated detergents, and specialized finishing equipment to create a cost-effective alternative to dry cleaning. The essential technological innovation of professional wet cleaning was to mechanically simulate hand-laundering by retrofitting front-loading commercial laundry machines with a computer to control the rotation of the drum in order to minimize agitation while providing sufficient movement for effective garment cleaning. Wet clean washers were also equipped with a computer-programmed detergent injection system, which allowed the cleaner to specify the amount and type of wet clean detergent used for each load. Biodegradable wet clean detergents were formulated by detergent manufacturers to maximize cleaning power while minimizing color change and shrinkage. Wet clean dryers included moisture sensors to ensure that garments retained a proper amount of moisture after the dry cycle is complete. Specialized tensioning pressing machines were used to enhance the restoration of constructed garments, such as suit jackets, suit pants, and tailored items. By redesigning commercial washers, dryers, detergents, and adding specialized finishing equipment, professional wet cleaning emerged in the mid- and late 1990s as a comprehensive pollution prevention alternative to dry cleaning for the garment care industry.

Evaluating a Pollution Prevention Technology

Soon after the introduction in the United States of the first professional wet clean washer and dryer systems in 1992, government agencies began to seek information about whether professional wet cleaning constituted a viable substitute for PCE dry cleaning. A number of agencies sponsored a series of empirical evaluations in the United States and Canada to assess the feasibility of professional wet cleaning in a commercial setting (*18*−*22*). These case studies, in turn, utilized three general criteria to evaluate the commercial viability of professional wet cleaning. Performance criteria addressed whether a professional wet cleaner could effectively clean the full range of garments normally cleaned in dry cleaning. Financial criteria were used to measure whether the one-time cost of equipment and the ongoing operating expenses associated with professional wet cleaning were similar to costs incurred in PCE dry cleaning. Environmental criteria were used to measure the resource and pollution impacts of professional wet cleaning as compared to PCE dry cleaning.

The results from the case studies have collectively provided a baseline of information regarding the performance, economic, and environmental viability of the pollution prevention substitute technology (see the discussion in the Supporting Information). In relation to performance (or cleaning abilities), professional wet cleaners were able to successfully clean the full range of garments normally taken to a dry cleaner. They also encountered few problem garments that they were unable to successfully clean and generated a high level of customer satisfaction with the cleaning process. In relation to its financial viability, the cost of purchasing professional wet clean equipment was lower than that for dry cleaning, while overall operating expenses were comparable. In relation to its environmental impact, no other environmental concerns were raised in operating a dedicated professional wet clean facility, even as a substantial pollution prevention benefit was gained as a consequence of the eliminating the use of PCE.

These evaluations established an initial baseline of information that allowed the government agencies who funded them to consider professional wet cleaning a potential pollution prevention alternative in their regulatory activity. This contrasted with the absence of any independent evaluation of the other proposed alternatives such as GreenEarth and CO_2. Given the information from the evaluations about the viability of professional wet cleaning, whether and how a pollution prevention approach could be integrated into public policy became the central question facing regulators, cleaners, and other critical stakeholders (e.g., neighboring businesses and residents, garment care employees, and customers).

Integration of a Pollution Prevention Approach into Public Policy

Once a pollution prevention substitute technology, such as professional wet cleaning, is considered viable and commercially feasible, as the evaluations referenced previously indicated, what role can public policy play in influencing its diffusion in the marketplace? At the federal, state, regional, and local levels, there are a number of laws and regulations that have the potential to influence a switch from PCE dry cleaning to professional wet cleaning. While knowledge about the viability of professional wet cleaning as a substitute technology can be incorporated into most of these public policies to facilitate the diffusion of professional wet cleaning, the lack of integration of these policies can create significant barriers for such a pollution prevention approach.

In the United States, the use of PCE in dry cleaning is regulated by most of the major environmental and occupational health statutes. In addition, there are a number of incentive-based policies that have the potential to encourage the use of pollution prevention technologies in the garment care industry. These include the development of a professional wet clean care label by the Federal Trade Commission as well as the creation of tax credit and low interest loan programs to encourage cleaners to purchase professional wet cleaning equipment. At a local level, city government involvement is possible through policies designed to encourage the use of clean technologies. A review of key legislation and regulations in the garment care industry can demonstrate how the integration of pollution prevention into public policy can occur.

Clean Air Act. Full implementation of Clean Air Act provisions, which designated PCE as a HAP, has the potential to create a significant shift in the garment care industry away from the use of PCE.

Congress set up a multistep implementation process to develop NESHAPs. These steps included an initial technology-based standard, a residual risk update, and continuous technology review. The first step of a NESHAP was to rapidly implement and enforce a technology standard based on the maximum degree of reduction, including prohibition of such emissions when technologically achievable (*8*). In theory, this provided the opportunity for the EPA to set a zero-emissions standard when a viable pollution prevention technology was identified. Yet, in practice, initial emissions standards were primarily based on available pollution control equipment. Such was the case with the 1993 NESHAP for PCE dry cleaning, which set emissions limits based on the use of end-of-pipe vapor recovery technology as well as operating practice requirements to ensure efficient maintenance of this control equipment. Enforcement of the NESHAP was given to individual states and regional agencies, with discretion to adopt their own stricter rules. In the first 7 years since the PCE dry clean NESHAP was promulgated, enforcement evaluations audits have revealed that very few cleaners have been in compliance with federal, state, or regional rules. For example, dry cleaner compliance rates have been just 2% for New York, 6% for Massachusetts, 14% for Sacramento, CA, 21% for the San Francisco Bay area, and 10% for the greater Los Angeles region (*10*−*14*). In the audits in which vapor leaks have been systematically tested, unacceptable PCE emissions levels were detected in 60% (Sacramento) and 67% (San Francisco Bay area) of the facilities.

The second health-based step in implementing a NESHAP directs the EPA to undertake a residual risk evaluation 8 years after the initial promulgation of each NESHAP and to further reduce emissions to meet a 1/million cancer risk threshold (*8*). While the EPA sought to relax the threshold requirements, Congress did not amend the law obligating the agency to uphold the stringent standard (*23*). In the case of PCE dry cleaning, while a considerable amount of attention has been paid to residual risk from colocated dry cleaning facilities (i.e., cleaners located on the first floor of a multistory building), most facilities in fact are likely to exceed the 1/million significance level (*7*).

Once establishing that an initial NESHAP exceeds the residual risk threshold, the EPA must decide how to bring cleaners into compliance with the 1/million threshold, through pollution control or pollution prevention. A pollution control approach would evaluate whether the 1/million threshold could be met by both additional pollution control requirements (such as room enclosures or forced ventilation systems) and limiting the use of PCE at cleaners such that the use does not exceed a 1/million risk. The viability of this approach is questionable. Risk assessments would need to be conducted and updated at each of the 35 000 dry clean facilities in the United States, a time-consuming and expensive task for both cleaners and regulators. In addition, new equipment and record-keeping requirements would be imposed on cleaners who have to demonstrate an inability to comply with less stringent requirements. Finally, it is questionable whether a cleaner could operate profitably if such additional control technology or solvent caps were imposed (*24*). If a dry cleaner is unable to be profitable at this limit, the issuance of such a permit will lead to the cleaner violating the PCE permit condition limit or lead the cleaner into bankruptcy. This condition is known as a “sham permit” and is prohibited by law (*25*). A pollution prevention approach, on the other hand, could resolve the issue of residual risk by setting a zero-emission standard based on the availability of substitute technologies, such as professional wet cleaning.

The third technology-based step in implementing a NESHAP directs the EPA to reevaluate the technological basis of each NESHAP no less than every 8 years (*8*). This provision allows each NESHAP to keep up with advancements in technology, including process changes that eliminate emissions. Designating professional wet cleaning as a viable pollution prevention substitute technology would set a zero-emission standard of PCE dry cleaning. By first setting a zero-emission standard through the technology review provision, the EPA could bypass the residual risk step altogether. In this light, it is important to note that the regional air district in southern California has endorsed a strategy of promoting nonperc alternatives for dry cleaning operations. This includes the use of alternative solvents (e.g., professional wet cleaning, carbon dioxide, and hydrocarbons) and a phase-in strategy for their use triggered when equipment is purchased for a new facility or when existing equipment has reached the end of its useful life (*26*).

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLA, the federal statute that assigns financial responsibility to cover the cost of cleaning up hazardous waste contamination, has become a significant issue for dry cleaners, creating increased interest in pollution prevention alternatives.

Before statutes regulating the disposal of hazardous waste were enacted, dry cleaners routinely disposed of PCE-contaminated water directly into the sewer drain. This practice has resulted in extensive soil and groundwater contamination; in Florida alone, over 1300 dry clean sites are known to be contaminated (*27*). Under CERCLA, no matter whether a practice was legal in the past, the cost of remediating contamination must by paid by all potentially responsible parties. Not only have dry cleaners been held responsible for the cleanup costs associated with PCE contamination, but court rulings have extended the liability to property owners. This has meant, for example, that real estate companies owning a shopping center or mini-mall where a dry cleaner is located or financial institutions that provide the loan for the purchase of such a site could be held liable if contamination is discovered at the site (*28*−*30*).

In response, a number of actions have been taken to reduce liability. At the federal level, dry cleaners have sought, unsuccessfully, to pass legislation to change the standards that trigger cleanup. With the support of dry cleaning associations, a series of bills designed to increase the threshold for liability under CERCLA and limit the cost of remediation have been introduced in Congress since 1996 (*31*). At the state level, dry cleaners have successfully promoted legislation in 10 states to establish liability insurance programs; these programs require dry cleaners to pay annual fees, a PCE tax, or a percent of gross receipts. Utilization of these funds by dry cleaners to cover remediation costs has already resulted in the need to increase insurance fees. For example, in Oregon, a tax on PCE rose from $12/gallon in 1996 to over $17/gallon in 2000 (*32*). While private liability insurance is also available to dry cleaners as well as to realtors and landlords, the increasing cost of insurance (both public or private) and the uncertainty of a future liability action has created an incentive for cleaners as well as realtors and landlords to explore alternatives to PCE dry cleaning, including professional wet cleaning.

OSHA. Workplace exposure to PCE at dry cleaners presents OSHA the opportunity to promote the use of zero-exposure substitutes, such as professional wet cleaning.

OSHA is empowered to identify toxic air contaminants (TAC) in the workplace and to set permissible exposure limits (PELs) to reduce or eliminate significant risk from TACs to the extent feasible. PELs define the maximum concentration of a given substance to which workers may be exposed over a given time period. OSHA identified PCE as a TAC in 1970 and set a PEL for an 8-hour time-weighted average (TWA-8), an acceptable ceiling concentration, and an acceptable maximum peak above the acceptable ceiling concentration for an 8-hour shift (*33*). In 1988, as increasing evidence of the adverse health effects of PCE emerged, OSHA moved to lower the TWA exposure limit by 75%, from 100 to 25 ppm. This OSHA regulation was part of a general strategy by the agency to establish new and revised PELs for over 400 substances. However, in 1992 the 11th Circuit Court of Appeals ruled that OSHA had not established a reasonable basis for each of the new exposure limits (*34*). OSHA is now in the process of setting a new PEL for PCE. This provides the opportunity to assess the extent to which the agency can integrate knowledge about professional wet cleaning into the development of the new PEL for PCE.

To integrate professional wet cleaning into the new PEL for PCE, OSHA would have to look at the use of PCE in dry cleaning apart from other industrial uses of PCE as well as evaluate the viability of substitutes in the dry cleaning sector. Historically, while OSHA tends to develop one set of PEL standards to cover all occupational settings, the agency does have the authority to partition a PEL by industry. The DC Circuit Court of Appeals created authority for OSHA to partition a PEL by source in the case of lead. The Court upheld OSHA’s rationale with regard to lead smelting industries because the agency made industry-specific findings in regards to technological feasibility and remanded the rule for numerous other industries because OSHA’s findings lacked a detailed industry- or operation-specific analysis (*35*). Thus, OSHA has the discretion to develop a separate PEL for dry cleaning. In addition, OSHA has evaluated the viability of substitutes in the context of developing PELs. For example, as part of the rulemaking process in setting a new PEL for methylene chloride, the agency reviewed the feasibility of substitutes for each of the 28 affected application groups and determined that, for some applications, technologically feasible substitutes were available (*36*). Therefore, if OSHA does set a separate PEL for PCE dry cleaning, it can consider the viability of professional wet cleaning as a substitute.

If OSHA were to consider the case of professional wet cleaning, then what standard might it use to judge whether this pollution prevention technology was a viable substitute? When developing a PEL, OSHA must assess the technical and economic feasibility of any measure intended to reduce risk. It is important to note that the courts have ruled that, when setting a standard, OSHA can point to "technology that is either already in use or has been conceived and is reasonably capable of experimental refinement and distribution within the standard's deadlines". Also, OSHA is not bound by "technological status quo" and has the authority to force industry to "develop and diffuse new technology" (*35*). A standard is considered technologically feasible if "the protective measures it requires already exist, can be brought into existence with available technology, or can be created with technology that can reasonably be expected to be developed". For a standard to be economically feasible, an industry must be able "to absorb or pass on the cost of compliance without threatening its long-term profitability or competitive structure (*37*)". In terms of economic feasibility, professional wet cleaning has been shown to be economically viable at the point when a new cleaning equipment purchase is required (*20*, *21*). However, if OSHA were also to consider a phase-out timetable, the agency would need to evaluate the cost to firms if they were prohibited from the use of dry clean equipment before the end of its useful life.

FTC Care Labeling. Changes in care labeling policies to create a new "professionally wet clean" instruction, currently under consideration by the Federal Trade Commission (FTC), could have the potential to significantly increase the diffusion of professional wet cleaning.

The FTC enforces and implements a number of federal consumer protection and antitrust laws. FTC activity is intended to eliminate acts or practices that are unfair or deceptive as well as prohibiting actions that threaten consumers' opportunities to exercise informed choice (*38*). In 1971, the FTC found that customers were not adequately protected against unfair and deceptive practices by the textile and apparel industry and promulgated a Care Labeling Rule requiring textile and apparel manufacturers and importers to place on each garment a care label instruction stating at least one method for regular care for ordinary use of the product (*39*). Triggered by EPA's desire to reduce the use of PCE, the FTC in 1998 proposed a change to its care label rule to create a new professionally wet clean care instruction (*40*). While the 1998 FTC proposal would simply have allowed manufacturers to use the new instruction, in 1999 the FTC began evaluating whether to require the professionally wet clean label (*41*). Increased momentum for a professional wet cleaning instruction was created by International Standards Organization (ISO) approval, in December 1999, of a system of standardized symbols for professional wet cleaning (*42*). However, in August 2000, the FTC ruled to defer creating the professional wet clean instruction because a definition of professional wet cleaning needed to be developed that was specific enough to be used by manufacturers to establish a reasonable basis for such a label. The Commission stated that it would reopen the rule once a definition or specific test procedure had been developed (*42*).

FTC's current care label rule, which allows garments to exclusively carry a "dry clean" label even if the garment could also be professionally wet cleaned, is a significant barrier to the diffusion of professional wet cleaning. Adding the professional wet clean label and simply allowing, but not requiring, manufacturers to use it does not fully eliminate this comparative disadvantage for a pollution prevention approach. Garment manufacturers are likely to continue to exclusively use a dry clean label, primarily because of the marginal increased cost in determining a reasonable basis for using a professionally wet clean label. Labeling garments dry clean that can also be successfully professionally wet cleaned itself may constitute a deceptive practice. Evidence for similar deception has already been demonstrated for garments labeled dry clean. While a dry clean label is meant to convey one method for carrying for the garment, in a survey conducted by the Clorox Corporation, over half of the general public has incorrectly understood the label to mean that dry cleaning is the most appropriate method for retorting the garment (*43*).

An FTC rule requiring the professionally wet clean label would likely eliminate an important barrier to pollution prevention and educate customers about the viability of this pollution prevention alternative. The importance of a requirement to the diffusion of professional wet cleaning was echoed in a leading garment care industry trade journal: "If the Federal Trade Commission (FTC) offers a "Professionally Wetclean" care label as an option for garment manufacturers, the pace of adoption will accelerate somewhat. If the FTC makes the instruction mandatory, then wetcleaning may indeed be the wave of the future (*44*)."

Tax Credit Programs. Tax incentives have been used as a public policy tool to encourage industries to switch to cleaner technology. Two states have passed tax credit legislation to encourage dry cleaners to purchase pollution prevention technology. Oregon developed a pilot tax credit program, offering a 50% credit to encourage the elimination of toxic chemical use in three industry groups: dry cleaners, electroplaters, and halogenated solvent users (*45*). North Carolina passed a 20% tax credit toward the purchase of professional cleaning equipment, explicitly excluding PCE and petroleum dry cleaning machines (*46*). Proposed federal tax credit legislation (H.R. 1303) was introduced in Congress in 1999 designed to provide a 20% tax subsidy for cleaners to purchase professional wet clean equipment as well as carbon dioxide equipment (*47*).

While the expressed purpose of these tax credit programs has been to create a positive incentive for cleaners to move away from PCE and petroleum dry cleaning, implementation of the two state programs has already pointed out difficulties with such an incentive approach. A loophole in the Oregon program permitted cleaners to use the tax credit to purchase advanced dry clean equipment; in fact, more cleaners have used the program to purchase dry clean equipment than wet clean equipment (*48*). Oregon terminated this program in December 1999 on the basis of poor industry response. In the North Carolina program, professional wet cleaning equipment was excluded because there was no description of what such equipment should include (*49*). These problems with state programs have reemerged in developing a federal tax credit program. While an amendment was introduced to explicitly include professional wet cleaning and CO_2 equipment, dry cleaning association representatives supported an amendment to also include advanced dry clean equipment (*50*).

Loan Programs. Low-interest loan and loan guarantee programs have also been developed to encourage industries to switch to less pollution technology. Low-interest loan programs reduced the capital cost of acquiring newer equipment by offering loans below conventional bank rates. For example, the California legislation created the Hazardous Waste Reduction Loan Program, which offers fixed loans at below conventional market rates to small businesses to finance equipment that reduces hazardous waste generation (*51*). While dry cleaners have extensively used this loan program to purchase advanced dry clean equipment, the first loan to a cleaner exchanging dry cleaning equipment for professional wet cleaning equipment was approved in December 2000. Private lending institutions have also expressed interest in providing low-interest loans to cleaners purchasing less polluting technology.

Loan guarantee programs are also available to businesses interested in purchasing less polluting technology. Loan guarantee programs allow businesses to obtain lower loan rates from banks by guaranteeing payment to the lending institution if the business defaults on payment. These programs are particularly important for small businesses such as professional cleaners, which often are classified as high risk by banks and, therefore, can only obtain high interest rate loans. The South Coast Air Quality Management District, for example, provides loan guarantees to small businesses purchasing new low emission technology (*52*).

While such low-interest loan and loan guarantee programs may provide an increased incentive for cleaners to switch to pollution prevention technology, by allowing cleaners to purchase advanced dry clean equipment and thereby lowering the capital cost of purchasing pollution control equipment, they also can serve as a barrier to the diffusion of professional wet cleaning. Amending such programs to exclude the purchase of pollution control technology when pollution prevention technology is available would eliminate this barrier.

Making Pollution Prevention Happen

The situation with dry cleaning and professional wet cleaning as a pollution prevention alternative is perhaps most instructive in illustrating the importance of integrating pollution prevention technology into public policy. By simply relying on changes in the market without policy interventions, pollution prevention (in this case, professional wet cleaning) is at a disadvantage because of the reluctance to change long-standing operations and policy frameworks (e.g., the emphasis on control measures and the care label rules).

By emphasizing the range of pollution control regulatory interventions for the garment care industry, a regulatory crisis has resulted. Most dry cleaners are unable to comply with existing regulations, regulators find it difficult to enforce existing regulations in a sector as diffuse as the garment care industry, and existing regulations are likely to only become more stringent over time. The great value of a pollution prevention approach, such as professional wet cleaning, is its ability to overcome this regulatory crisis by eliminating regulatory oversight altogether and, therefore, the need for compliance, enforcement, or continuous rule revisions.

With the dry cleaning industry, a number of options exist to facilitate such integration. By designating professional wet cleaning as a viable pollution prevention substitute for dry cleaning (e.g., as Best Available Control Technology), the EPA, OSHA, and other state and regional regulatory agencies could use existing statutory authority to phase out the use of PCE. In addition, the diffusion of professional wet cleaning would be significantly enhanced if the FTC required garment manufacturers to use a professionally wet clean care label for garments currently labeled dry clean or dry clean only. Tax credit legislation as well as low-interest loan and loan guarantee programs could establish incentive-based policy options, provided they are structured as explicit pollution prevention programs.

The existing crisis in regulation, the availability of a pollution prevention substitute and its evaluation as a viable alternative, and the identification of regulatory and incentive-based public policies strongly suggest the need for transitional support mechanisms to be developed within the garment care industry. Such support mechanisms can enable facility owners to learn the new process, retrain employees, develop a specific facility plan when switching technologies, and establish new mechanisms for quality control. The need for transitional support mechanisms will undoubtedly be important in any sector in which viable pollution prevention technologies have been identified and evaluated and where public policies are in place to encourage or require a transition to the cleaner technology. For pollution prevention to succeed, it needs both a process for evaluation and the policy instruments that establish the pathway for change.

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Supporting Information Available

Summary of methods and results of real-world case studies evaluating the viability of professional wet cleaning. Factors evaluated include performance capability, financial capacity, and environmental impact. This material is available free of charge via the Internet at http://pubs.acs.org.

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