

THE ROLE OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY IN
FOSTERING INNOVATION TO DEVELOP CLEANER INDUSTRIAL
TECHNOLOGIES THAT PREVENT POLLUTION:

A CASE STUDY OF THE REGULATORY ENFORCEMENT PROCESS

by

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Submitted to the Department of Civil and Environmental Engineering
in partial fulfillment of the requirements for
the degree of

**MASTER OF SCIENCE IN
TECHNOLOGY AND POLICY**

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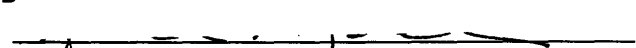
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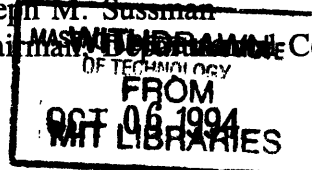

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ABSTRACT

The environmental and economic merits of preventing pollution at the source, rather than controlling or remediating pollution at the "end-of-the-pipe", are achieving increasing recognition by industries, government, workers and citizens alike. As in all technological revolutions, invention and technological innovation, i.e., the commercial adoption of a new technical idea, drive the development of cleaner industrial technologies that prevent pollution.

The central question examined in this thesis is how the U.S. Environmental Protection Agency (EPA) can foster the development and commercialization of cleaner technology in U.S. manufacturing firms. Part I establishes the conceptual framework and examines key factors--internal and external to the firm--that affect a firm's propensity to undertake pollution prevention innovation. Part II examines the ways in which the U.S. EPA has, and could, foster pollution prevention innovation through regulatory and non-regulatory programs. Part III presents an in-depth case study of EPA's experience in promoting pollution prevention--both innovative and non-innovative--in enforcement settlements. This empirical research centers around ten case studies of actual enforcement settlements containing pollution prevention conditions. The case studies were constructed from legal and technical documentation on the ten settlements as well as interviews with EPA and firm negotiators.

Several key conclusions emerged from this research. First, the case studies documented many successful outcomes of EPA's efforts to include pollution prevention in enforcement settlements though mainly through the adoption of widely-used technologies rather than through innovation. Second, though the enforcement process is a challenging setting in which to facilitate innovation, several cases demonstrate that firms may choose to innovate if incentives and sufficient time are granted. Finally, numerous barriers--within the agency and firms--to pollution prevention innovation must be overcome to expand the number of successful cases.

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1.0 INTRODUCTION

The environmental and economic merits of preventing pollution at the source, rather than controlling or remediating pollution at the "end-of-the-pipe", are achieving increasing recognition by industries, government, workers and citizens alike. Slowly, environmental debates within both private and public organizations in the U.S. are moving beyond the discussion of whether to pursue pollution prevention, toward the question of how to realize it in a cost effective manner. As in all technological revolutions, invention and technological innovation, i.e., the first commercial adoption of a new technical idea, drive the development of industrial technologies that prevent pollution.

The role of government in this process is critical and not without precedent. Governments have always had strong influence over paths of technological development through research, purchases of new technologies, subsidies, tax policy and regulation. By determining the stringency, flexibility, timing and continuity of regulatory requirements and enforcement, the U.S. Environmental Protection Agency largely establishes and shapes the market for environmental technology. As such, EPA can--and should--play a pivotal role in fostering pollution prevention innovation through its regulatory and non-regulatory programs.

The central question examined in this thesis is how the U.S. Environmental Protection Agency can foster the development and commercialization (innovation) of pollution prevention technology in American manufacturing firms. The examination is conducted in three parts. Part I establishes the conceptual framework by defining central concepts (such as pollution prevention and technological innovation) and examining key factors--internal and external to the firm--that affect a firm's propensity to undertake pollution prevention innovation. Part II examines the ways in which the U.S. EPA has, and could, foster pollution prevention innovation through regulatory and non-regulatory programs. Finally, Part III presents an in-depth case study of EPA's experience in promoting

pollution prevention--both innovative and non-innovative--in enforcement settlements. This original, empirical research centers around ten case studies of actual enforcement settlements containing pollution prevention conditions.

PART I DEFINITIONS AND CHARACTERIZATIONS OF POLLUTION PREVENTION TECHNOLOGICAL CHANGE

2.0 POLLUTION PREVENTION

The term "prevention" refers to proactive measures taken to avoid adverse affects. Preventing, rather than controlling pollution, averts the transfer of pollution and risks from one environmental or human medium to another (a problem endemic to pollution control strategies), and typically produces gains in material and energy efficiency. The pollution control approach typically consists of a device "added-on" to a process to capture or transform a process waste. In contrast, pollution prevention measures are generally integrated into a manufacturing system. Pollution prevention can be integrated into the design of new technologies¹ or existing systems, although the latter is often more challenging.

The United States Congress provided a good working definition for pollution prevention, as part of the Pollution Prevention Act of 1990:

the reduction or prevention of pollution at the source by any practice which reduces the amount of any hazardous substance, pollutant or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment or disposal; and which reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants.

The term *pollution prevention* is typically used here in referring to an activity (i.e., the pursuit of prevention measures) or as an adjective describing a measure, technique, project, investment or innovative activity that is designed (in whole or in part) to pursue pollution prevention as described above. The term *cleaner technology* is also used to describe a technology that embodies the principles of pollution prevention.

¹ The terms "green design" or "design for the environment" are commonly used to refer to the incorporation of environmental objectives into the design of new technologies.

Pollution prevention techniques can be grouped into four basic categories:

- 1-product reformulation or redesign
- 2-materials (input) substitution
- 3-process modification (including in-process recycling)
- 4-improved operating practices

While significant gains can be made by improving operating practices, the focus of this thesis is on pollution prevention through technological change, involving one or more of the following activities: materials substitution, product reformulation, and process modification (i.e., activities one through three above). Based on the above definition, Figure 1 presents the possible locations of technological change for pollution prevention.

Process modifications can be characterized according to the "locus" of technical change within the series of manufacturing processes that create a final product (not necessarily from the perspective of an individual firm). Changes can be made to *primary*, *secondary*, or *ancillary* processes, where a primary process is one that defines the product and yields its key functional property(s) (e.g., metal casting in the case of a steel bolt); a secondary process is one that is not primary to the function of the product but serves a supplemental function (e.g., the metal plating of the part which provides a non-corrosive or aesthetically-pleasing finish), and ancillary processes are cleaning, degreasing, defluxing and similar operations which are often necessitated by the choice of primary and secondary processes (e.g., use of a chlorinated organic solvent to remove and oil-based metal cutting fluid).

The next two sections provide additional frameworks for characterizing pollution prevention technological changes, specifically in regard to the origin of the technical idea or device.

3.0 TECHNOLOGY DIFFUSION

Pollution prevention technological changes may be achieved either through technology

diffusion or innovation (described below). The term *diffusion* is typically used to mean the widespread adoption of existing technology, involving minor adaptation but little or no

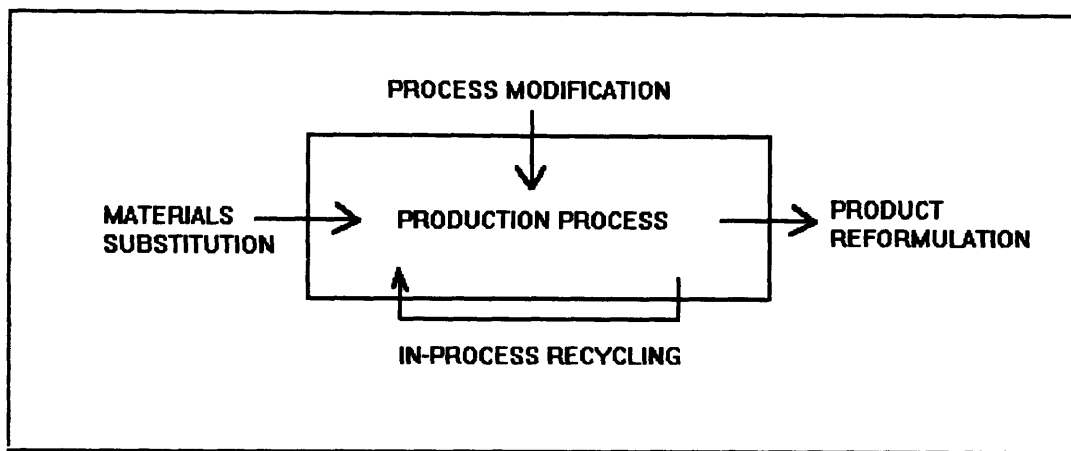


Figure 1. Locations of Pollution Prevention Technological Change in a Generic Manufacturing System

innovation. The term *technology transfer* refers to diffusion between different industries or countries. A significant array of effective pollution prevention technology exists and can be adopted with little or no adaptation. Aqueous-based and mechanical cleaning alternatives to organic solvent-based systems, water-based paints and powder coating alternatives to organic solvent-based coatings, and water or soy-based inks as an alternative to solvent-based inks are but a few examples of pollution prevention technologies which are fairly well developed for many applications.

The cost of a new technology and the accessibility of technical information and assistance (e.g., through consultants and equipment vendors) are critical factors in diffusing pollution prevention technology, particularly where small and medium-sized firms are concerned. Small and medium-sized firms typically have high environmental costs, since they lack economies of scale, and their willingness to adopt new, cleaner technologies is highly dependant upon capital and operating costs of new equipment and inputs. Smaller firms face greater challenges in obtaining objective advice from chemical and equipment vendors.

Perceived risk and uncertainty, accompanying any change of technology or practice, may act as a significant barrier to the adoption of a new cleaner manufacturing process. A switch to a cleaner manufacturing process carries with it the technical and economic risk of modifying production routines and workplace organization (e.g., new activities, work plans, positions, job descriptions). Staff must develop new knowledge and experience with new equipment, materials and products.

4.0 TECHNOLOGY INNOVATION

Innovation is the first commercial exploitation of a new invention and can be categorized in various ways.² *Major or radical innovation* represents a significant shift in technology; *incremental innovation* involves smaller changes or significant adaptation of existing technology. Along another dimension, the categories termed *product* and *process innovation* refer to the creation of a marketable new end-product and a change in production process, respectively. Often, the distinction between a product and process innovation is unclear because new products typically require substantial process innovations to facilitate their production, and process innovations may result in changes in product design.

Technological innovation is considered to be an important force in inducing economic growth by increasing productivity, opening up new markets, and helping to create new firms and jobs. In the language of welfare economics, innovation is an important means to achieve increases in social welfare. Innovation can decrease costs or increase the value of products. By decreasing product costs and holding demand constant, personal disposable income rises. With increased income, more goods can be purchased and social welfare also rises. If the value of the product is also increased through innovation, and if demand remains constant, consumer surplus and net welfare rise.

² Ashford N.A., Heaton, G.A., "Regulation and Technological Innovation in the Chemical Industry," in Law and Contemporary Problems, Vol. 46, No. 3., 1983.

Although technological innovation has, in some cases, created environmental problems, research has shown that innovation is one important pathway to solving technology-based environmental, health, and safety problems particularly where the adoption of existing technology brings only limited benefit.

Traditionally, innovation designed to solve environmental problems has been both compliance-motivated and end-of-pipe oriented. This type of innovation is quite distinct from what is termed *main-business innovation*; i.e., innovation which occurs as a traditional activity of a firm, aimed at increasing the firm's economic competitiveness and profitability.³ A firm's pursuit of pollution prevention innovation, however, may be motivated both by compliance concerns--over current and anticipated regulatory standards--as well as a desire to enhance profitability and competitiveness by cutting waste and liability costs and/or by opening up markets for new processes or improved products. Pollution prevention innovation represents the integration of environmental concerns into main-business innovation activities. This is in contrast to pollution control where the technology of production remains essentially unchanged and end-of-pipe approaches are used.

Pollution prevention innovation can be directed at either reducing the environmental impact of existing products and processes, or at creating less polluting substitute products and processes. Examples of these two types of innovative pollution prevention activities are found in the case studies contained in Part III of this thesis. In one case, Casted Metal Products Manufacturer (CMPM), the company redesigned rinse systems for their acid cleaning, bluing, and phosphate coating areas to reduce water use (by approximately 100,000 gallons per day) and wastewater generation. These changes were significant--technically, economically and environmentally--but they did not involve a fundamental and radical change in the product or in key manufacturing processes.

³ Ibid.

In contrast, in the Bleached Kraft Pulp Manufacturer (BKPM) case, the company developed a non-chlorine-based substitute bleaching process to replace its chlorine-based system. This process change, currently being implemented as part of an EPA regulatory consent agreement, eliminates the generation and emission of toxic chlorinated organic compounds in the mill's bleaching process and the risk of chlorine exposure to workers and the public.

The willingness and capacity of the firm to undertake pollution prevention innovation can be affected by factors internal and external to the firm. Kemp *et al* view environmental technology development (including pollution prevention and control) as competing with, and generally lagging behind, main business innovation since environmental technologies have subordinate status vis-a-vis purely profit-driven innovation.⁴ Furthermore, some manufacturing technologies may have a negative impact on product quality. Gaps in knowledge concerning environmental impacts of inputs, processes and products act as a barrier to action, as do the ever-present barriers to organizational change.⁵

Other factors affecting the firm's propensity to pursue pollution prevention innovation are highlighted here.

Internal factors include:

1. Maturity of the firm and industry. Some researchers have found that the firm's capacity to innovate decreases as it evolves from a small technology-based enterprise to a high volume producer. In the early stages, the firm is flexible and can accommodate product and process innovations relatively easily. In its most mature stage of development,

⁴ Kemp, R.P.M., Olsthoorn, A.A., Oosterhuis, F.H., Verbruggen, H., "Instruments to Promote Environmental Technology," unpublished manuscript from the Institute of Environmental Issues at the Vrije Universiteit of Amsterdam and the Maastricht Economic Research Institute on Innovation and Technology (MERIT) at Limburg University, The Netherlands, July 1991.

⁵ Ibid.

the firm focuses on selling a standardized product at low cost with capital-intensive mass production equipment. Since the cost of major innovation is high, the firm tends to make only incremental changes in products and processes aimed at reducing cost. The "rigidity" of the mature firm's technology can beget a corporate structure and attitude that can act as another barrier to technical change.⁶

An exception to this general picture of technological development are those firms, such as the 3M Company, that produce a diverse and constantly changing array of products. These firms tend to remain technologically and managerially flexible, resulting in greater capacity and opportunity for pollution prevention innovation.

2. Size of the firm. Large firms are often identified as the major sources of innovation, in part because they tend to have larger R&D budgets and better access to information on already existing technology. Innovation at large firms, however, may be hindered by a desire to protect old technologies, indifference to technological advances, and misdirected research. Smaller firms may have an innovative advantage through more flexible markets, dynamic and entrepreneurial management, and better internal communication.⁷

3. Economic position of the firm and industry. The financial capacity of the firm, i.e., cash flow and access to financing (partly an external factor) for R&D and investment, is an important factor affecting a firm's ability to innovate. The present economic position and future outlook for the firm and industry are relevant factors, although they have been shown to cut both ways. A period of growth is conducive to technical change in general and represents a window of opportunity for addressing environmental concerns since pollution prevention can more easily be built into a new investment than be retrofitted onto

⁶ Abernathy, W.J., and Utterback, J., "Patterns of Industrial Innovation," Technology Review, June/July 1978.

⁷ Karmali, A. "Stimulating Cleaner Technologies Through the Design of Pollution Prevention Policies: An Analysis of Impediments and Incentives," Unpublished Master's Thesis, Technology and Policy Program, MIT, May 1990.

existing technology. On the other hand, while economic recession (an external factor) or industrial decline can slow technical change generally, research has documented increased investment in pollution prevention technologies during such periods, motivated by a desire to cut costs.⁸

Finally, the option to pursue pollution prevention innovation may become economically interesting at the time when capital goods need replacing. Otherwise, sunk capital costs may act as a strong disincentive to change existing technology.⁹

4. Type of Industry. Different industrial sectors have varying abilities to innovate. Pavitt's work, for example, concludes that "supplier dominated sectors", such as agriculture, textiles, and printing, are almost entirely dependant on their equipment suppliers for new process innovations. Science-based sectors, on the other hand, such as the chemical, pharmaceutical and computer industries, carry out large scale, highly scientific research and hence tend to have significant innovative capacity¹⁰ which can be (and to some degree have been) turned to developing cleaner technologies.

External factors affecting the willingness and capacity of the firm to undertake pollution prevention innovation include the following:

1. Regulation and liability. Strict regulation, enforced in a stringent yet flexible way¹¹,

⁸ OECD cited an example of this phenomenon. In France, during the period 1974-1977, the adoption of "cleaner technologies" was greatest in industries where there was a relative decline in investment (except food production). Organisation for Economic Co-Operation and Development (OECD), "Environmental Policy and Technical Change," Paris, 1985.

⁹ Kemp, R.P.M. et al, 1991, op.cit.

¹⁰ Pavitt, K., "Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory, Research Policy, Vol. 13, 1984, pp. 343-373.

¹¹ Flexibility may take several forms, including: varying length of time to comply with regulations to permit R&D, varying strictness according to special industry circumstances, and temporary exemptions tied to a "contract" between the industry and the agency to carry out an R&D program in new technologies. (OECD, 1985. op.cit.)

has been found to stimulate innovative and efficient (with regards to energy and raw material costs) technological changes.¹² Some industry members claim that the threat of liability, for environmental impairment (under RCRA) and cleanup (under CERCLA) has stimulated innovation and preventive technological changes; others suggest that the cost associated with posting performance bonds, as required by these acts, impedes innovation.¹³ Liability concerns on the part of large firms have been translated into requirements on component suppliers to meet certain environmental standards (e.g., hazardous waste reduction efforts or CFC-free manufacturing), these requirements have given some smaller supplier firms incentive to change their technology.

Stringent regulation can stimulate technical change either within the regulated firm, on the part of equipment or chemical suppliers to the regulated firm, and/or can motivate a non-regulated firm to enter the market with a substitute product.¹⁴ An example of the first response is the Bleached Kraft Pulp Manufacturer (BKPM) case (summarized in Appendix A). This regulated mill changed its manufacturing technology to meet effluent toxicity standards. The second type of response characterizes the development of aqueous degreasing technology--developed by equipment and chemical vendors--to replace chlorinated organic solvent-based degreasing systems at regulated firms. Finally, the third type of response--innovation by a new market entrant--occurred when EPA phased-out the production and use of PCBs. Monsanto, the sole manufacturer of PCB transformer fluid, sought to find a replacement for PCBs, but could not.¹⁵ Dow-Silicone replaced PCBs with silicone-based fluid which was developed originally for other purposes but recognized by

¹² OECD, 1985. op.cit..

¹³ Karmali, 1990. op.cit..

¹⁴ Ashford, N.A., Ayers, C., Stone, R.F., "Using Regulation to Change the Market for Innovation," Harvard Environmental Law Review. Vol. 9, No.2, Summer 1985, pp. 419-466.

¹⁵ The company's inability to find a suitable substitute may be attributable to its attempts to develop another fluid based on the basic molecular structure of PCB (i.e., the biphenyl ring). Monsanto's former PCB dielectric business can be described as mature, large-scale, and automated. According to the framework described in Section C.1. above, a firm with this technology profile is an unlikely candidate for innovation.

Dow-Silicone as having suitable dielectric properties. Silicone has since become one of the principal transformer dielectrics on the market today.

Figure 2 presents a model for regulation-induced technological change. The effect of regulation on innovation is elaborated upon further in Section 5.1.

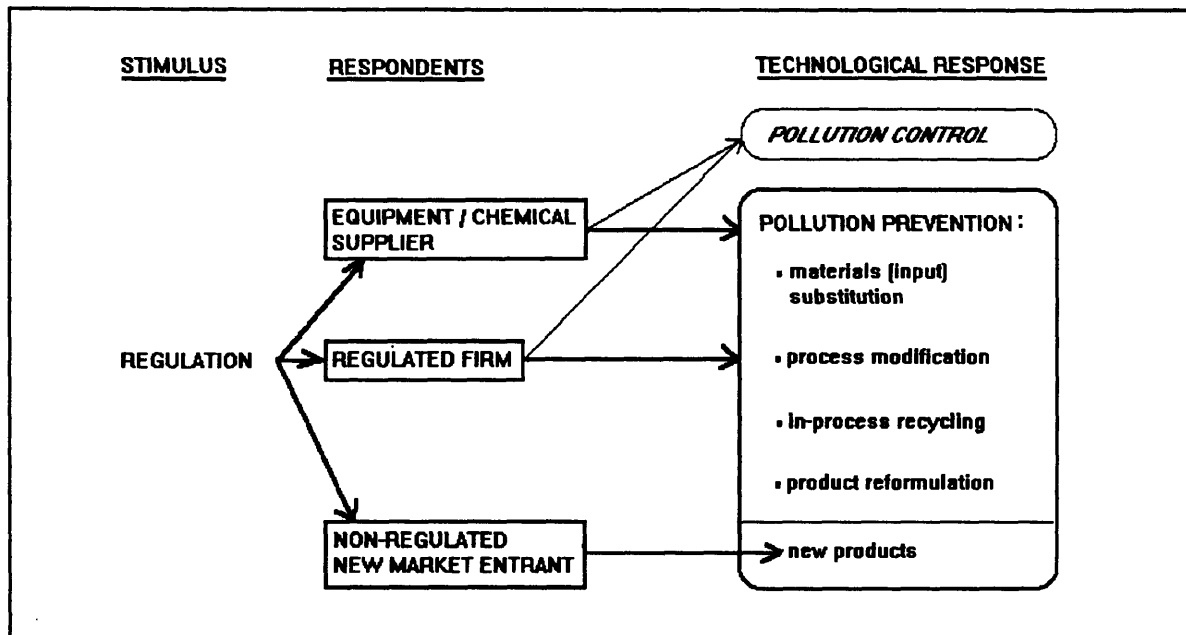


Figure 2. A Model for Regulation-Induced Technological Change (after Ashford, Ayers, & Stone, 1985, see footnote 14)

2. Markets for new processes and products. Innovation can be stimulated by the prospect of developing new technology or products for the market. The success of the innovation in this context is a function of both the technical and marketing abilities of the firm.¹⁶ For example, in cases where the adoption of a cleaner manufacturing process will result in a change to the characteristics of the product, the success of the innovation may be largely

¹⁶ For a discussion of the implications of innovation for the success or failure of the innovating firm, see: Abernathy, W.J., and Clark, K.B., "Innovation: Mapping the Winds of Creative Destruction" in Tushman, M.W. & Moore, W.L. Readings in the Management of Innovation, 2nd edition. Cambridge: Ballinger, 1988.

determined by the ability of the firm to marshal its marketing forces to gain acceptance for the new product. The Bleached Kraft Pulp Manufacturer case study in Part III of this thesis is an excellent example of this point.

The distinction between product and process innovation is important here. Demand for cleaner consumer products can be created by the market. This "demand pull" can be a significant motivation for firms to develop new cleaner products. By contrast, the demand for cleaner manufacturing processes is still primarily driven by environmental regulation; therefore, environmental technology suppliers face a more uncertain (and often less motivating) market for their cleaner manufacturing technologies.¹⁷ This issue is explored further in Part II.

3. Public and market pressure. Armed with data from the SARA Toxics Release Inventory and other sources of information on emissions and impacts, the public is exerting pressure on firms to change their technology to less polluting modes of production. In addition, a growing demand for lower-impact products has stimulated product and process change within existing firms and has created new "green product" market entrants. These developments are slowly creating a new arena of competition around environmental performance, resulting in an incentive for technical change.

4. Technical expertise. Technical change for both main business and environmental purposes requires that the engineers and scientists expand their objective functions to include environmental concerns along with performance and cost.¹⁸ This mode of thinking has not yet been widely embraced by universities, treating environmental concerns as a design problem that is separate from the manufacturing process itself.

¹⁷ Kemp, R.P.M. et al., 1991, op.cit.

¹⁸ Allen, T.J., Utterback, J.M., Sirbu, M.A., Ashford, N.A. and Holloman, J.H., "Government Influence on the Process of Innovation in Europe and Japan," Research Policy, Vol. 7, No. 2, April 1978. In an analogous fashion, managers must be held accountable for environmental performance as well as product quality and production cost.

In conclusion, pollution prevention innovation holds great promise for solving environmental problems and for realizing increased efficiencies or expanding markets. However, uncertainty associated with innovative technical change can be a significant barrier to industry's willingness to undertake it. The firm may face technological uncertainty concerning the success or failure of the technical change, financial uncertainty over the full cost of developing and implementing the innovation, and market uncertainty regarding the ability of the firm to market a new product or process along with changing market conditions. Furthermore, there may be regulatory uncertainty, particularly for firms acting in anticipation of future regulatory standards.¹⁹ Innovation is risky, but larger returns (measured both in dollars and environmental improvement) over diffusion-driven pollution prevention can be realized only with some risk taking.

¹⁹ OECD, 1985, *op.cit.*.

PART II - THE ROLE OF EPA IN FOSTERING INNOVATION TO DEVELOP POLLUTION PREVENTION TECHNOLOGIES: REGULATORY AND NON-REGULATORY APPROACHES

In January of 1994, EPA released an external discussion draft of its "Technology Innovation Strategy" (referred to henceforth as "the Strategy"), prepared by EPA's Innovative Technology Council--an agency-wide coordinating committee that reports to the EPA Assistant Administrator for Policy, Planning and Evaluation. The Strategy outlines a broad range of actions designed to foster the development and adoption of innovative end-of-pipe controls, cleaner industrial technologies that prevent pollution, monitoring and instrumentation, and environmental management information technology. The explicit goals of the Strategy are to foster technology innovation to help meet national and international environmental goals, as well as to stimulate the domestic environmental technology²⁰ industry and expand export capacity. The Strategy is seen as an integrated part of the Clinton Administration's February 22, 1993 technology policy ("Technology for America's Economic Growth: A New Direction to Build Economic Strength"), which assigns the federal government a catalytic role in promoting the development of new technologies in several strategic sectors, including environmental technologies.

²⁰ While not explicitly defined in the Strategy, a study by Kemp, Olsthoorn, Oosterhuis, and Verbruggen provides a useful definition of the term "environmental technology" as that which is "sufficiently focused on reducing the burden on the environment by the production or consumption process; either as a result of pressure or coercion by government and/or pressure groups, or for reasons to do with market opportunities or social considerations." In this way, environmental technology innovation is distinct from what is termed "normal technology innovation" which is aimed at improving productivity by increasing input or production efficiency or to improve or create new products. Kemp, R.P.M., Olsthoorn, A.A., Oosterhuis, F.H., Verbruggen, H., 1991, op.cit.

The Strategy lays out four objectives:

1. Adapt EPA's policy, regulatory and compliance framework to promote innovation;
2. Strengthen the capacity of technology developers and users to succeed in environmental technology innovation;
3. Strategically invest EPA funds in the development and commercialization of promising new technologies; and
4. Accelerate the diffusion of innovative technologies at home and abroad.

The Technology Innovation Strategy comes on the heels of three key reports on environmental technology innovation and diffusion, issued by the National Advisory Committee for Environmental Policy and Technology (NACEPT), through the efforts of its Technology Innovation and Economics (TIE) Committee. The TIE Committee reports provide a critical assessment of the ways in which U.S. environmental policies act as barriers to environmental technology innovation²¹--both end-of and pollution prevention--and make recommendations to overcome these barriers. The Committee was made up of representatives from state and federal agencies, industry, academia, consulting, and non-profit sectors. In developing its analysis, the committee conducted its own investigation, and convened several focus groups with similar representation. The efforts of the TIE Committee constituted the first comprehensive governmental attempt to examine the connection between specific U.S. environmental policies, technology development and diffusion.

²¹ U.S. EPA, NACEPT, TIE Committee, "Report and Recommendations of the Technology Innovation and Economics Committee, Permitting and Compliance Policy: Barriers to U.S. Environmental Technology Innovation," EPA 101/N-91/001, January 1991; U.S. EPA, NACEPT, TIE Committee, "Improving Technology Diffusion for Environmental Protection, Report and Recommendations of the Technology Innovation and Economics Committee," EPA 130-R-92-001, October 1992; U.S. EPA, NACEPT, TIE Committee, "Transforming Environmental Permitting and Compliance Policies to Promote Pollution Prevention: Removing Barriers and Providing Incentives to Foster Technology, Innovation, Economic Productivity, and Environmental Protection," EPA 100-R-93-004, April 1993.

With the issuance of the Technology Innovation Strategy, and the reports of the TIE Committee, EPA appears positioned to launch a major initiative to stimulate technological innovation for the environment. The next two sections contain an overview of regulatory and non-regulatory mechanisms that have been used, effectively or otherwise, to foster the development of pollution prevention technologies. These sections draw from EPA's Technology Strategy, the TIE Committee reports and other sources.

5.0 REGULATORY OPTIONS

Over the years, federal environmental regulatory programs have created a bias--on the part of regulators and the regulated community--toward the resolution of environmental problems through the adoption of existing pollution control technologies. This section presents an overview of key issues regarding the ways in which federal environmental regulatory programs present barriers to, and opportunities for, pollution prevention innovation.

5.1 Standard Setting

EPA typically bases emission standards on the effectiveness of specific pollution reducing technologies that are known to itself and to industry. The Clean Water Act, for example, requires that the regulated community achieve as much or more control as that offered by the best available technology (or BAT) for "nonconventional" and toxic pollutants, in consideration of the cost of achieving such reductions and other factors.²² While industry is allowed to choose any technology to meet the standard--pollution control or prevention--in practice industry tends to choose the technology that was cited by EPA in the standard development process. By choosing this course, firm's believe they are reducing their risk of being found out of compliance since they are simply following, as directly as possible, the mandate of the agency.²³ By choosing the low-risk, EPA-anointed technology, an

²² Clean Water Act, 33 U.S.C. Sections 301(b)(2) and 304(b)(2)(B).

²³ Tietenberg, Tom. Environmental and Natural Resource Economics. 3rd Edition. New York, New York: Harper Collins, Inc., 1992, page 492.

opportunity for the regulated industry to innovate is lost. The incentive for a chemical or equipment supplier to innovate is lost as well, since the regulated community is not creating a demand for a new, cheaper, or more efficient technological alternative.

EPA permit writers also perceive an elevated risk associated with innovative approaches to meeting standards. The EPA official faces a professional risk in approving an innovative technology--which has an unproven track record--over a proven, identified option. If the permit writer lacks the knowledge and experience to determine the appropriateness of a proposed innovative technology for compliance purposes, if insufficient time is available to review the proposal, if the official is not encouraged or rewarded for the extra effort associated this endeavor, or if bureaucratic obstacles slow-down or frustrate the approval process, the likelihood of an innovative outcome is slim.²⁴

Theoretically, performance-based standards (i.e., standards that are not based on a specific type of existing technology, sometimes called "media-quality-based standards"), should cure the tendency of the regulator and regulated to adopt the exact technology upon which the standard was based. Such standards may be designed to meet specific environmental targets rather than to promote the rapid adoption of the best existing technology. However, unless the standard is sufficiently stringent, firms and regulators may still opt for a tried-and-true technology in favor of taking the innovative route. Ashford, *et al* view regulatory stringency as the single most important determinant of an innovative regulatory response. A regulation is considered stringent if: it requires significant reduction in exposure to toxic substances; compliance using existing technology is expensive; or compliance requires a significant technological change.²⁵

The OECD defined four types of regulatory standards which embody differing "attitudes"

²⁴ U.S. EPA, NACEPT, TIE Committee, "Report and Recommendations of the Technology Innovation and Economics Committee, Permitting and Compliance Policy: Barriers to U.S. Environmental Technology Innovation," EPA 101/N-91/001, January 1991.

²⁵ Ashford, et al, Summer 1985. op.cit.

toward technical change.²⁶

1. An "average standard" is based on a majority technology which can be adopted by remaining firms without great difficulty. This practice, which may be justified on economic grounds (i.e., economic feasibility), may hamper technical innovation and will likely encourage diffusion of existing technologies.
2. A "model standard" is based on technology applied by the most advanced and innovative firms. This type of standard promotes the widespread adoption of state-of-the-art technology, but does not promote innovation.
3. An "experimental standard" forces firms to achieve a standard based on the performance of technology that has been developed in the laboratory, or is in the experimental stage, but not yet in commercial use. This type of standard can be considered technology-forcing.
4. A "venture standard" is one for which there is no existing technological solution. This standard is clearly technology-forcing.

According to OECD, to promote an innovative response, the adoption of technology-forcing standards, i.e., experimental and venture standards, must be coupled with R&D assistance, financing assistance, provision of technical information, and flexible compliance and enforcement strategies. More is said about these activities in subsequent sections.

5.1.1 Chemical Bans and Phase-Outs

Chemical bans and phase-outs, two classes of regulatory controls, can be viewed as very stringent environmental standards having particularly interesting implications for innovation. Chemical bans prohibit either the production, use, a subset of uses, or the distribution of a chemical; phase-outs ban the use or production of a chemical over a

²⁶ OECD, 1985, op.cit..

period of time.²⁷

Bans and phase-outs tend to be stringent relative to emissions standards since they disallow the chemical itself, rather than permit a manufacturer or user of the chemical to adopt measures to reduce chemical emissions.²⁸ Some of the handful of chemical bans and phase-outs that have been implemented have brought about significant product innovation designed to produce new substitutes for the restricted substance. For example, the 1976 banning of PCBs under TSCA was the impetus for the development of silicone as a substitute dielectric; the 1978 banning of CFC's in aerosols prompted the introduction of a mechanical substitute ("the pump") and a non-fluorocarbon CO2 propellant. More recently, the following statement was contained in a 1991 assessment, developed by the Technology and Economic Assessment Panel, of the progress made under the London Amendment to the Montreal Protocol:²⁹

Lesson 1. Technological optimism is amply justified by the historical record. Innovation to replace CFCs has been rapid, effective, and economical. Fears that substantial cutbacks in the use of ozone-depleting substances (ODSs) would reduce the quality and/or increase the price of goods and services previously dependent on CFCs have largely been proven groundless. While the path of technological substitution has not always been smooth, and although it is probable that some setbacks and disappointments will occur between now and the final phase-out of ozone-depleting substances, it has nevertheless been generally true that scientific, engineering, and entrepreneurial innovations have been sufficient to overcome the losses of ODSs. Not only has it been technically possible to replace CFCs in a continuously expanding range of applications, but in many cases it also has been relatively inexpensive or even profitable to do so. And while it may be expensive

²⁷ The Massachusetts Toxic Use Reduction Institute, "Toxic Chemical Management in Massachusetts: An Analysis of Further Chemical Restriction Policies," University of Massachusetts Lowell, 1993.

²⁸ In some cases performance standards may be so stringent that they effectively prohibit the use of a substance.

²⁹ The Montreal Protocol on Substances that Deplete the Ozone Layer is an international treaty signed in 1987 and entered into force on January 1, 1989. Before its revision in 1990, the Protocol required each party to reduce its production and consumption of CFCs and to freeze production and consumption of halons to 1986 levels. The London Amendments to the Protocol sets out an agreement to phase-out carbon tetrachloride, 1,1,1 trichloroethane, and CFCs.

to substitute for some high-value uses of ODSs as the phase-out deadline approaches, it is only in a few highly specific cases that such replacements might prove to be infeasible.³⁰

In some cases, however, the substitutes that were developed to replace banned substances were themselves harmful. This was the case when in 1972 EPA banned DDT for most agricultural uses. The pesticide was first replaced by Toxaphene, a human health hazard that was eventually banned in 1983. Subsequently, DDT has been replaced by malathion and parathion; two chemicals with greater adverse health impacts for workers.³¹

In the U.S., three federal agencies have the authority to ban chemicals: the EPA, the Food and Drug Administration (FDA), and the Consumer Product Safety Commission (CPSC). The Toxic Substances Control Act (TSCA) gives EPA authority to prohibit or limit the manufacturing, processing or distribution in commerce of a chemical or product, though the agency can take this action only after substantial study of the costs and benefits of the policy and if they can prove that a ban is the "least burdensome" regulatory method.³²

Bans and phase-outs pose many economic and other potential disadvantages, making them politically difficult to implement. Problems may include: economic costs on chemical manufacturers and industrial users, costs to the economy in general, economic dislocations owing to plant closings or relocation overseas, and the lost benefit to consumers stemming from the use of the banned substance. For these reasons, all previous attempts to ban a chemical have been met by strong opposition from economic interests. Typically, these

³⁰ Montreal Protocol, 1991 Assessment, Report of the Technology and Economic Assessment Panel, December 1991.

³¹ TURI, 1993, op.cit.

³² 15 U.S.C. §2605 (a). A 1991 court ruling may constrain EPA's future inclination or ability to ban chemicals under TSCA. In 1991 the U.S. Court of Appeals, Fifth Circuit, ordered the withdrawal of EPA's proposed regulation under TSCA banning most uses of asbestos. The Court's ruling was primarily based on a determination that the agency had not carried out a requirement of TSCA by failing to first evaluate the less-burdensome alternatives to banning, before proposing the asbestos ban. Corrosion Proof Fitting, et al., Petitioners, versus the Environmental Protection Agency, 33 ERC 1961 (5th Cir. 1991).

interests argue that the problems associated with the substance are non-existent or exaggerated, more research is needed before action is taken, no technically and economically feasible alternatives exist, and that serious economic hardship would occur if the substance was banned. Hence, EPA must be able to justify an investment of a significant amount of time and political capital to enact just a single chemical prohibition.³³

5.1.2 Regulatory Uncertainty

Regulatory uncertainty may be prejudicial to innovation. Time delays in promulgating regulations and frequent changes in enforcement schedules (i.e., through postponements of compliance deadlines) impede long-term investment planning. A lack of precision in regulations and the threat of regulatory amendments can also create a climate of uncertainty for the prospective innovator.³⁴ If the market for environmental technologies is unpredictable, technology developers find difficulty in obtaining financing and risk developing technologies that either over or under-comply with new standards. This climate creates an incentive to adopt in-use, existing technologies, rather than to create new technologies which may be more effective and efficient.³⁵

5.2 Market-Based Incentives

Some economists believe that market-based approaches to environmental protection stimulate the private sector to develop new pollution reduction technologies, at a lower cost than the command-and-control approaches discussed above. Economic incentive approaches include pollution charges (i.e., taxes or levies) and tradeable permit systems that theoretically drive firms to reduce their pollutant emissions to a point where the marginal cost of pollution reduction is equivalent to the pollution tax or market price for a unit of pollution, respectively. If the system operates properly, low-cost controllers

³³ In the case of six chemical bans--carbon tetrachloride, DDT, EDB, CFCs, PCBs and urea-formaldehyde foam insulation--it took an average of 10 years to enact federal bans from the time that a hazard was identified. TURI, 1993, op. cit.

³⁴ OECD, 1985, op.cit., page 78.

³⁵ U.S. Environmental Protection Agency, "Technology Innovation Strategy", January, 1994, page 12.

would control more pollution and high-cost controllers would control less, and the net result would be a cost-effective distribution of the pollution reduction burden on industry. Compared to technology-based standards, these schemes (in theory) are less discouraging of a firm's choice of how to achieve a reduction in pollution. Furthermore, if investments in pollution reducing innovative technologies can improve a firm's profits under incentive-based systems, firms will be encouraged to develop and adopt innovative technologies.³⁶

5.3 Innovation Waivers

Innovation waivers, currently built into the Clean Air Act, the Clean Water Act and RCRA, offer an incentive for technological innovation by extending compliance deadlines during new technology trial periods. However, as a study by Ashford et al point out, innovation waivers have not been successful in achieving their intended purpose.³⁷ The Clean Air Act Amendments of 1977 contain two innovation waiver provisions--one for new sources and another for existing sources. The new source waiver grants the EPA Administrator the authority to waive the New Source Performance Standard to encourage the use of innovative technology for emissions reduction. Among other requirements, the new technology must be likely to either reduce emissions below the NSPS requirement or reduce to the NSPS requirement at lower cost. Companies must apply for a waiver; the EPA Administrator may establish a waiver period not to exceed seven years after the issue date or four years after the source begins operation. If the innovative technology fails, the waiver is terminated; the company then has up to three penalty-free years to comply with the regulation using conventional technology. Section 111(j) of the Act requires notice and opportunity for a public hearing prior to the granting of a waiver.³⁸ A condition for granting a waiver for an existing source is if the source is unlikely to use the innovative technology unless a waiver is granted. An existing source waiver can extend the

³⁶ Stavins, Robert N., ed. "Project 88 -- Round II, Incentives for Action: Designing Market-Based Environmental Strategies." A Public Policy Study sponsored by Senator Timothy E. Wirth, Colorado, and Senator John Heinz, Pennsylvania. Washington, D.C., May 1991, Chapter 1, pp. 1-13.

³⁷ Ashford, et al, Summer 1985. op.cit.

³⁸ 42 U.S.C. §7411(j).

compliance date up to five years from the date that the source would otherwise be required to comply and a three-year, penalty-free compliance period should the innovative technology fail.³⁹

The Clean Water Act contains a provision that authorizes the EPA Administrator to grant BAT compliance extensions to existing sources. Dischargers may be eligible for a waiver either if they install innovative technology that reduces effluents significantly in excess of the BAT requirement or at the level of the BAT standard but at significantly lower cost. In either case, the technology must be shown to have potential for industry-wide application.⁴⁰

The 1984 amendments to RCRA included a waiver provision within the section that sets forth permit requirements for new and existing facilities that treat, store and dispose of hazardous waste. This provision, called a Research, Development and Demonstration Permit, authorizes EPA to issue permits for RCRA-regulated activities which constitute innovative or experimental hazardous waste treatment technologies or processes.⁴¹ (Since the RCRA waiver provision deals with waste treatment, and not pollution prevention, it is not discussed further.)

In a 1980 study of activity under the Clean Air Act waiver provisions, Evans found that from 1977 to 1980, few companies had applied for innovation waivers, EPA had granted only one, and companies that had applied were reluctant to do so again.⁴² Reasons given for the lack of success included: agency and industry perceived ambiguity in legislative

³⁹ 42 U.S.C. §7411(j)(2)(A).

⁴⁰ 33 U.S.C. §1311(k).

⁴¹ U.S.C. § 6925(g).

⁴² Evans, "Opportunities for Innovation: Administration of Sections 111(j) and 113(d)4 of the Clean Air Act and Industry's Development of Innovative Control Technology," in Department of Commerce ETIP Policy Research Series, Vol. 3 Incentives for Technological Innovation in Air Pollution Reduction 7, Jan. 1980; cited in Ashford, et al, Summer 1985, op.cit.

directives resulting in confusion regarding waiver eligibility (e.g., the lack of a clear definition of what is considered "innovative" or "new" technology), prolonged delays within EPA in determining eligibility for a waiver, and the assignment of waiver implementation to an enforcement-oriented division of EPA (i.e., the Stationary Source Compliance Division, "SSCD").

According to Ashford et al, the waiver provision of the Clean Water Act is clearer than the Clean Air Act in its definition of innovative technology.⁴³ Furthermore, the waiver provisions in the Clean Air Act requires that the applicant show that the technology will operate effectively and prove that it has not yet been demonstrated effective. This presents a statutory dilemma for the applicant since a technical feasibility assessment may require demonstration. The Clean Water Act, on the other hand, requires that the applicant demonstrate that its technology will result either in lower discharges than the BAT standard or achieve BAT at lower cost; a much more straightforward approach. The determination of eligibility is made by the a State Director or EPA Regional Administrator in consultation with a technical review panel, not an enforcement-oriented arm of the agency. This avoids the "enforcement orientation bias", inherent in the Clean Air Act program, from the agency review process. If, after a good faith effort, the discharger fails to meet the extended compliance deadline due to a technical failure, EPA may choose not to impose a civil penalty on the violator and instead enter into another consent decree establishing a new compliance schedule.⁴⁴ This type of "fail soft" approach, according to Ashford et al, is a necessary enticement for innovators to take advantage of waiver provisions since the development of innovative technologies can be complicated, full of unanticipated delays and risky.

In its 1991 report on permitting/compliance policy and innovation, the TIE Committee

⁴³ Defined as "a production process, a pollution control technique, or a combination of the two . . . which has not been commercially demonstrated in industry of which the requesting discharger is a part." 40 C.F.R. § 125.22(a).

⁴⁴ Ashford, et al, Summer 1985, op.cit.

found that the regulated community has made very limited use of waiver provisions in both the Clean Air Act and Clean Water Act for over a decade. The waiver provisions were viewed as having great potential for removing barriers to the implementation of pollution prevention innovation, in particular. Therefore, the Committee recommended that the agency make a policy and organizational commitment to revitalizing its waiver authorities and to adopting "soft landing" policies to complement innovation waiver programs.⁴⁵

5.4 Testing and Demonstrating Innovative Technology⁴⁶

Through all stages of the creation of a new technology--research, development, and demonstration--the creator needs to evaluate system performance and cost. Undoubtedly, testing is a critical part of the development of new technology designed (completely or in part) for environmental compliance; thorough testing increases the likelihood that a new technology will perform well when it is scaled-up and demonstrated to a regulatory authority. However, the Clean Air Act, Clean Water Act and RCRA contain limited provisions to accommodate or foster the testing of innovative technologies during the permitting process, and these limited provisions have been narrowly defined and/or underutilized by EPA and its state designees. The lack of a working and predictable process to test and demonstrate new technologies during the permitting process inhibits the introduction of new environmental technologies.

RCRA, contains a provision (in Section 3005(g)) that provides the agency with the authority to permit a technology specifically for "research, development and demonstration" (RD&D). However, this provision has been narrowly interpreted and little used (fifteen such permits were issued between 1985 and 1991). Under the Clean Air and Water Acts, no equivalent provisions exist, though *ad hoc* mechanisms have been used to accommodate testing in some cases. For example, testing of pollution control technologies have been conducting under a Clean Water Act provision allowing permit-writers to use

⁴⁵ U.S. EPA, NACEPT, TIE Committee, 1991, op.cit., pp. 66-68.

⁴⁶ Ibid.

"Best Professional Judgement" when writing permits.⁴⁷

Testing of new pollution prevention technologies may be doubly discouraged by the lack of cross-media coordination in permitting (discussed below). Pollution prevention technologies may affect emissions to more than one medium, thereby transcending the agency's single media-based institutional boundaries.

The TIE Committee devised several recommendations to overcome limitations in current regulatory programs for testing and demonstration of new technologies. These recommendations were aimed at: increasing the flexibility and cross-media coordination of RCRA, Clean Water Act and Clean Air Act permitting systems to accommodate testing; ensuring that public health and environmental protection are assured during testing; increasing the clarity, for the regulated community, of the agency's intentions to encourage testing of innovative technologies in its permitting processes; and assuring the confidentiality of secret information about innovative technologies during testing and demonstrations.

5.5 Permitting and Compliance Policy

EPA's primary regulatory administrative activities aimed at implementing environmental regulations are its permitting and compliance policies. A regulated entity must obtain a discharge permit from the agency (or its state or local designee) which establishes a limit to the amount of a pollutant that may emitted, consistent with the relevant regulatory effluent limitation. A permit constitutes an agreement between the firm and the agency on the specific technology that will be used to meet regulatory requirements; therefore, the permitting process can represent a critical point in determining whether pollution prevention or control will be used and whether a firm will adopt an existing technology or develop a new one. Compliance policy embodies all activities that the agency undertakes to monitor and enforce regulatory compliance, such as the evaluation of self-reported

⁴⁷ Ibid.

discharge data and on-site inspections.

The 1991 TIE Committee report on *innovation* and permitting/compliance policy concluded the following:

...permitting and compliance systems, as they function today, discourage all stakeholder groups from taking the risks necessary to develop innovative technologies--whether for pollution prevention or for pollution control--and to bring them into routine use to solve environmental problems.⁴⁸

The 1993 TIE Committee report on *pollution prevention* and permitting/compliance policy added another dismal appraisal:

Two decades of permit requirements based on the control of releases to a single medium have produced expectations and analyses, both among the regulated community and the regulators, which isolate fragments of environmental problems. These patterns are now embedded in individual permits, in the expectations surrounding negotiations over new permits or permit renewals, in the organizational structure of environmental agencies and industry environmental staffs, in the training programs and career rewards available to those at all levels of federal, state, and local government agencies, and in the management and technology strategies of industries supporting environmental compliance....This fragmentation encourages media-specific pollution control fixes rather than overall reductions in the pollutants generated, allowing cross-media transfers of pollutants, and discouraging companies from comparing the total costs and benefits of pollution control systems in all media with the costs and benefits of pollution prevention alternatives.⁴⁹

In general, the TIE Committee viewed the processes of permitting and compliance as key windows-of-opportunity for fostering innovation and pollution prevention; though many barriers act to prevent the agency and the regulated community from realizing this potential. The next few sections contain a summary of the findings of the TIE Committee

⁴⁸ Ibid, p. 50.

⁴⁹ U.S. EPA, NACEPT, TIE Committee, "Transforming Environmental Permitting and Compliance Policies to Promote Pollution Prevention: Removing Barriers and Providing Incentives to Foster Technology, Innovation, Economic Productivity, and Environmental Protection," EPA 100-R-93-004, April 1993, page 22.

and their recommendations for furthering the goals of pollution prevention innovation.⁵⁰

5.5.1 Permitting

The Committee concluded, that in order to facilitate innovative outcomes, permitting processes and permit conditions must be flexible, predictable, clear, respecting of confidential information, and stringently enforced. The statutory ability and personal willingness, on the part of regulators, to consider alternative technological means to achieve a regulatory standard and to extend the statutory time limit for permits including RD&D of innovative technology are critical factors.

The TIE Committee observed that the outcome of obtaining an operating permit, when an innovative technology is involved, appears less certain, takes longer to resolve, and costs more than if a conventional technology was involved. Uncertainty increases when multiple media and/or multiple jurisdictions are involved, since effective coordination between media offices and jurisdictions is rare. This has been found to be particularly true for RCRA, and to a lesser extent the Clean Air and Clean Water Acts. As a result of this uncertainty, potential technology developers find the prospect of creating new technologies risky, time consuming, and costly.⁵¹

An important barrier to permitting innovative pollution prevention technologies stems from the lack of permit process coordination, across environmental media and among federal, state, and local jurisdictions. Single medium focused permitting processes encourage media-specific/end-of-pipe solutions, rather than more comprehensive efforts to substitute

⁵⁰ In its examination of the barriers to, and opportunities for, technological innovation, the TIE Committee examined both pollution control and pollution prevention innovation. Some of the issues relating to the development of new pollution prevention technology and pollution control technology are similar, and some are dissimilar since the two processes often entail different motivations, actors, and outcomes. The TIE Committee report on innovation often paints the issue of innovation with one broad brush. Therefore, for this discussion, I have highlighted those issues that seem to be most pertinent to pollution prevention innovation.

⁵¹ U.S. EPA, NACEPT, TIE Committee, 1991, op.cit.

inputs and redesign production technology. Coordination among media offices can be achieved either through the development of multi-media permits (also called facility-wide permits), or through single-media permits involving close collaboration with experts in other media offices.

The State of New Jersey (with financial support from EPA) has been active in developing multi-media permitting programs designed to facilitate the inclusion of pollution prevention. New Jersey has embarked upon a pilot program to develop and test facility-wide permitting process at three volunteer firms in the state (the program will expand to 15 facilities after the completion of this first phase). The process is designed to encourage the use of pollution prevention technologies and to increase the overall efficiency of permitting activities by consolidating permitting, monitoring and reporting requirements for air and water compliance, eliminating pre-construction approval requirements for certain process changes, and providing pollution prevention technical assistance.⁵²

The successful reorientation of the agency's permitting efforts is largely contingent upon its ability to retain, retrain, support, reward permit writers to create and exploit opportunities to negotiate innovative pollution prevention technologies into permits. The TIE Committee made several recommendations to meet this need including: establish a job ladder for permit writers and specialties in single-media, cross-media and regional liason permit writer; provide training to teach skills necessary to write innovative permits, establish performance evaluation and reward systems that promote inclusion innovative pollution prevention technologies in permits; and improve data and technical information sources on innovative technologies which can aid permit writers.⁵³

5.5.2 Compliance

The TIE Committee concluded that to ensure protection of human health and the

⁵² U.S. EPA, NACEPT, TIE Committee, 1993, op.cit.

⁵³ U.S. EPA, NACEPT, TIE Committee, 1991, op.cit. pp. 87-88.

environment and to create a clear and consistent regulatory climate for technology developers, the regulated community must be confident that they will be required to comply with all permit requirements during testing, demonstration, and commercial use of innovative technologies. This requires systematic compliance monitoring on the part of regulators. The public must be assured that permits for testing and development of new technologies will not be used as a loophole to circumvent compliance.⁵⁴

5.5.3 Compliance Inspection

The TIE Committee and others have concluded that multi, rather than single-media, compliance inspections encourage both regulators and regulated firms to view the facility as a whole and hence foster a prevention-oriented mode of problem solving. In addition, coupling multi-media inspection with referrals to state programs of pollution prevention technical assistance puts the inspected firm in touch with technical information and expertise to facilitate the implementation of pollution prevention as injunctive relief (i.e., the means by which a violator comes into compliance) or outside of an enforcement context.

In their Blackstone Project (1989-1990), the Massachusetts Department of Environmental Protection tested the effectiveness of several multi-media inspection strategies designed to promote pollution prevention. Field inspectors and their supervisors were trained to conduct multi-media inspections, identify source reduction opportunities during inspections, write multi-media inspection reports, and recommend source reduction-based enforcement strategies. After conducting multi-media inspections, the inspectors referred the firms to the state's non-regulatory technical assistance office. Of the 26 facilities inspected in the Blackstone Project, inspectors identified specific source reduction opportunities at 16 facilities. In addition, several of the inspection models were found to be more cost-effective than typical single-medium inspections--from the standpoint of both the agency

⁵⁴ Ibid.

and the firms.⁵⁵ Of the 26 referrals made to the technical assistance program, eight firms requested their services.⁵⁶

The concern of EPA and some state agencies is that integrating pollution prevention into inspection activities will compromise the primary purpose of inspection, i.e., to identify non-compliance. Greiner *et al* argue that this does not have to be so.⁵⁷ In their view, a well designed pollution prevention inspection can be used as a tool that a regulatory agency can use to improve environmental results without exposing the inspector or agency to liability if a firm implements a process change that fails. These authors recommend that well-trained and informed inspectors should: distribute general "how to" and resource information, emphasize prevention during meetings, point out the benefits of prevention, give specific examples of relevant technology by referring to a company (unnamed) that successfully implemented a similar pollution prevention change, and facilitate the discovery (by the firm) of prevention opportunities by asking open-ended questions about the manufacturing process.

5.5.4 Enforcement

The enforcement process can be used to facilitate the development and adoption of innovative pollution prevention technologies. Part III of this thesis presents a detailed case study evaluation of EPA's recent experience in this area.

6.0 NON-REGULATORY OPTIONS

There are a myriad of non-regulatory programs that EPA can pursue to stimulate and

⁵⁵ Roy, M., Dillard, L.A., "Toxics Use Reduction in Massachusetts: The Blackstone Project," Journal of the Air and Waste Management Association. Volume 40, No. 10, October 1990. pp. 1368-71.

⁵⁶ Commonwealth of Massachusetts, Executive Office of Environmental Affairs, Department of Environmental Protection, "FY 90 Report on the Blackstone Project," July, 1990.

⁵⁷ Greiner, T.J., Richard, P.H., and Dillard, L.A., "Facility Inspections--Obstacles and Opportunities." in Pollution Prevention Integration, A Practical Guide for State and Local Government, Boca Raton, FL: Lewis Publishers, 1993. pp. 45-54.

support the development and adoption of innovative pollution prevention technologies. An exhaustive listing and elaboration of these options is well beyond the scope of this thesis. Therefore, what follows is a summary of the specific options that the agency has recently committed to pursuing in its 1994 Technology Innovation Strategy ("Strategy"). They are arranged according to three distinct objectives, as established in the Strategy.

6.1 Capacity Building Within the Technology Development Community

According to the Strategy, potential innovators of new environmental technologies often lack the information, skills, tools, and facilities necessary to successfully innovate and regulated parties that need to procure new technologies may not have the tools to evaluate them (particularly in the case of small businesses). The financial community, regulators and the public often lack information or the ability to make informed judgements about new technologies without verifiable data on performance, cost, and applicability. These barriers can be viewed as a source of inefficiency in the market for new environmental technologies. Specifically, inefficiencies stem from: the lack of credible performance data on new technologies; the lack of testing venues to test pilot-scale technologies; the lack of government assessments and forecasts of future needs for technology; the lack of design and decisionmaking tools (e.g., life-cycle analysis models and environmental accounting methods); the lack of government understanding of the technology development community, its needs and constraints; and the lack of skills, financial capacity and facilities on the part of technology developers necessary to commercialize new technologies.⁵⁸

To remedy these perceived inefficiencies, the Strategy proposes several activities for the agency, including:⁵⁹

- (a) Improve the system for developing and validating technology performance data through: the development of standardized testing protocols used in conducting

⁵⁸ EPA, Technology Innovation Strategy, 1994, op.cit., pp. 17-19.

⁵⁹ Ibid, pp. 20-23.

demonstrations for developing performance and cost data and reporting results; piloting a program to evaluate the claims of technology vendors; and expanding efforts to collect, review and report data on technology performance.

(b) Expand availability of sites for evaluating innovative technologies (e.g., EPA laboratories, closed military bases and other federal facilities).

(c) Develop partnerships with industry associations, individual companies, equipment suppliers, and non-profits to develop new technologies. This may include some financial support through Cooperative Research and Development Agreements (CRADAs).

(d) Develop and issue assessments of existing and anticipated technology gaps impeding the attainment of environmental objectives.

(e) Increase the agency's understanding of the market barriers to innovation of environmental technologies.

6.2 Investment in Development and Commercialization of Promising New Technology

Direct public investment in environmentally beneficial technology may be warranted when the level of private investment is inadequate. Insufficient private investment may be a result of the inability of the private investor to capture the social benefit brought about by a new technology and/or when development of a new technology is proposed before a regulatory requirement creates a market for it. Financiers often regard investments in environmental technology as risky, particularly if their fate in a permitting process appears uncertain.

The Strategy proposes that EPA make direct financial contributions to private and public sector technology developers--particularly those developing pollution prevention technologies--primarily to enhance the likelihood of successful commercialization of technologies that will fill an environmental or regulatory need.⁶⁰

⁶⁰ Ibid., pp. 24-26.

6.3 Acceleration of the Diffusion of Innovative Technologies In the U.S. and Abroad

The wide-spread adoption of new technology is contingent upon the transfer of information about the technology from developers, vendors, users, and governments to potential adopters. EPA can play an important role in transferring environmental technology information. However, it recognizes that direct involvement may prove unproductive since the regulated community may worry that EPA will use its knowledge of technology with improved performance to ratchet up regulatory standards. Therefore, the Strategy proposes that EPA focus its efforts on strengthening other domestic and international technology transfer organizations.

Specific proposals for diffusion of innovative technologies domestically and overseas include:

- (a) Catalyze domestic demand for innovative technologies through voluntary programs that help stimulate markets for new technologies. Examples of such programs are the "Green Lights" program that encourages the use of energy efficient lighting in commercial buildings and the "Golden Carrot" program that stimulated the development and commercialization of energy-efficient refrigerators by assuring a market for them.
- (b) Encourage and facilitate (through amendments to procurement policies) an expansion, by other federal agencies, of innovative technologies purchases or purchases of products manufactured with clean technologies.
- (c) Promote the transfer of U.S. environmental technologies overseas through technical assistance, training and capacity-building programs to expand the overseas market for environmental technologies; collecting and distributing information on overseas environmental technology markets to U.S. technology suppliers; promoting the participation of U.S. public and private sectors in the setting of technology standards abroad; and providing financial support for technology feasibility studies for international environmental projects.

7.0 CONCLUSIONS

With the release of the Technology Innovation Strategy, EPA appears convinced of the need for new environmental technology and of its role in fostering technology development. Furthermore, the agency seems poised to launch a substantial effort to promote new environmental technology development through its regulatory activities and through non-regulatory programs. Two important questions remain: (1) are the proclamations contained in the Strategy merely rhetoric or a genuine commitment to doing the hard work necessary to realize the stated goals; and (2) assuming a true top-level commitment, will the agency be able to achieve its goal?

Palmisano prepared an historic review of earlier (1979 - 1985) EPA initiatives to promote innovation,⁶¹ including:

- the Experimental Technologies Incentives Program (1972 to 1982), a partnering program of the Department of Commerce that worked with EPA to evaluate, recommend, and conduct several experiments in a variety of EPA administrative actions and policies that could be used to promote innovation
- EPA and Department of Commerce funding of several studies during 1979 and 1980 on environmental policies and innovation
- an assessment by the Assistant Administrator for EPA's Office of Policy, Planning and Evaluation in 1980 to assess the effects of EPA's programs on innovation
- the development and implementation of the innovation waiver provisions of the Clean Air Act and the Clean Water Act; and two related but uncoordinated initiatives within EPA's Office of Research and Development in 1980, namely the establishment of expert groups to develop lists of "undeveloped" needed environmental technologies and a list of activities EPA could develop which might

⁶¹ Palmisano, J., "Recapturing EPA's Institutional Memory: Innovation-Promoting Activities from 1979 - 1985," unpublished manuscript, November 1989.

promote innovation in pollution control

According to Palmisano, none of these initiatives made lasting contributions to technology innovation. Several common themes emerged from the author's analysis: the programs were plagued by a lack of support from senior EPA officials, middle-level management did not buy-into the programs, and staff participated only when bureaucratic pressure was applied from senior officials; a champion for innovation failed to emerge to take political and personal risks to evaluate, study or comment on innovation-related activities; studies on the subject of innovation were narrowly distributed and uninfluential; policy staffers who were charged with the task of recommending changes had no authority to implement them; and administrators of innovation waiver programs had risk-averse mind-sets rather than those of facilitators.

The study contained a number of relevant conclusions concerning the necessary elements of an EPA effort to promote innovation. Several are highlighted here:

1. The importance of innovation to achieve environmental protection must be articulated from the top. Absent a strong signal from the top, innovation policy will be treated by senior and mid-level bureaucrats as just another "interesting add-on." Since the rewards of innovation-promoting activities are unlikely to produce results until five or ten years out, bureaucrats seeking near-term rewards are unlikely to pursue these activities unless their managers are clear about the importance of these efforts.
2. A champion for innovation must be created to win support for, and lead, innovation-related activities.
3. Performance measurements of innovation promotion activities must be made with a long-term perspective.
4. EPA must establish links with a variety of stakeholders involved in the innovation process and must send a strong signal of its interests in promoting innovation.

5. Personnel and mission turnover rates at EPA are too high to sustain innovation interventions, measure outcomes and cross-fertilize success stories.

The Technology Innovation Strategy may signal the high-level support for innovation that Palmisano recommends, but it is only a first step in what will be a long and challenging process. Given the entrenched bureaucracies that have been built up around current regulatory programs, the refocusing of such activities will be difficult at best. The agency may realize greater success in creating the new, non-regulatory initiatives that it proposes.

PART III A CASE STUDY OF EPA'S RECENT EXPERIENCE IN INCLUDING POLLUTION PREVENTION IN ENFORCEMENT

8.0 BACKGROUND

Pollution prevention is a stated priority of the United States Environmental Protection Agency (EPA).⁶² In June 1989, the Office of Enforcement issued the Enforcement Action Plan which provided the agency's strategy for pollution prevention in enforcement. One of the primary tools identified was the settlement process. The agency has relatively little statutory or regulatory authority to *require* violators to implement pollution prevention technology settlement. Therefore, the settlement process provides an opportunity for both the agency's negotiators and violators to consider pollution prevention as part of the overall settlement process.

In early 1991, the Office of Enforcement (OE) had issued an Interim Policy on the Use of Pollution Prevention Conditions in Enforcement Settlements and a Policy on the Use of Supplemental Environmental Projects (SEPs) in Enforcement Settlements. Together, these two policies provided formal guidance and criteria for negotiating pollution prevention conditions either as injunctive relief (i.e., the actual steps taken to correct the violation), or as supplemental conditions incidental to the correction of the violation.

9.0 INTRODUCTION

The primary objective of the evaluation of pollution prevention/innovation presented here is to systematically evaluate the existing barriers and incentives to the inclusion of pollution prevention generally--and innovative pollution prevention specifically--into enforcement settlements negotiated by the U.S. EPA.. This evaluation is structured around case studies of ten enforcement settlements containing pollution prevention conditions drawn from the

⁶² See for example, EPA's 1989 "Pollution Prevention Policy Statement" issued by then-Administrator of EPA, Lee Thomas; and, more recently a June 15, 1993 EPA Memorandum to EPA Employees from EPA Administrator Carol Browner, "Pollution Prevention Policy Statement: New Directions for Environmental Protection."

universe of judicial and administrative enforcement actions negotiated by the EPA regions⁶³ and Headquarters media programs up to and including FY 1992. The cases were submitted by the regions to the Office of Enforcement in June and October 1992.

10.0 EPA'S INITIATIVE IN INCLUDING POLLUTION PREVENTION IN ENFORCEMENT SETTLEMENTS

In February of 1991, EPA transmitted its Interim Policy on the Inclusion of Pollution Prevention and Recycling Conditions in Enforcement Settlements (referred to here as the "Pollution Prevention in Enforcement Policy"). The purpose of the Policy was to encourage pollution prevention and recycling both as a means of returning to compliance (i.e., via injunctive relief) and as supplemental environmental projects (SEPs) incidental to the correction of the violation itself. In conjunction with the Policy on the Use of Supplemental Environmental Projects in EPA Settlements (February 12, 1991) (referred to here as the "SEP Policy"), the Pollution Prevention in Enforcement Policy was designed to offer incentives to the agency and companies for including pollution prevention in settlements, preserve effective deterrence and accountability for compliance and environmental results, and support funds to provide incentives to the agency to address potential demand on staff resources for review of pollution prevention opportunities.

As the Pollution Prevention in Enforcement Policy points out, the agency in general cannot require pollution prevention in enforcement settlements, nor for that matter in any capacity given the absence of statutory or regulatory directive. Prior to an enforcement action, the regulated community is generally free to choose the method by which they will comply with federal environmental requirements. However, once a civil or administrative action has been initiated, the means of returning to compliance are subject to mutual agreement between the agency and the respondent. In addition, an agreement can be structured to include an environmentally beneficial project, such as a pollution prevention project, that goes beyond compliance. Therefore, the settlement process is an *opportunity* for the

⁶³ EPA has ten regional offices that handle most of the agency's compliance and enforcement activities.

agency and companies to identify and implement pollution prevention consistent with the agency's overall enforcement approach.

The next few sections contain highlights of several components of the Pollution Prevention in Enforcement Policy and the SEP Policy that have surfaced as important determinants of the agency's and companies' willingness and capacity to include pollution prevention in settlements, as well as the nature of pollution prevention projects included. These components are organized according to their relevance to injunctive relief projects and SEPs.

10.1 Pollution Prevention as a Means of Correcting the Violation--Injunctive Relief

10.1.1 Timeliness for Implementing Pollution Prevention Conditions

As stated in the Pollution Prevention in Enforcement Policy, EPA's enforcement policy calls for the "expeditious" return of the violator to compliance. The agency team is granted some additional flexibility in negotiating an implementation schedule for pollution prevention remedies, especially if new or innovative technology is involved. However, in determining whether to extend the "normal" timeline for resolving the violation, the policy recommends consideration of the following factors: seriousness of the violation, aggregate reduction in amount or toxicity of pollution through prevention as compared to an end-of-pipe response, reliability/availability of the technology, applicability of the technology to other facilities, and prospects for future compliance.⁶⁴

10.1.2 Failure in Implementation ("good-faith failure")

To insure against a situation where a respondent--despite his or her best efforts--fails to successfully achieve compliance through an agreed-upon pollution prevention remedy, the Pollution Prevention in Enforcement Policy requires that such agreements contain a "fall-back" schedule for compliance using a specified proven technology. Under circumstances of project failure, the respondent may or may not have to pay an additional penalty,

⁶⁴ Pollution Prevention in Enforcement Policy, pp. 4-6.

depending on the economic benefit of further delay in compliance and expenditures on the failed pollution prevention remedy.⁶⁵

10.2 Supplementary Environmental Projects

10.2.1 Categories of SEPs

The SEP Policy permits five categories of SEPs, provided that they meet the criteria contained in the policy; these categories are: pollution prevention projects, pollution reduction projects (i.e., a project which goes substantially beyond compliance to further reduce pollution), environmental restoration projects, environmental auditing projects (i.e., compliance auditing), and enforcement-related environmental public awareness projects.⁶⁶

10.2.2 Nexus Requirement

The SEP policy requires that there is an appropriate "nexus" or relationship between the nature of the violation and the environmental benefits to be derived from the SEP. For pollution prevention SEPs (as well as for pollution reduction, environmental restoration, and environmental auditing projects), the nexus may be either "vertical" or "horizontal". A vertical nexus exists when the SEP reduces the emission of a pollutant to a medium that are the same pollutant and medium addressed in the violation. A horizontal nexus exists when the SEP involves either (a) relief for different media at a given facility or (b) relief for the same medium at different facilities. The horizontal nexus condition is met only if the SEP would reduce the overall health or environmental risk posed by the subject facility or reduces the likelihood of future violations similar to those of the enforcement action. Each proposed administrative settlement which has a horizontal nexus to the violation must be approved by the Assistant Administrator for Enforcement or her designee.

10.2.3. Status of the Enforcement Action/Compliance History of Defendant/Respondent

Although any defendant/respondent may propose a SEP, the SEP policy recommends that

⁶⁵ Pollution Prevention in Enforcement Policy, pp. 8-9.

⁶⁶ SEP policy, p. 2-4.

the agency consider the following factors in determining whether to accept the respondent's proposal: the status of the action, resources committed to the case, the respondent's enforcement history, as well as the respondent's capability, technical and economic resources to implement the project.

10.2.4 Main Beneficiary of a SEP

The SEP policy contains a limitation on projects that represent a "sound business practice", i.e., capital or management improvements where the firm, rather than the public, is likely to receive the substantial share of the benefits. However, this limitation can be waived for pollution prevention projects having significant environmental benefit.⁶⁷

10.2.5 Penalty Mitigation

The agency's penalty policies require the assessment of a substantial monetary penalty generally at a level which captures the defendant/respondent's economic benefit of noncompliance plus some appreciable portion of the gravity component of the penalty (emphasis added). In addition, EPA must not lower the penalty by more than the after-tax amount the violator spends on the project. Therefore, a portion of the gravity component of the penalty may be mitigated by an amount up to the net present after-tax cost of the SEP, depending on the environmental benefit of the SEP. Where a violation is found which did not confer significant economic benefit, e.g., a failure to notify, the settlement must include a penalty that at least captures a portion of the gravity component.⁶⁸

10.2.6 Treatment of Pollution Prevention Studies as SEPs

SEPs for studies are not permitted without an accompanying commitment to implement the results. Pollution prevention studies are eligible for a penalty offset only when they are part of an agency-approved set of actions to reduce, prevent, or ameliorate the effects of

⁶⁷ SEP policy, page 9.

⁶⁸ SEP policy, page 10.

pollution at the respondent's facility.⁶⁹ The size of the penalty offset may include the costs of the studies. However, the agency retains the right to review the studies to determine the technological and economic feasibility of the results. If the respondent is unwilling to implement the results and the agency has determined that they are feasible, the agency can rescind the penalty offset for the study.

10.2.7 Failure in Implementation

If the respondent does not comply satisfactorily with the terms of the SEP, she or he will be required to pay the portion of the assessed penalty that was reduced (with applicable interest). The consent agreement should contain a mechanism for the payment of these penalties (called "stipulated penalties").

11.0 OPPORTUNITIES AFFORDED BY THE INCLUSION OF POLLUTION PREVENTION IN ENFORCEMENT SETTLEMENTS

Pollution prevention injunctive relief offers the opportunity for both the agency and firm to reduce or eliminate an environmental problem at the source, without cross-media transfer of pollutants. Pollution prevention SEPs, and injunctive relief in some cases, offer the possibility of reducing environmental impacts in excess of that which is required by regulation. Furthermore, a prevention remedy or SEP may also reduce impacts to media other than that which is targeted by the enforcement action, if the technology is chosen or designed to deliver multi-media environmental pay-offs. Taken together, these benefits can enhance the firm's prospects for future environmental compliance.

Significant "indirect" environmental, health, and economic benefits can be achieved through the transfer of pollution prevention technology to other processes in the subject plant or to other plants owned by the firm; organizational changes that lead to improved environmental practices; and further implementation of other pollution prevention

⁶⁹ While studies are not by themselves eligible for penalty offset, an exception is made for pollution prevention studies when they are part of an agency-approved plan to correct a violation.

technology. Furthermore, particularly in the case of SEPs (where penalty relief is granted), the option to include a pollution prevention project creates an opportunity to turn a negative situation into a better or positive situation for the firm and to improve the relationship between the firm and the agency.

By including pollution prevention in enforcement settlements, the agency can translate its stated preference for pollution prevention into action. The pollution prevention knowledge and skill, gained by agency negotiators, can help to build the agency's overall base of pollution prevention knowledge and experience (see discussion in Section 16.4.4) which can be leveraged in standard setting, permitting, and inspection activities as well as in industry outreach programs.

Enforcement activities can serve as a vehicle by which the agency encourages or partially underwrites technological risk-taking in pursuit of innovative pollution prevention solutions to challenging environmental problems. This strategy can be targeted toward certain industries, technologies, or high-risk chemicals that have been assigned top priority for risk reduction, and/or where no or few cleaner technological alternatives are available.

The option to promote pollution prevention within the enforcement context permits the agency to pursue a settlement that optimizes environmental performance, rather than a settlement aimed only at achieving compliance.

12.0 PREVIOUS STUDIES ON POLLUTION PREVENTION IN ENFORCEMENT

At least three other studies have been conducted on the agency's experience in including pollution prevention in enforcement. They are: "Investigation of Environmentally Beneficial Expenditures for Settlement Agreements," by IT Environmental Programs, Inc. for U.S. EPA Office of Compliance Monitoring, Toxics Enforcement Branch, May 1992; "Pollution Prevention Through Compliance and Enforcement: A Review of OPTS Accomplishments", U.S. EPA Office of Compliance Monitoring, January 1992; and "Innovations in Compliance and Enforcement: Supplemental Environmental Projects in

EPA's Toxics and Pesticides Program", U.S. EPA Office of Compliance Monitoring, Office of Prevention, Pesticides, and Toxic Substances, November 1992. This thesis, based on research undertaken for EPA through a cooperative grant between EPA and MIT, has benefitted greatly from, and builds on, this previous work.

13.0 ORGANIZATION OF CASE STUDIES

The remainder of Part III is organized into seven sections and two appendices. Section 13 contains a description of the methodological approach used in the research. Section 14 presents a discussion of the criteria that we used for evaluating successful efforts in incorporating pollution prevention into enforcement agreements. Section 16 contains an overview of the ten case studies in tabular form and case commentary and analysis. Section 17 presents research findings on the barriers, inappropriate incentives, and inadequate incentives to pollution prevention in enforcement. Section 18 presents policy recommendations for increasing the success of EPA efforts to include pollution prevention in enforcement settlements. Section 19 contains conclusions.

Appendix A contains the questionnaires used for the unstructured interviews with agency negotiators and case study firms. Appendix B contains the detailed case studies.

14.0 METHODOLOGICAL APPROACH USED IN CASE STUDY DEVELOPMENT

This evaluation of pollution prevention innovation in enforcement is structured around case studies of ten enforcement settlements containing pollution prevention conditions. Case study research, which consisted primarily of interviews with agency and firm negotiators, was supplemented by numerous discussions with media, legal, and policy office managers and staff in both EPA Headquarters and in EPA regional offices. In this section, the case selection process and the limitations of the case study methodology are discussed.

14.1 Case Selection Process

The objective, in case study selection, was to choose a total of 10 cases that contained

pollution prevention projects involving chemical substitution, process change, and closed-loop recycling that seemed: (a) technically innovative, (b) to address a category of technology or industry not commonly found in pollution prevention case study literature (e.g., battery manufacturing), and/or (c) that contained novel settlement features (e.g. a settlement that includes research and development). Cases where pollution prevention was successfully negotiated into enforcement agreements (irrespective of whether the project had been successfully completed by the violator) were sought; cases where the opportunity to negotiate a SEP presented itself during the negotiation process, but failed to materialize were not chosen. However, the latter was discussed as a general issue with regional staff.

Ultimately, for reasons of practicality, cases chosen had to be distributed among only three EPA regions. This constraint did not appear to be a serious limitation to the findings and conclusions contained herein since there was more noticeable diversity in strategy and content *between settlements*, than *between regions*.

The case selection process began with a review of the pollution prevention settlement summaries submitted by the regions to the Office of Enforcement in June and October 1992. From these submittals, cases were tagged if they appeared to involve chemical substitution, process change, and product reformulation consistent with the definition of pollution prevention. This process produced a list of 33 cases. Next, these tagged cases were divided into two categories: Tier 1 and Tier 2. Roughly, cases were assigned to Tier 1 if: the technological or material change seemed innovative, the category of technology or industry is not commonly found in pollution prevention literature, or the settlement contained a novel settlement approach. Tier 1 cases were viewed as top choices for study. Tier 2 contained other projects, not as novel, many of which involved a switch from organic solvent to aqueous-based cleaning or degreasing systems. This process yielded 18 cases in Tier 1, and 15 in Tier 2. This selection was conducted without regard to regional distribution (this concern was addressed in subsequent iterations). Tier 2 cases were to be selected only if there were too few cases in Tier 1, or if sufficient written documentation or important agency or firm negotiators for Tier 1 cases were inaccessible.

All but one of the 33 settlements with pollution prevention conditions were negotiated as SEPs. The one settlement which contained pollution prevention as the means of correcting the violation was the only pollution prevention injunctive relief case reported in the regional summaries. (This settlement is one of the cases included in the final sample.)

Next, the case study research methodology was pilot-tested in one region. The investigation began with several exploratory meetings with the deputy regional administrator, regional counsel, regulatory office chief, and an attorney who had been designated as a SEP specialist for the region. The attorney provided access to case files for both the Tier 1 and 2 cases that had been pre-selected. Through a review of these files and discussions with the regional attorney, three cases were selected for study on the basis of the criteria discussed above. (A fourth case was added later on in the process.)

The second and third regions were chosen primarily on the basis of the nature and number of interesting pollution prevention settlements, as determined by the initial case screening. The final case selection process within these regions was similar to that used in the first region. Three cases were selected in each of these two regions.

14.2 Case Study Research Approach

Case study research was initiated by further reviews of information contained in case study files. Next, unstructured interviews were conducted with the regional case officers and attorneys who had negotiated the settlements. Most interviews were conducted in person and most were conducted with both the case officer and attorney team being interviewed together. Several interviews were conducted over the phone. In advance of these interviews, a list of questions was sent along with a request that the prospective interviewees simply read the questions as a preview to the interview. (Appendix A contains a copy of the questionnaire.) Interview questions dealt with both specific aspects of the cases as well as general questions regarding strategies used to negotiate pollution prevention into enforcement settlements. At each interview, the name of a contact person at the subject facility was requested.

Interviews were conducted with a representative(s) at each of the ten case study firms. Six firm interviews were conducted in person and the remaining four were conducted over the telephone. Each firm was sent a questionnaire prior to the unstructured interview (See Appendix A) to preview the type of questions that would be asked. In all but one case, interviews were conducted with two or more firm representatives who were involved in negotiating and/or developing and implementing the pollution prevention projects. Interviews lasted from one to two hours and were typically, though not always, conducted with all representatives together in one room.

Given the potential for disclosure of sensitive information, the names of the firms are masked. For reasons of sensitivity, and in order to confirm the accuracy of information gained during the interview, interview write-ups were sent back to the firms for their review, corrections, and suggestions for the deletion of sensitive information. The majority of requested revisions were obliged since they were not critical to the overall integrity of the case. None of the firms objected to having the write-up included in the report; in fact, most were very pleased with the objectivity and accuracy of the write-ups. It was noted that some firms were at first reluctant to participate because they were apprehensive about the reporting of something that might jeopardize their relations with the agency. This was a particular concern for those firms that had not yet completed their projects.

Draft case studies were also sent to EPA region negotiators for comments and corrections.

In retrospect, the case study research approach utilized here appears both appropriate and effective in evaluating barriers and incentives to the use of pollution prevention in enforcement. While there are some limitations to this approach, the research into the structure and content of enforcement settlements coupled with the collective perspectives of the interviewees are extremely informative, valuable windows on the current state of, and potential for, efforts to promote innovative pollution prevention in the enforcement context, and in general.

14.3 Overview of Case Study Structure

The detailed case studies, contained in Appendix B, contain three sections: Section I Case Overview, Section II Description of Pollution Prevention SEP, and Section III Analysis. Information for the case overview and pollution prevention project came primarily from documents contained in case files, particularly the consent agreements and final orders (CA/FO). Case file information was supplemented as needed from data collected during firm and agency interviews.

EPA and Company perspectives, as detailed in the analysis sections, came from interviews. These sections vary in depth and coverage from case-to-case; this is a function of the both the diverse nature of the cases as well as the willingness and level of interest/enthusiasm of the interviewees to discuss the specific details of the case.

14.4 Limitations of the Case Study Methodology

As the description of the case selection process indicates, this study was specifically designed to focus (to the greatest degree possible) on settlements that involved innovative pollution prevention technology and settlement approaches, as well as cases where the technology or industries involved are not commonly addressed in the pollution prevention literature. In other words, this study was not designed to evaluate a representative sample of settlements, or a representative sample of settlements containing pollution prevention conditions. The study of cases where pollution prevention was successfully negotiated permits evaluation of elements of success and barriers that might have either made the negotiation or monitoring process difficult and/or limited the success of the final outcome. However, this research approach does not *directly* capture, i.e., through case study analysis, the lessons that can be learned from "failed attempts" and "missed opportunities". "Failed attempts" implies cases where the opportunity to negotiate pollution prevention arose--either at the suggestion of the agency or the firm--but never materialized. "Missed opportunities" implies instances where the possibility of including pollution prevention in a settlement was never raised during the negotiation process, either by the violator or the agency. Although instances of failed attempts and missed opportunities were never studied

directly, significant indirect evidence was gained in interviews through questions about the conditions that lead to these scenarios.

Questions surrounding failed attempts are researchable, in a fashion similar to that which was employed here, since these cases can probably be located. Missed opportunities, on the other hand, would be quite difficult to study.

Finally, a limitation associated with interview research is that the data obtained is self-reported and often difficult to verify. There are two general types of data contained in this study: factual information and personal impressions/opinions. Verification of certain factual information was attempted by duplicating some questions on the agency and firm questionnaires and by cross-checking certain questionable information during interviews. Personal impressions and opinions of, for example success or failure of a process or outcome, and conjecture (e.g., when a firm states that they would have implemented the pollution prevention project eventually, in the absence of the enforcement action) must be taken at face value.

15.0 CRITERIA FOR EVALUATING THE SUCCESS OF SETTLEMENTS CONTAINING POLLUTION PREVENTION

Prior to initiating the case study research, and during the course of the research, criteria to evaluate the success of settlements containing pollution prevention conditions were developed. These criteria were drawn from goals and objectives of EPA's Interim Policy on Pollution Prevention in Enforcement, verbal and written communication with project sponsors, as well as on previous research.

The criteria are divided into two major categories: (a) pollution prevention *project* success from the agency and firm perspectives, and (b) *settlement process* success from the agency perspective. Project success is further subdivided into direct measures of success, i.e., measures that evaluate changes in firm technology and associated environmental and human health benefits, and indirect measures of success stemming from project implementation.

Criteria listed in the second section--process success--are designed to evaluate the success of the settlements (and enforcement approaches in general) in translating stated agency goals for pollution prevention into action.

15.1 Criteria for Pollution Prevention Project Success (Agency and Firm Perspectives)

A. Direct environmental, energy and economic measures

1. Risk Reduction and Material/Energy Conservation

- a. reduction in pollution volume
- b. reduction in the level of toxicity of materials used in manufacturing and of pollution
- c. reduction in raw and process materials and energy used
- d. reduction in worker exposure to toxic chemicals
- e. reduction in community exposure to toxic chemicals
- f. reduction in product toxicity

2. Economic Benefits

- a. reduction in raw material; waste disposal, pollution control, and compliance costs
- b. avoided future liability

B. Indirect economic benefits and other measures

1. settlement technology implemented in other parts of the plant or at other plants owned by the company
2. additional pollution prevention projects implemented as a result of the settlement project
3. organizational changes that lead firms to view and address pollution sources in a more holistic, preventative manner

4. subsequent compliance performance of the firm improved as a result of the project
5. resulting major or incremental technological innovation
6. changes in vendor/consultant relations that will facilitate future adoption of preventative rather than control strategies
7. transformation of a negative situation into a better or positive situation for the firm, and for the relationship between the firm and the agency
8. improvement in the firm's public and product image

15.2 Criteria for Settlement Process Success (Agency Perspectives)

A. Pollution prevention technology transfer

1. inclusion of a technology potentially having wide applicability to the same or other industries
2. inclusion of a technology of which the agency had little prior knowledge

B. Pollution prevention technology development

1. construction of a settlement that led to the development and/or implementation of a new pollution prevention technology, or a new adaptation of an existing technology
2. construction of a settlement that led to the development and/or implementation of a new pollution prevention technology, or a new adaptation of an existing technology where such achievement was necessary to attain a specific environmental objective (e.g., an alternative to chlorine-based bleaching of kraft pulp)

C. General agency goals

- 1. contribution to the agency's stated goal of making pollution prevention a major component of all agency programs**
- 2. preserving the deterrence impact of the agency's enforcement programs**

These criteria of success were used throughout this research and analysis. First, the criteria were used in the development interview questionnaires (see Appendix A) and to guide the unstructured interviews. Second, they were used to guide the case study analysis presented in Section 16. Third, they were used as a guidepost to evaluate barriers to the agency's efforts to promote pollution prevention through enforcement (Section 17) and to develop policy recommendations (Section 18) and conclusions (Section 19).

16.0 CASE DESCRIPTIONS AND COMMENTARY

This section contains tabular overview of the ten case studies, case study commentary and analysis.

16.1 A Tabular Summary of Individual Cases

The next five pages contain a tabularized summary of the individual cases. SEPs are presented first, in alphabetical order (by pseudonym), followed by the injunctive relief case.

Table 1. A Tabular Summary of Individual Cases
1. Supplementary Environmental Projects

<u>Company</u>	<u>Sales/No. of Employ.</u>	<u>Violation</u>	<u>Description of PP Project</u>
Casted Metal Products Manufacturer (CMPM)	1,200 employees	CWA, failure to file a Baseline Monitoring Report (Section 403.12) and exceeding chromium and pH limits	Redesign of rinse systems on several coating and cleaning process lines to reduce water use and wastewater; substitution of organic solvents and Freon with aqueous & semi-aqueous cleaners
Industrial Coater (IC)	Projected sales of \$20 million dollars and 150-170 employees (1989).	EPCRA 313, failure to file Form R's for toluene and MEK.	Reformulation of toluene-based coating for plastic film and modifications to dryer section of coater.
Lid Manufacturer (LM)	200 employees	Clean Air Act, Section 133d. Failure to certify coating lines.	Conversion of one of four production lines (constituting 1/3 of total lid production) from the rubber and heptane (VOC)-based gasket formulation to a new non-VOC material.
Medical Device Manufacturer (MDM)	100 employees, earnings of \$50 million/yr	EPCRA 313, failure to file Form R's for xylene, trichloroethane and trifluoroethane	Engineer, test, and ultimately purchase of deionized water degreaser to replace freon.
Metal Filing Furniture Manufacturer (MFFM)	65 factory workers	RCRA, treating waste without a permit	Installation of a solvent recycling system, paint baffle collection system, and other measures to reduce paint and solvent use, emissions and waste; administrative measures to encourage pollution prevention.

Table 1. A Tabular Summary of Individual Cases (cont.)

<u>Company</u>	<u>Environmental Benefits</u>	<u>Innovativeness of Change</u>	<u>Technology Transfer Benefit</u>	<u>Organizational Change</u>
CMPM	Reduced wastewater discharges by approx. 100,000 gpd (75% reduction), reduced energy consumption and use of Freon, perchloroethylene, 1,1,1-trichloroethane, nitric acid, and isopropyl alcohol	1) Customized process redesign of rinse systems-incremental process innovations;2) switch to aqueous cleaners-widely diffused, existing technology	Company has transferred some technology to their other plant	Company has developed the internal capacity to pursue pollution prevention and is pursuing multi-media view of environmental problems.
IC	Reduction in toluene use (56,000 to 5,600 lbs) and MEK use (50% reduction) and toluene and MEK emissions, waste and worker exposure. Net energy savings of 890 kw per hour.	Incremental innovation, first commercial application of non/low-solvent technology in particular product niche	Potential to transfer to other product lines	none apparent
LM	The Company estimated that heptane usage would decrease by 203 tons per year, resulting in a reduction in VOC emissions of 50 tons per year. Particulates from manufacturing, natural gas usage and oven emissions may increase by 3.65 tons per year, and NOx, CO, HC and SO ₂ may increase by less than 1 ton per year each.	Incremental innovation, significant adaptation of existing technology	Potential to transfer to other three production lines	none apparent
MDM	Elimination of the use of 16,000 lb/yr of Freon	Existing technology, not widely diffused	Company will transfer system to another plant	none apparent
MFFM	Project designed to reduce paint and solvent use, waste and emissions. Small success to date.	Existing, widely-diffused technology needing relatively minor adaptations	none apparent	SEP includes measures for organizational change, e.g., pollution prevention training.

Table 1. A Tabular Summary of Individual Cases (cont.)
1. Supplementary Environmental Projects

<u>Company</u>	<u>Sales/No. of Employ.</u>	<u>Violation</u>	<u>Description of PP Project</u>
Metal Finishing Company (MFC)	80 employees, \$18 million/yr (1991)	RCRA, including: improper hazardous waste storage, and labelling	Extension of nickel plating tank to reduce lead contaminated polishing dust waste; conversion from hexavalent to trivalent chromium. (A second small SEP involved improvements to polishing dust collection system)
Metal Machining Company (MMC)	1,000 employees	EPCRA 313, failure to file Form Rs for: 1,1,1 trichloroethane; xylene; methyl ethyl ketone	Reduction in use of 1,1,1 trichloroethane used by 130,000 pounds per year through retrofit a 1,1,1 degreaser and substitution of 1,1,1 degreaser with semi-aqueous degreaser
Powder Metallurgy Manufacturing Company (PMMC)	50 employees, sales of \$5-6 million per year	EPCRA 31, failure to file Form Rs for: Copper, chromium, trichloroethylene, and ammonia.	An environmental audit, substitution of blended hydrogen/nitrogen sintering atmosphere for anhydrous ammonia, elimination of a trichloroethylene vapor degreaser by switching to an aqueous tapping fluid, and closed loop cooling
Pump Service and Sales Co. (PSSC)	96 employees	EPCRA 313, failure to file Form Rs for Freon 113.	Substitution of Freon degreaser with semi-aqueous degreaser

**Table 1. A Tabular Summary of Individual Cases (cont.)
1. Supplementary Environmental Projects**

<u>Company</u>	<u>Environmental Benefits</u>	<u>Innovativeness of Change</u>	<u>Technology Transfer Benefit</u>	<u>Organizational Change</u>
MFC	Reduction in lead contaminated dust generation (83-85%), elimination of health hazard assoc. with hexavalent chromium, reduce chromium use (bath strength decreased by 1/30) and sludge generation (67%). Nickel use will increase from 5,500 to 12,650 lb/yr.	Nickel tank extension-customized process improvement, incremental process innovations; trichrome-existing technology, not widely diffused	Potential to transfer to other Companies.	Trichrome system seen as competitive advantage. They have set up a new chemical lab to monitor plating bath chemistry, regular environmental compliance facility tour, no new chemicals into the plant without review of MSDSs.
MMC	Reduction in the use (30 to 17,000 gal/yr), emission (130,000 lb/yr) and disposal of 1,1,1 trichloroethane-an ozone depleting substance and a health hazard to workers	Existing and widely-diffused technology needing relatively minor adaptations	Other plants and maintenance shops are moving to eliminate the use of 1,1,1.	The Company has developed the skills to work toward their goal of total solvent elimination. Given
PMMC	Elimination of ammonia release threat, elimination of trichloroethylene use and approx. 26,860 lb/yr of fugitive emissions and reduction of 1,600 gal/yr of waste oil.	Sintering atm.-customized process improvement, incremental process innovation; Tapping oil-existing and widely-diffused technology needing relatively minor adaptations	Possible transfer benefits to other companies in trade association.	President has changed his thinking about environmental investments--better to lead environmental standards He now sees projects to eliminate hazardous operations as economically and environmentally sensible for the Company.
PSSC	Elimination of the use of Freon 113, an ozone depleting chemical, at the subject facility and another facility in another state.	Existing and widely-diffused technology needing relatively minor adaptations	SEP called for use in a second facility, in a different state and EPA region.	none apparent

Table 1. A Tabular Summary of Individual Cases (cont.)
 2. Injunctive Relief

<u>Company</u>	<u>Sales/No. of Employ.</u>	<u>Violation</u>	<u>Description of PP Project</u>
Bleached Kraft Pulp Manufacturer (BKPM)	(600 tons per day of bleached kraft pulp)	CWA, violation of NPDES permit's effluent limits for chronic toxicity	Elimination of chlorine in bleaching of kraft pulp (TCF bleaching) accomplished by modifications to the bleaching process

<u>Company</u>	<u>Environmental Benefits</u>	<u>Innovativeness of Change</u>	<u>Technology Transfer Benefit</u>	<u>Organizational Change</u>
BKPM	Elimination of threat of chlorine gas releases (a public and workplace hazard), reductions in the creation of chlorinated organic compounds, color, odor, and foam	Moderately innovative, first commercial application of process technology in U.S. market	Potential for transfer or license to other plants	Company will seek to involve technical personnel in initial discussions with Regulatory Agencies and bring attorneys in later on in the process.

16.2 Case Commentary and Analysis

16.2.1 SEPs versus Injunctive Relief

Of the ten case studies of pollution prevention in enforcement, only one case involves pollution prevention *as a means to come into compliance* (i.e., injunctive relief). The other nine cases involve SEPs. As discussed in Section 14.1, the case study selection criteria were not inherently biased toward SEPs; rather innovative, somewhat unique pollution prevention projects from among the sample population of both SEPs and injunctive relief cases. were sought One case that was selected, Bleached Kraft Pulp Manufacturer (BKPM), was the only injunctive relief case reported that contained a pollution prevention compliance strategy. It was selected because the pollution prevention project--elimination of chlorine in kraft pulp bleaching--was innovative and had great technology transfer potential. (Section 17.1.2, contains a discussion of why pollution prevention is not commonly used as injunctive relief).

16.2.2 Overview of Firms

Since the selection of case studies was made largely on the basis of the nature of the technological change, the distribution of company type and size are an artifact and not criteria of, the selection strategy employed. The sample is dominated by metal products manufacturers (six out of ten companies). Considering that many processes used by these manufacturers are environmentally problematic (e.g., metal plating, painting, and degreasing), and that historically, a great deal of attention has been focused on pollution prevention in these industries, the dominance of these firms in the sample is not surprising. The other four case study firms represent a rather broad array of industries: plastics coating, medical device manufacturing, pump service and sales, and bleached kraft pulp production.

With regard to size, three case study firms--MFFM, MFC, and PMMC--are single plant companies ranging from 50 to 80 employees. Two case studies--IC and PSSC--involve small, autonomous divisions of larger holding companies. Four case studies--CMPM, LM, MDM, and MMC--involve small/medium-sized plants (100 to 1,200 workers) that are

owned-by medium-sized, multiplant companies. The injunctive relief case--BKPM--is a large manufacturing plant owned by a large corporation.

16.2.3 Nature of the Violation (Regulatory Program)

Of the ten case studies, five arose out of violations of Form R reporting requirements under EPCRA, Section 313; two stem from CWA violations; one from a CAA violation; and one from RCRA. The predominance of EPCRA cases in the study sample reflects the relatively large number of pollution prevention SEPs in the larger sample population that were negotiated in EPCRA 313 settlements. There are several reasons why the majority of SEPs have arisen in EPCRA cases. EPCRA violations occur in companies that are using or producing toxic chemicals (so called 313 chemicals). In recent years, pollution prevention efforts within and outside the agency have focused heavily on the elimination, reduction or recycling of toxic substances (e.g., EPA's 33/50 Program). Thus, EPCRA cases tend to be natural candidates for pollution prevention SEPs. This is particularly true for companies using chlorinated organic solvents that are slated to be phased-out under the Montreal Protocol and amended U.S. Clean Air Act. Spurred by the London Amendments (1990) to the Montreal Protocol, the amended U.S. Clean Air Act established a phase-out of CFC-113 (also called Freon) and 1,1,1-trichloroethane (also called TCA or 1,1,1) in the years 2000 and 2002, respectively. HCFCs will be banned between 2020 and 2040 or earlier as spelled-out in the London Amendments. As these dates approach, the costs of these materials are increasing and, as a result, the alternatives are becoming more economically favorable. Numerous, relatively low-cost aqueous or semi-aqueous systems are now widely available. A switch to these alternatives typically poses relatively low or no technological risk to the firm⁷⁰ and may save the firm considerable amounts of money.⁷¹

⁷⁰ FDA-regulated firms, such as pharmaceutical and medical device manufacturers, are a notable exception. In these cases, manufacturers must obtain FDA approval to switch from solvent to aqueous-based cleaners (FDA regulates product and process). The approval process can take several years and can be very costly. Therefore, these firms tend to choose solvent recycling strategies rather than chemical substitution since recycling does not generally require FDA approval.

These features are motivations for both the firm and the agency to negotiate SEPs into these cases.⁷²

Finally, according to one regional attorney, since the penalty assessed for 313 violations constitute "gravity" only, and not "economic benefit" (because there is no economic benefit to be gained by not filing a Form R), a large percentage of the penalty can be used to leverage a SEP.⁷³

16.2.4 Original and Final Penalties, Project Cost and Payback

Table 2 summarizes the penalty information and pollution prevention project costs for the nine SEP case studies. Penalty reductions granted for SEPs range from \$7,350 to \$237,000. In seven of nine cases, the penalty reduction leveraged a significantly greater pollution prevention expenditure by the firm. One notable case is LM which expended \$298,000 to reformulate their lid gasket material for a penalty reduction of \$38,000. In one case, MFC, the cost of the pollution prevention project was 25% higher than the penalty reduction.

⁷¹ The SEP policy contains a limitation on projects that represent a "sound business practice", i.e., capital or management improvements where the firm, rather than the public, is likely to receive the substantial share of the benefits. However, this limitation can be waived only for pollution prevention projects having significant environmental benefit (SEP policy, page 9).

⁷² Region V Attorneys and Case Officers offered several other reasons for the preponderance of 313 SEPs. The EPCRA 313 reporting requirement is relatively new (since 1988); it virtually "grew up" with the Agency's initiative to include SEPs and pollution prevention in enforcement agreements. According to a Case Officer in the Region's Pesticides and Toxic Substances Branch (housing the TSCA and EPCRA programs), company attorneys and private law firms are as unfamiliar with 313 as they are with SEPs, and it is easier to couple SEPs with 313 settlements than with settlements arising out of other regulatory programs.

⁷³ According to the SEP Policy, only the gravity portion of the penalty can be mitigated by the SEP (refer to Section 9.2.5).

Table 2. SEP Case Study Original and Final Penalties, and Project Costs

<u>Company</u>	<u>Original Penalty</u>	<u>Final Penalty</u>	<u>Penalty Reduced for SEP</u>	<u>Project Cost</u>
CMPM	\$ 95,000	\$30,000	\$ 65,000	not avail.
IC	\$ 50,000	\$30,000	\$ 20,000	\$ 54,000
LM	\$123,947/\$76,000*	\$38,000	\$ 38,000	\$298,000
MDM	\$ 31,350	\$24,000	\$ 7,350	\$ 80,000
MFFM	\$360,000/\$330,000*	\$93,130	\$218,000	\$218,000
MFC	\$150,900	\$23,300	\$127,600	\$249,000
MMC	\$ 76,000	\$11,400	\$ 64,600	\$201,000
PMMC	\$ 76,000	\$30,550	\$ 45,450	\$ 78,300
PSSC	\$ 17,000	\$ 8,500	\$ 8,500	\$ 69,475

*First number is original penalty. Second number reflects a reduction for good faith.

Payback information was obtained from case study firms during interviews. In one case, MFC, a copy of the company's profitability analysis was acquired. This analysis had been submitted to EPA during their SEP negotiations. The data are a mixture of numerical payback estimates and qualitative impressions of project profitability. In some cases it was not possible to gain this information, either because it was too soon for the company to know (MFFM) or because they considered this information to be somewhat sensitive (LM).

Project payback ranges from a very profitable 8 months (\$300-400,000 saved over a four year period) to a less profitable 5-8 years. Projects that involve the reduction or elimination of ozone-depleting chemicals seem to be more profitable than others because the cost of these organic solvents is steadily increasing as the final phase-out date approaches.

It is important to note that profitability analysis of pollution prevention investments is highly subjective. In particular, companies tend to omit certain financial benefits of pollution prevention projects, such as avoided liability and regulatory costs, because these costs are difficult to estimate and are speculative. Therefore, caution should be exercised in drawing conclusions from reported payback data.

16.2.5 Environmental and Human Health Benefits

There are two categories of environmental benefits that arise from pollution prevention SEPs and injunctive relief projects. The first category constitutes environmental benefits directly attributable to the SEP or injunctive relief project; these benefits are the subject of this section. The secondary category consists of the indirect benefits from pollution prevention implemented "beyond" the enforcement settlement which were leveraged by the SEP/injunctive relief either through technology transfer within/outside of the firm, or through organizational change within the firm. While the former is easier to measure and evaluate, the latter may be significant and should not be overlooked. Indirect benefits are addressed in the section on technology transfer below.

To evaluate environmental benefits of pollution prevention, used as a means to compliance, i.e., injunctive relief, one can analyse the absolute benefits of the project and the benefits relative to the technology that the company might have implemented had they not chosen a preventative strategy. In the case of BKPM, the absolute benefits of eliminating chlorine are quite significant, they include: the elimination of chlorinated organic compounds from wastewater; reductions in wastewater color, odor, and foam; elimination of worker hazards associated with chlorine and chlorine dioxide; and public health hazards associated with

the elimination of chlorine transport and storage. In addition, by eliminating chlorine, the mill can cycle bleach plant effluent into their black liquor recovery system to recover energy and pulping chemicals from bleach plant effluent and reduce BOD in discharged effluent.

When considering how to meet the wastewater toxicity limits in their Consent Decree, BKPM initially considered increasing chlorine dioxide and hydrogen peroxide substitution of elemental chlorine--process changes that constitute preventative strategies for reducing chlorinated organic compounds. In addition, they considered conventional secondary wastewater treatment and non-traditional treatment technologies (e.g. coagulation/precipitation, ultrafiltration, and catalyzed ultraviolet light treatment). The mill's chosen strategy appears far superior on environmental, occupational/public health grounds to both the alternative prevention strategies and the treatment alternatives. The TCF option will eliminate rather than simply reduce chlorinated organics in effluent, will eliminate chlorine hazards to workers and the public rather than reducing them under the other prevention options -- or having no effect under the treatment strategies.

To evaluate the environmental benefits of pollution prevention SEPs, one can also consider the absolute benefits of the project and the benefits relative to a hypothetical scenario of the settlement without a SEP. The environmental benefits of SEPs--summarized in Table 1 and in more detail in the full case studies (Appendix B)--are presented again in summary form in Table 3 for ease of reference.

Table 3. Summary of Environmental and Health Benefits of Pollution Prevention in Enforcement Case Studies

<u>Company</u>	<u>Environmental and Health Benefits</u>
<u>SEPs:</u> Casted Metal Products Manufacturer (CMPM)	Reduced wastewater discharges by approx. 100,000 gpd (75% reduction), reduced energy consumption and use of Freon, perchloroethylene, 1,1,1-trichloroethane, nitric acid, and isopropyl alcohol
Industrial Coater (IC)	Reduction in toluene use (56,000 to 5,600 lbs) and MEK use (50% reduction) and toluene and MEK emissions, waste and worker exposure. Net energy savings of 890 kw per hour.
Lid Manufacturer (LM)	The Company estimated that heptane usage would decrease by 203 tons per year, resulting in a reduction in VOC emissions of 50 tons per year. Particulates from manufacturing, natural gas usage and oven emissions may increase by 3.65 tons per year, and NOx, CO, HC and SO ₂ may increase by less than 1 ton per year each.
Medical Device Manufacturer (MDM)	Elimination of the use of 16,000 lb/yr of Freon
Metal Filing Furniture Manufacturer (MFFM)	Project designed to reduce paint and solvent use, waste and emissions. (Small success to date.)
Metal Finishing Company (MFC)	Reduction in lead contaminated dust generation (83-85%), elimination of health hazard assoc. with hexavalent chromium, reduce chromium use (bath strength decreased by 1/30) and sludge generation (67%). Nickel use will increase from 5,500 to 12,650 lb/yr.
Metal Machining Company (MMC)	Reduction in the use (30 to 17,000 gal/yr), emission (130,000 lb/yr) and disposal of 1,1,1 trichloroethane--an ozone depleting substance and a health hazard to workers.
Powder Metallurgy Manufacturing Company (PMMC)	Elimination of ammonia release threat, elimination of trichloroethylene use and approx. 26,860 lb/yr of fugitive emissions and reduction of 1,600 gal/yr of waste oil.
Pump Service and Sales Co. (PSSC)	Elimination of the use of Freon 113, an ozone depleting chemical, at the subject facility and another facility in another state.
<u>Injunctive Relief:</u> Bleached Kraft Pulp Manufacturer (BKPM)	Elimination of threat of chlorine gas release (a public and workplace hazard), reductions in the creation of chlorinated organic compounds; wastewater color, odor, and foam.

The following is a characterization of the *types* of environmental benefits achieved.

- The implementation of five of the nine SEPs have/will result in significant reductions in use and emissions of ozone-depleting chlorinated organic solvents--Freon and 1,1,1 trichloroethane. While the use of these solvents will be phased-out under the Montreal Protocol, and amended U.S. Clean Air Act, these SEPs achieve an accelerated reduction of long-lived ozone-depleting substances.
- The use and emissions of seven of the list of 17 target chemicals of EPA's Industrial Toxics Project were/will be reduced in the nine SEPs studied: chromium and compounds, lead & compounds, methyl ethyl ketone, nickel and compounds, toluene, 1,1,1-trichloroethane, trichloroethylene.
- Two SEPs--IC and MFFM--will/have achieved reductions in non-chlorinated solvent use (including methyl ethyl ketone and toluene) that will, among other benefits, improve the quality of the work environment.
- MFC switched from hexavalent to trivalent chromium, resulting in an improvement in conditions for workers as well as reduced chromium emissions to the environment. By reducing the generation of polishing dust containing lead and nickel, MFC's SEP reduces worker lead exposure and environmental loading of lead and nickel.
- Through the reformulation of jar lid gaskets, LM has significantly reduced its VOC emissions in a non-attainment area for VOCs.

While the pollution prevention projects implemented under the nine SEPs studied result in significant environmental and human health benefits, it is important to point out that in some cases new sources of exposure or pollution are created by the new technology. For example, aqueous and semi-aqueous cleaning agents, used in several SEPs to replace organic solvents, become a new wastestream either released in wastewater to wastewater treatment plants or drummed and disposed of as hazardous waste. Aqueous cleaners are not typically hazardous but may become contaminated with hazardous substances during

cleaning.⁷⁴ If this is the case, spent cleaner must either be treated to remove contaminants before discharge to the sewer or, like the organic solvents they replaced, must be disposed of as hazardous waste. In these cases, it is the contaminant (i.e., the material "cleaned-off" the product) that is the culprit, not the aqueous cleaner itself.

While semi-aqueous cleaners are biodegradable, non-ozone depleting and often recyclable, they may contain slightly hazardous constituents. For example, the cleaner adopted by PSSC contains terpene, a plant-based hydrocarbon material which pose the risk of flashing at room temperature. While EPA has not fully studied terpenes, limited testing of a terpene called d-limonene by the National Toxicology Program in 1990 has shown positive carcinogenicity in male rats. The strong odor of terpenes may be offensive to workers, requiring adequate ventilation.⁷⁵ Like their aqueous counterparts, semi-aqueous cleaners may be contaminated by hazardous materials during cleaning. For example, spent semi-aqueous cleaner used to de-contaminated pumps at Pump Service and Sales Company (PSSC) is disposed of as a hazardous waste.

In the case of LM, reductions of VOC emissions came at the price of small increases in NOx, CO, HC and SO₂ emissions and MFC reduced the generation of lead contaminated nickel dust by increasing its overall use of nickel by 130%.

What would have happened if SEPs were not included in these nine settlements? Certainly, the nine companies would have paid higher penalties to the U.S. Treasury. Beyond this, in some cases it is possible and in some cases it is virtually guaranteed (e.g., Freon users), that the pollution prevention projects implemented as SEPs would have been implemented by the firms some time in the future. Several firms stated that they would have eventually implemented the projects. This issue will be examined in a subsequent section. It is

⁷⁴ U.S. Environmental Protection Agency. "Guide to Clean Technology: Alternatives to Chlorinated Solvents for Cleaning and Degreasing." July, 1992.

⁷⁵ Ibid.

relevant to consider the environmental benefits of accelerated implementation where projects would most likely have been implemented eventually. The environmental benefit of accelerated elimination of long-lived ozone-depleting substances--the outcome of five SEPs studied here--is probably most profound.

All but one case study consisted either entirely or partially of multi-media pollution prevention projects, i.e., they reduced or eliminated two or more of the following: emissions to air, emissions to water, generation of waste, and exposure of workers to hazardous substances. The exception is the gasket reformulation project implemented as a SEP by LM which was designed as a VOC reduction measure and had no positive impacts on other media. None of these SEPs with multi-media impacts, however, were explicitly negotiated via a multi-media enforcement initiative.

16.2.6 Source of the Technical Idea

Case study companies sought and obtained technical ideas from: their own staff, environmental consultants, technical consultants, trade journals, vendors, and their EPA case officer. Several companies used more than one source.

Companies switching from organic solvent to aqueous degreasing relied heavily on the expertise of equipment/chemical vendors. MFC learned of trivalent chromium technology from the chemical supplier. One company, MDM, saw an advertisement for deionized water cleaning equipment in a trade journal. One company, LM, used a technical rather than environmental consultant, to help with equipment design.

In only one case, CPM, did the case officer play a significant role in providing technical expertise and specific suggestions. In the case of MFFM, all technical ideas contained in the SEP came from an environmental consultant hired by the firm. The company did not feel that they had the necessary expertise to develop pollution prevention ideas.

Most case study firms stated that they would prefer not to involve the agency in the process

of developing technical proposals for a SEP, particularly if it would require repeated agency site-visits. Many of these firms typically had, or quickly developed, project ideas that were on/consistent with their long-term critical technology path. One firm stated that they would not reject a good idea provided by the agency, but they were certainly not looking to the agency for ideas.

In one exceptional case, MMC, company representatives indicated that they sought technical assistance from the regional case officer but the case officer was unwilling to provide help. MMC's manufacturing engineer was seeking (and was strongly encouraged by the agency to seek) alternatives to 1,1,1-trichloroethane-based cleaning systems for technically demanding applications, at a time when aqueous and semi-aqueous technology was fairly immature.

Several case officers reported that they were reluctant to provide technical advice for two principal reasons. First, they are concerned that if the company follows their advice and the project fails, the case will be jeopardized and the case officer will be reprimanded. Second, because companies understand their processes better, they are in a better position than case officers to develop appropriate and creative technical ideas. A suggestion from a case officer may also short-circuit the company's own creative technical process and lead to a less innovative and/or less effective project. Generally, case officers prefer to have the violator propose a SEP, and then once proposed, the case officer can perform their role as evaluator of the project's environmental merit and technical feasibility.

The role of the environmental consultant⁷⁶ in the CPM and MFFM cases was particularly important and worth noting. At the outset of the enforcement process, neither company was familiar with pollution prevention concepts or techniques, nor did they have the technical capability to develop or implement prevention projects. Therefore, these companies

⁷⁶ By environmental consultant, it is meant consultants engaged primarily in studies, engineering design, and implementation projects for environmental compliance, remediation and pollution prevention.

entrusted their hired consultants with the development of project proposals and implementation during the settlement process. In addition, the regional negotiators, knowing that the companies lacked necessary capabilities, openly relied on the expertise of the consultants (and in some ways used the consultants as neutral arbiters) and thereby invested these consultants with significant power in the settlement process. These factors elevated the role of the consultants in this process and, to a large degree, the outcome was determined by the consultant's knowledge, expertise, experience with specific technologies (e.g., baffle collection system for paint overspray), and technical orientation (e.g., waste minimization vs. product reformulation), rather than the knowledge, etc. of the companies.

In the case of IC, the environmental consultant designed the SEP and assumed a primary role in monitoring and reporting project progress during the implementation phase. It may be that the focus in this case--waste minimization as opposed to more "up-stream" process changes--is a result of the technical orientation of the consultant rather than a factor of what made most sense from a technical/environmental and economical standpoint. If this is so, both the lack of technical expertise within the company and the orientation of the consultant may help to explain why the projects implemented are not performing well environmentally or economically.

At first, CMPM's environmental consultant--a geotechnical/environmental engineering firm--took a major role in making technical recommendations for bringing the company into and beyond compliance. The consultants recommended a \$250,000 combined-flow treatment plant that the company realized they did not need.⁷⁷ This realization came about as a result of a process investigation that the company performed at the request of the regional case officer. At this point, the company lessened the role of the hired consultant and, to a significant degree, the regional case officer assumed the consultant's role in developing pollution prevention options. The outcome of the case--a SEP consisting mainly of the

⁷⁷ If CMPM built this plant, they would have had significantly less incentive to implement pollution prevention in the context of the SEP and into the future.

redesign of several rinsing and coating lines in the metal finishing area--is largely a function of the case officer's expertise. The case officer had just finished a year-long rotation with the state's pollution prevention technical assistance program which has participated in numerous metal finishing, plating/rinsing redesign projects. According to CPM, the regional attorneys trusted the consultants and therefore, they assisted the company throughout much of the negotiation process by helping to win EPA approval for the technical changes that the company sought to implement.

In contrast to IC and CPM is the case of PPMC. PPMC hired an environmental consultant to perform an audit (one part of the SEP), but all of the pollution prevention ideas included in the audit came from within the plant. The consultant served primarily to endorse the ideas. It is interesting to note that in this case, the company became extremely motivated by the success of the pollution prevention projects implemented in the SEP.

Sections 17 and 18 contain a discussion on the role of the consultant in the development of pollution prevention ideas and how the consultant could be either a barrier to, or promoter of, innovative pollution prevention. Given the absence of pollution prevention technical assistance office participation in developing pollution prevention SEPs, Sections 17 and 18 include a discussion on barriers to, and the potential for, involvement of these organizations, respectively.

16.2.7 Type of Pollution Prevention Implemented in the Case Study Firms

The case studies contain a wide array of pollution prevention techniques, including: chemical substitution, product reformulation/redesign, process modifications to conserve water/energy, and waste reduction measures.

Six SEPs dealt with chemical substitution in cleaning processes. Four consisted of substitution of chlorinated organic solvent-based cleaning/degreasing systems with aqueous/semi-aqueous degreasing or deionized water-based processes. In one case, PPMC, the company switched its tapping fluid to an aqueous formulation which enabled them to

shut-down their 1,1,1 trichloroethane degreasing unit--formerly needed to remove an oil-based tapping fluid.

Three cases involved chemical substitution in non-cleaning processes. MFC substituted trivalent chromium for hexavalent chromium in its chrome plating line. PMMC replaced its ammonia sintering atmosphere with a safer blend of nitrogen and hydrogen gases. BKPM eliminated chlorine use in bleaching by making significant changes to the chemistry of its pulping and bleaching processes.

Three cases involved product reformulation/redesign (usually necessitating process changes as well). LM reformulated their gasket coating material to eliminate VOC-producing heptane from the recipe. This change required modifications to drying equipment. IC agreed to reformulate their coating in order to eliminate the toluene coating vehicle. This change required significant equipment redesign. MFC reduced lead contaminated dust generation by redesigning their product. They increased the thickness of the nickel plate on the product to improve surface finish so that a larger percentage of parts do not need polishing--the dust-generating process. This change also required significant process modifications.

Two cases involved process modifications to conserve water and energy, and to reduce wastewater. CPM redesigned rinsing systems on several process lines to conserve water and reduce wastewater discharge. PMMC implemented a closed-loop cooling system.

One case, MFFM, implemented a SEP consisting of several waste reduction measures designed to reduce organic solvent and paint waste generation; these included a solvent recycling system and a paint overspray recycling system (baffled collection system).

16.2.8 Innovation vs. Diffusion and the Locus of Technological Change

The technological changes undertaken by case study firms can be categorized by a framework that classifies pollution prevention projects according to the locus and

innovativeness of technological change. By locus it is meant whether the change was made to a primary, secondary or ancillary production process. A primary process is one which yields the key functional property or properties of the product (i.e., defines the product). Using the example of a steel bolt, the primary production process is the casting of the part. An example of a secondary process is the metal plating of the part. Plating may provide a functional (e.g., non-corrosive) or aesthetically-pleasing finish, but it is not primary to the function of the product. An ancillary process is, for example, cleaning of the bolt prior to plating. Ancillary does not mean unimportant. As any metal plater will tell you, dirty parts do not plate properly.

Innovation is the first commercial application of a new technical idea. To categorize the innovativeness of the technological change, three general headings are used: major innovation, incremental innovation and diffusion. Major innovation involves a significant shift in technology, incremental innovation involves smaller changes or the adaptation of existing technology, and diffusion is the widespread adoption of existing technology (i.e., involving little or no innovation).

When the "locus" and "innovativeness" characterizations of technological change are combined, one produces the three-by-three matrix pictured in Table 4. Projects that are located in the upper left-hand corner of the matrix, i.e., major innovation in primary production processes, represent dramatic changes in the core technology of the firm. Generally, these projects tend to require relatively high capital investment and pose greater risk to the firm, particularly when changes in product characteristics may disrupt established markets or when new technical expertise is needed and old expertise becomes obsolete.⁷⁸

⁷⁸ Abernathy, W.J., Clark, K.B., 1988, *op.cit.*

Table 4. Characterization of Pollution Prevention Technological Changes Made by Case Study Firms According to Locus and Degree of Change

<u>Locus of Change</u>	<u>Major Innovation</u>	<u>Degree of Change</u>	
		<u>Incremental Innovation</u>	<u>Diffusion</u>
<u>Primary Production Process</u>	BKPM-TCF bleaching	IC-organic solvent-free coating LM-reformulate gasket	PMMC-ammonia to nitrogen/hydrogen atm.
<u>Secondary Production Process</u>		CMPM-redesign of rinse systems MFC-nickel tank extension	MFFM-paint and organic solvent recycling/waste reduction MFC-conversion to trivalent chromium
<u>Ancillary Process</u>		MDM-substitution of deionized water degreasing system	CMPM-substitution of aqueous cleaners MMC-substitution of semi-aqueous cleaners PMMC-substitution of aqueous tapping fluid and closed loop cooling PSSC-substitution of semi-aqueous cleaners

If the technological changes made by case study firms are located within this matrix (Table 4), one can see that the majority of changes are diffusion driven, while a smaller number can be considered incremental innovations and only one--BKPM--can be considered a major innovation. There is a fairly even distribution of technological changes across the spectrum of primary, secondary and ancillary processes.

When this distribution is considered in the context of the selection criteria used to choose case studies, it should be noted that although the most innovative projects were selected for study, the sample was largely made up of diffusion-driven technological changes. In

addition, by seeking case studies involving process redesign and product reformulation, the sample contains a significant number of changes to primary or secondary production processes. If a random case study selection process had been used, the sample would have been much more heavily weighted toward the lower right-hand corner of the matrix, i.e., diffusion-driven changes to ancillary production processes, since a large number of SEPs consisted of the replacement of organic solvent-based cleaning systems with aqueous/semi-aqueous-based systems.

In Section 16.2.14 below, the length of the project implementation period is discussed as a factor in the inclusion of innovative projects in enforcement settlements.

16.2.9 Technology Transfer Benefits

In two cases, CPM and MMC, the companies have transferred the ideas for solvent use reduction and water use reduction, respectively, to other plants. The SEP implemented in the PSSC settlement included the substitution of aqueous cleaning systems in both the subject plant and another plant in another state and EPA region (even though no violation had been cited in the second region).

IC and LM will evaluate the success of the SEP projects to decide whether to implement the technology on other product lines within the subject facilities. In two cases, MFC and PMMC, there is particularly significant potential for technology transfer to other firms since MFC participates in a state-sponsored pollution prevention group of industries and uses the state pollution prevention technical assistance office; the President of PMMC is active in his trade association.

In the case of MDM, the company will not implement the deionized water degreasing system in the subject facility, since this facility will soon close. However, the company will seek FDA approval to install the system in a new facility that will replace the production capacity of the subject plant.

Finally, the technology transfer benefits arising from the implementation of TCF pulping in BKPM are quite significant. When the project is completed, BKPM will be the first mill in the U.S. to produce bleached kraft pulp without the use of chlorine. Since the company has disclosed information regarding process changes that they are implementing, the project will certainly push an important technological/environmental frontier in pulp and paper industry.

16.2.10 Organizational Change

In interviews with case study firms, an attempt is made to identify whether and how the company has made organizational changes as a result of implementing pollution prevention SEPs or injunctive relief projects. It is difficult, in some cases, to determine whether changes made were a result of implementing pollution prevention or a result of the enforcement action in general. With this caveat in mind, this section contains an overview of the organizational changes made by case study firms as communicated to us by the companies.

- In the case of PMMC, the President's perception of environmental investments has changed. He now believes that it is economically sensible to stay one step ahead of environmental regulations by eliminating hazardous operations.
- CPM increased their environmental staff by adding one full time engineer and three part-time technicians.
- Through the SEP process, technical staff at CPM and MMC developed knowledge and skills to enable them to pursue pollution prevention beyond the SEP, and they are applying their abilities to management goals of total elimination of organic solvents and zero-discharge, respectively.
- MFM's SEP contained specific organizational change initiatives, proposed by the firm's environmental consultants, including pollution prevention training and the promotion of plant engineer to vice president for manufacturing and environmental quality to carry out a pollution prevention policy and program.

- It was not apparent that the SEP process catalyzed organizational change in MDM. Prior to the enforcement action, a new state hazardous waste reduction law motivated the company to reevaluate their approach to environmental compliance and the true cost of the materials they use. They had already made significant strides toward reduction of Freon use and pollution prevention in general.
- BKPM had also implemented many process changes, prior to their consent order, to improve the efficiency and reduce the waste generated by its processes. Their experience in seeking EPA approval for the TCF project has changed their views on the best way to approach regulatory matters in the future. They will seek to involve technical people only in initial discussions with EPA and bring attorneys in later on in the process.
- Two companies have instituted new policies that prohibit new chemicals from the plant without approval of environmental personnel.
- Two companies started working with state pollution prevention technical assistance offices.
- No organizational change was apparent in either LM or PSSC.

It is also important to consider whether in-house counsel or retained private bar were supportive or skeptical of SEPs and whether their views changed. With respect to in-house counsel, only one case can be used to develop insight. In the case of MDM, the company's in-house corporate environmental attorney was interviewed. This attorney played a significant role in negotiating the SEP. The attorney was, and continues to be, supportive of the SEP policy as a way to recognize the efforts of a violator (via penalty mitigation) to make environmental improvements through a project that is beneficial to the company as well.

The majority of case study firms relied primarily on outside counsel during the negotiation process. The next section considers the role of outside counsel in the settlement process.

16.2.11 The Role of Outside Counsel (Retained Private Bar)

Six out of the ten case study firms stated that their outside counsel was instrumental in negotiating SEPs and, in particular, helping to establish implementation schedules, milestones, and stipulated penalties. The following summarize relevant portions of the interviews.

- MFFC stated that they had a good outside attorney--with experience in environmental litigation--who was instrumental in crafting the company's SEP proposal.
- MDM's in-house environmental counsel gives substantial credit for the successful inclusion of the SEP to their outside counsel. The idea of a SEP came out of an initial meeting between EPA negotiators and the outside attorney who conveyed to the company that the agency was very interested in including a pollution prevention SEP in the settlement and asked the company if they had an appropriate project. The attorney was both assertive and creative in his dealings with the company and EPA and he managed to work out an agreement between the two parties despite the difficulties that arose over the implementation schedule.
- According to EPA negotiators, MFFC's outside counsel was formerly with the U.S. Attorney General's Office and had worked on EPA settlements in that capacity. She was very familiar with the settlement process and this made the negotiations much smoother. The region considered her involvement to be a contribution to the success of the SEP negotiation.
- The regional negotiators stated that LM used an outside attorney who understood the SEP policy well and was very proactive.
- PMMC stated that their outside counsel was very helpful in negotiating the SEP, particularly in establishing the implementation schedule.

In one case, CMPM, the firm stated that their outside attorney hampered the process because he was unfamiliar with environmental regulations and agencies.

Although it was not possible to directly interview the outside counsels spoken of by the case study firms and described above, the general impression is that these counsels were supportive of SEPs. Since the firms view SEPs positively, the outside counsels role is viewed as a beneficial contribution since they helped the firm to negotiate a SEP. For their part, the counsels can point to their role in reducing the penalty--a tangible "value added" service.

It was not possible to determine whether the views of outside counselors changed in the course of the settlement process.

16.2.12 Change in Vendor/Consultant Relations

Two case provide contrasting experiences in changed relations with consultant/vendor. CMPM was dissatisfied with their technical consultants--a geotechnical/environmental engineering consulting firm that contributed to some degree with process change ideas--by reviewing and modifying recommendations from the EPA case officer--but largely recommended traditional technical problem-solving approaches. The company would be hesitant to use them again. LM was very pleased with their technical consultants who were knowledgeable about both manufacturing technology and environmental regulations.

Two companies now have begun to use state pollution prevention technical assistance programs. MMC hired a consulting branch of a chemical manufacturing company. MMC's manufacturing engineer has found that his knowledge of pollution prevention technology has enabled him to be a better evaluator of technical options for his company than these potentially biased consultants.

In four cases, no change in vendor/consultant relations was apparent.

16.2.13 Projects Not Completed Under the SEP

In two cases, IC and MDM, the companies did not fully implement the SEP projects within the established timeline and, as a result, paid stipulated penalties to the agency. During

project implementation, IC experienced unanticipated technical problems in using their existing coating equipment to apply the new coating formulation. Therefore, they were not able to meet the SEP implementation deadline. Despite the regions' willingness to grant an extension, the company paid the penalty to eliminate the SEP deadline pressures. They are planning to re-initiate the project in the near future since they consider it to be a "bonafide win-win situation for the environment and [their] enterprise."

MDM has chosen not to purchase the deionized water cleaning system for the subject plant because they will be closing the subject facility in February of 1994 and will be moving its operations to another plant. However, given the success of the technical evaluation conducted under the SEP, the company will seek FDA approval for the deionized system at the new site and implement it if approval is granted.⁷⁹

16.2.14 Time to Implement the Pollution Prevention Project

For each case study, Table 5 below presents information on the timeline established in the consent agreement and final order (CA/FO) for SEP/injunctive relief project implementation. Specifically, the table contains: the date of the agency's complaint⁸⁰, the date of the CA/FO (i.e., the date it received final signature(s)), and the implementation deadline contained within the CA/FO.

By reading the notes that accompany the entries, one can see that these dates do not always present a clear picture of the actual time taken to implement the projects. In three cases--CMPM, MMC, and PSSC--the companies began implementation of the projects prior to the finalization of the CA/FOs. In two cases--IC and MDM--the projects were not completed

⁷⁹ Given the uncertainty of FDA approval and the need for R&D, agency and company negotiators put significant effort into developing the stipulated penalty schedule. Stipulated penalties did not appear to be a major concern, or to require much negotiation effort, in other cases.

⁸⁰ The agency files a complaint, after an inspection, if violations were found during the inspection. The complaint typically contains the findings of the violation, notice of the proposed assessment of a civil penalty against the respondent, and notice of respondent's opportunity to request a hearing on the proposed penalty assessment.

as SEPs (see Section 16.2.13 above). Looking only at those SEPs where project implementation began at or near the CA/FO date, and was completed under the agreement (i.e., LM, MFFM, MFC, and PMMC), implementation periods ranged from 3 to 17 months. The shortest period, 3 months for the MFC case, is a result of the fact that the company needed to compress the implementation process into its one-week scheduled shut-down period, which fell within 3 months of CA/FO finalization.

The unique circumstances of each case, and the limited size of the sample, make it difficult to draw generalizations on the length of time needed to implement projects. However, it is worth noting one point that relates the type of technological changes made (as discussed in Section 16.2.8 above) to implementation periods. The changes characterized as incremental innovations in Table 4 are: CPM (redesign of rinse systems), IC, LM, MDM and MFC (nickel tank extension project), and with the exception of MFC, each of these required more than one year for implementation. The single case of major innovation--BKPM--is on a 3-year implementation timeline. With the exception of IC, agency negotiators were willing to accommodate longer timelines in these cases. The approximately 10 month timeline established in the IC case was a factor in the company's inability to complete the project as a SEP. These observations provide a preliminary indication that innovative projects may often require more than the "maximum 1-year implementation timeline rule-of-thumb" that is often applied by agency negotiators.

Table 5. Time to Implement Pollution Prevention Projects

<u>Company</u>	<u>Date of Complaint</u>	<u>Date of CA/FO (signature date)</u>	<u>Project Deadline (per CA/FO)</u>
<u>SEPs:</u> Casted Metal Products Manufacturer (CMPM)	September 1989	August 1992 (company began studying and implementing process changes in August 1990)	September 1993 (per CA/FO, extended to September 1994)
Industrial Coater (IC)	August 1989	March 1992	December 1992 (project not completed, see Section 16.2.13 above)
Lid Manufacturer (LM)	July 1992	December 1992	May 1993 (plus 4 month grace period)
Medical Device Manufacturer (MDM)	April 1991	April 1992	September 1993 (project not completed, see Section 16.2.13 above)
Metal Filing Furniture Manufacturer (MFFM)	October 1991	May 1992	November 1992 - project implementation, May 1993 - documentation of P.P. program implementation
Metal Finishing Company (MFC)	February 1992	July 1992	September 1992
Metal Machining Company (MMC)	March 1989	October 1991 (project initiated in April 1990)	September 1991 (protracted negotiation period led to project implementation prior to CA/FO)
Powder Metallurgy Manufacturing Company (PMMC)	September 1989	January 1992	January 1993
Pump Service and Sales Co. (PSSC)	March 1990	October 1991 (company initially proposed, and began to implement, SEP in September 1990)	December 1991
<u>Injunctive Relief:</u> Bleached Kraft Pulp Manufacturer (BKPM)	September 1989	September 1992	September 1995

16.2.15 An Examination of Whether Pollution Prevention Projects Would Have Been Implemented Without the SEP

Most of the projects implemented as SEPs had been considered by the case study firms before they were cited for violations by the agency. It is difficult to know whether, and when, these projects might have been undertaken if the regions had not granted penalty reductions in exchange for the firm's commitment to implement the projects. By examining the information that the companies provided during the interviews, one can gain insight into this question.

- IC considered reformulating their coating prior to the SEP, but the concept and implementation had been accelerated through the SEP process in two principal ways: the project was initiated sooner and it maintained high priority status despite difficulties in development and pilot testing.
- LM had considered the gasket formulation project prior to the enforcement action and may have otherwise implemented it. The SEP provided an impetus to undertake the project and was, from the company's perspective, an alternative to litigation over the penalty amount and to spending additional money on attorneys' fees.
- The projects implemented by PMMC under the SEP policy, had been proposed by various members of the company (in manufacturing) prior to the issuance of the complaint. The SEP process was the necessary impetus for implementation.
- In the months prior to the complaint, MDM explored the possibility of eliminating freon use in degreasing through the substitution of a deionized water degreasing system. They began conducting first-stage evaluations of the performance of the equipment on the company's products.
- MMC's plant engineer stated that the plant would have eventually moved to eliminate their use of 1,1,1-trichloroethane, particularly given the increasing cost of the material. The SEP process was considered a stimulus.
- The facilities manager at PSSC stated that the SEP did not accelerate the

aqueous degreasing system; the company would have implemented the project on roughly the same schedule without the SEP.

- Prior to EPA's complaint, CMPM realized their water usage costs were high and that they should reduce water consumption but had made no efforts to do so. The company stated that EPA compelled them to implement water-use reduction measures far in advance and in excess of what they would have done without the enforcement action.
- MFC had reviewed vendor information on trivalent chromium plating prior to the complaint, but there were no plans to convert over at that time since the trivalent system produced an unacceptable surface finish. They felt able to propose the trichrome system as a SEP because by that time, the process had been sufficiently improved.
- It is unlikely that MFFM would have implemented the pollution prevention measures without the SEP.
- The EPA case officer believes that BKPM chose to implement the TCF project to meet the toxicity limits in the consent order in anticipation of state promulgation of new, stringent effluent limitations for dioxin.

It is difficult to evaluate the validity of these statements particularly because discretionary projects (e.g., many pollution prevention projects) are often carried along from year-to-year and only implemented when and if the will and resources exist to do them. In many cases it appears that the SEPs serve as a catalyst to pollution prevention implementation by overcoming financial and institutional barriers within firms.

16.3 Impact on the Agency's Enforcement Program

In the course of the case study research, one could observe several types of impacts on the agency's enforcement programs stemming from the inclusion of pollution prevention in enforcement agreements. Given that only one of ten cases involved pollution prevention as injunctive relief, the majority of the observations came about in the context of studying

SEPs. However, most of this section seems to apply both to SEPs and injunctive relief. In addition, it was not possible to conduct an extensive study of the impact of this policy on the agency and most of the agency interviews were conducted with staff involved in, and supportive of, pollution prevention SEPs/injunctive relief. Therefore, the ability to draw general conclusions on this subject is necessarily limited. However, the observations and commentary contained herein can be regarded as an indication of a subset of impacts arising from this policy.

16.3.1 Attitudinal and Organizational Effects

The EPA attorneys and case officers who negotiated the settlements studied here are very motivated by their experiences in negotiating SEPs in general and pollution prevention SEPs in particular, into enforcement agreements. As related to us by one EPA attorney who has negotiated many SEPs, "in spite of resource constraints, I would like to see a SEP in every case because it gives me a sense that [the region] is really doing something beneficial for the environment. Even if it is just a paperwork violation, we can turn it into something better. Many people in the region feel this way." One case officer said that the satisfaction he gets from negotiating SEPs helps to overcome certain frustrations in his job. In the case of MFFM, the case officer was disheartened over the prospect of levying a large fine on this small company for violations that stemmed not from egregious and willful violations but from a lack of understanding and information on regulatory requirements. The pollution prevention SEP was a way to turn this situation into something positive for the environment, the agency and the company.

In two out of three regions within which the case studies reside, it was observed that a small number of largely self-motivated case officers and attorneys had become active and expert on pollution prevention SEPs. These people are known as experts by administrators and managers within and outside of the region (i.e., in Headquarters), were recommended to us as initial regional contacts, and were involved in negotiating many of the SEPs selected for study. These staff are personally motivated to include pollution prevention in enforcement settlements and seem to find this activity an added and enjoyable challenge.

Stemming largely from their interest, they have developed the necessary technical and/or negotiation skills.

While pollution prevention SEP activity is not the sole province of these "experts", this activity is not evenly distributed throughout the regions. However, according to one so-called expert, their numbers are slowly growing as more and more case officers and attorneys have an opportunity to be involved in this process. Enforcement cases are assigned to a team of one or more case officers and attorneys. If, according to one case officer, the team contains a case officer who is a pollution prevention SEP enthusiast, the case is more likely to have a SEP. A supportive attorney on the case can help to guide the negotiation process toward SEP inclusion. There are attorneys and case officers who see SEPs as a complication and are not interested in including them in settlements. Some individuals are philosophically opposed to reducing a penalty in exchange for a prevention or other type of project. These staff are unlikely to change their opinions and will tend to not include SEPs in cases they are involved in.

It appears motivated individuals are either hampered, simply allowed, or in some cases, encouraged by their management to pursue pollution prevention SEPs. The EPA Administrator's clear statement that pollution prevention is an agency priority, said one case officer, has helped to get more support from management within the region. But still, there are both supporters and detractors all through the ranks of management and regional administration. His immediate supervisor is not supportive of pollution prevention SEPs, seeking to maximize the final to proposed penalty ratio statistic for the Section. But the case officer's division director and the regional administrator are supportive and therefore, overall, the climate for SEPs is friendly.

Another picture was painted by a case officer in the region that was not one of the two regions discussed three paragraphs above. She noted that she encountered a great deal of resistance from her managers when she decided to incorporate the SEP, but after she settled the case no one "bothered" her. She observed that staff within her region are afraid to

include SEPs because regional managers do not want to reduce the overall dollar value of fines paid. Some managers and some case officers find SEPs personally too risky, and younger staff in particular are afraid to jeopardize their careers at the agency if projects are deemed failures. If this is widespread in this region, the increase in the number of individuals involved in, and enthusiastic about, SEPs will be slow.

While a primary reason for resistance to SEPs seems to be the traditional, internally and externally (e.g., Congress)-driven perception that a successful enforcement program is one that maximizes the final to proposed penalty ratio, there does not seem to be a discernable pattern of support or resistance in management. For example, it does not appear that one can explain the pattern of resistance by assessing who is held most accountable in the penalty incentive system. Resistance seems to be a function of an individual's adherence to a traditional view of the penalty-based metric of success. Support is based either on a true belief in the advantages of the pollution prevention/SEP approach, or on a duty-based desire to follow a high-level administrative mandate. One case officer believes that if the full value (i.e., level of company investment, environmental benefit, etc.) of pollution prevention SEPs was evaluated by the critics, they would see that the benefit of the projects bring the proposed to final penalty ratio to one, or greater.

16.3.2 Time Requirements

There is an obvious and important correlation between the time needed by case officers and attorneys to settle and monitor cases and the number of cases that can be settled during a given period of time--the more time needed per case, the fewer cases that can be settled. Two viewpoints were heard on time requirements. Most case officers and attorneys asserted that on average, settlements with pollution prevention SEPs required more time to negotiate and monitor than settlements without them. Alternatively, several case officers and attorneys contended that SEPs are not more difficult or more time consuming if you

structure them correctly (e.g., requiring third party certification and documentation).⁸¹

It appears that time requirements for inclusion of pollution prevention can vary greatly depending on many factors, including:

- time needed by the violator/time given to the violator to develop a project proposal (may be a function of the technical sophistication of firm, complexity of project, need for a consultant's pollution prevention audit, etc.)
- time needed for case officer to determine environmental merit and technical feasibility (may be a function of the knowledge and expertise of the case officer, project complexity, etc.)
- the length of the implementation/monitoring period and number of progress reports needing review (may be a function of the technical difficulty of the project, etc.)

I did not try to deduce the average time needed to negotiate and monitor settlements with and without pollution prevention in the course of the research. Based on observations, however, one could expect that an EPCRA 313, Form R reporting case would take longer to settle with a pollution prevention SEP than without, because Form R cases tend to be (but are not always) straightforward. SEPs negotiated in the context of violations of pollution limitations might not take all that much longer to conclude. However, if the case officer and attorney have experience, knowledge in pollution prevention and SEPs/injunctive relief, and are motivated, the additional time requirement may be minimal.

⁸¹ One finding reported in the ITEP study of EPCRA pollution prevention EBEs was that only a small oversight burden was placed on the Agency from each case studied. This determination, however, was based on the fact that facilities were not typically visited by EPA to assess the projects. (Many Regional Offices did not find it practical or necessary to follow-up with site visits since agreements typically contain documentation and reporting requirements to verify expenditures.) ITEP did not consider the negotiation process and review of documentation. IT Environmental Programs, Inc. for U.S. EPA Office of Compliance Monitoring, Toxics Enforcement Branch, Investigation of Environmentally Beneficial Expenditures for Settlement Agreements," May 1992.

If the project is not particularly novel or complex, or if the case officer and the firm are confident in the technical feasibility of the project (even if the project is innovative), it is likely that little extra time will be needed for settlement negotiations. On the other hand, if the violator sought to incorporate a more innovative and complicated project which requires R&D, or if the case officer is not confident of the project's technical feasibility, the time needed to review the project/negotiate the settlement would likely increase.

In one region, it was apparent that there was a troubling lack of consensus among management and staff on the appropriate time trade-off between numbers of settlements and numbers of SEPs. While the degree to which this trade-off exists is not clear, it was evident that open dialogue on the question was needed. Further, the basis for staff evaluations vis-à-vis SEP versus traditional settlements remains an unresolved important issue.

Section 17 contains a discussion of how the issues raised here manifest themselves in a variety of barriers to pollution prevention SEPs and injunctive relief.

16.3.3 Technical Resource Requirements

There was no apparent demand, on the part of case officers, for either published information on pollution prevention (e.g., technical case studies) or training. Case officers, for example, often either never heard of or never used, the Pollution Prevention Electronic Information System (PPEIS). One reason appears to be that case officers are primarily in a reactive mode, i.e., they generally prefer to rely on the companies to propose projects and are not, by-and-large, helping companies to come up with specific technical ideas (although they might provide examples of "acceptable" pollution prevention projects). Typically, case officers use their own technical knowledge and/or their colleagues' knowledge to evaluate company proposals.⁸² If they have questions on the environmental impacts of the

⁸² Technical staff in companies also tend to prefer to acquire environmental/technical ideas through verbal communication with their colleagues in other companies either through one-on-one interactions or at trade associations or conferences.

technology proposed (e.g., where chemical substitution is involved), they might seek out advice from a technical expert within another branch of the region. One case officer stated that there is not enough time in the day to peruse technical documents.

With respect to training, a case officer active in negotiating pollution prevention SEPs stated that it would be useful to provide training on pollution prevention concepts and techniques. However, full-day intensive training sessions are not effective. Training must be structured in short sessions (i.e., 2 hours), over a longer period of time, in regular intervals, to be effective. In addition, trainees should be given an opportunity to apply the concepts to reinforce them. Effective training can support the personal communication-based information-sharing network, described in the preceding paragraph.

16.3.4 Advancement of the Agency's Pollution Prevention Objectives

By negotiating pollution prevention into an enforcement settlement, case officers and attorneys not only gain knowledge and experience in pollution prevention for use in future enforcement cases, but they can also bring the knowledge into the organization for either their direct use in other activities (e.g., permitting) or as a source of information for other individuals in the organization. One EPCRA case officer, actively involved in negotiating SEPs, has become a well-known pollution prevention resource within the regional office. His pollution prevention expertise, gained in part through SEP negotiations, is leveraged both within the regional office as well as in EPCRA's outreach programs to the regulated community. With regard to the latter, the Pollution Prevention Act of 1990 requires that companies submitting Form R's under EPCRA 313 include a report of toxic chemical source reduction and recycling activities for each toxic chemical reported. The case officer assists companies in this endeavor and, in the process, transfers his pollution prevention knowledge to the firm. The case officer also uses his expertise in leading the pollution prevention section of EPCRA's compliance workshops. An attorney in another region commented that SEPs are an excellent way for her and her colleagues to learn about new technology; this knowledge has been very useful to her in permitting activities.

The degree to which pollution prevention knowledge gained through enforcement is leveraged in other activities is not only a function of the flow of information into the enforcement program but also a function of how interested and capable other programs are in getting the knowledge and incorporating it into their activities.

16.4 Impact on the Firm

There are many impacts on the firm stemming from the inclusion of pollution prevention in enforcement. This section contains observations and analysis, organized into two parts: impact during the enforcement process and impact beyond enforcement. The same limitation of the study here, as is given in Section 16.4 above, is noted, namely that the majority of the observations documented came about in the context of studying SEPs; however, most of the conclusions reached in this section seem to apply both to SEPs and injunctive relief.

16.4.1 The Enforcement Process

All nine SEP case study firm representatives interviewed stated that they support the SEP policy. Whether or not their projects were successfully implemented as spelled out in the CA/FO, and whether or not they expended far more or slightly more resources on the project than they received in penalty relief, they were gratified to have had the option to implement a pollution prevention project in exchange for some penalty reduction. Before discussing the reasons why these companies support this policy, it is important to note that while in the final analysis, the SEPs took some of the sting out of the enforcement process for case study companies, it did not eliminate the very significant economic and psychological impacts associated with being caught out of compliance by EPA.

With or without a SEP, attorney's fees and staff resources needed to negotiate the settlement take a direct economic toll on the firm. Some firms, particularly those still in the implementation stages of their projects, were initially reluctant to talk to us. This indicated to us that these firms were concerned about continued agency oversight. This factor may be more pronounced in the SEP case study firms because they tended to be either small or

medium-sized companies for which the impact of an enforcement case was particularly significant.

In most of the cases, the companies were pleased to have negotiated a pollution prevention SEP because they could achieve a reduction in the fine for implementing a project that was beneficial to them either because the project cut their costs, eliminated a source of current⁸³ or future regulation, or gave them a competitive edge (e.g., switching from hexavalent to trivalent chromium). In some cases, pollution prevention projects secured a combination of these benefits. In many cases the projects had been considered prior to the enforcement action. The reasons why these firms did not implement the projects prior to the enforcement action vary from the lack of top management interest/approval, to a profitability estimate that did not meet company performance criteria, to the absence or shortage of the necessary in-house technical staff or time burdens on existing staff.

All companies see SEPs as an opportunity to turn a negative situation into a more positive one. Some companies stated that SEPs help to recognize their efforts to make improvements. They rekindle staff morale because they send out a message that while the company broke the law, EPA reduced the fine because the company elected to implement an environmentally beneficial project.

16.4.2 Beyond Enforcement

While the pollution prevention projects themselves create environmental benefits, greater benefits may be realized if pollution prevention implemented in an enforcement context is a catalyst for additional prevention beyond the enforcement process. The discussions on technology transfer and organizational change in Section 16.3.9 and 10 demonstrate that many of the firms studied have taken, or are working toward, further pollution prevention steps and that these steps seem to be linked to their experience with SEPs.

⁸³ This does not mean being required by the Agency to implement the project under current regulations. Rather, this refers to, for example, eliminating a wastewater pollutant for which the company has a permitted discharge limit. The SEP policy explicitly excludes projects that are required by regulation.

It is difficult to tell, at this stage, which firms will implement the most pollution prevention beyond their SEP/injunctive relief project. It appears that within the most active firms--CMPM, MFC, MMC--there is great potential for further pollution prevention. At this early stage, it is not possible to conclude that the type of project implemented--classified by the framework presented in Table 3--is a strong determinant of the company's pollution prevention activities beyond the enforcement settlement.

16.4.3 The Impact of Pollution Prevention SEPs on the Deterrence Effect of the Agency's Enforcement Programs

Based on interviews conducted, none of the case study firms knew of the SEP policy prior to EPA's inspection.⁸⁴ This is not surprising since the policy is relatively new and many of the inspections were conducted between 1988-91. One can be reasonably sure, that within the sample, knowledge of the SEP policy did not act to compromise the deterrence effect of the agency's enforcement programs. This profile is changing. According to one EPCRA case officer, several attorneys representing EPCRA 313 violators have asked him at the outset of the negotiation process whether a SEP can be included in the settlement. As more and more companies and corporate attorneys learn of the SEP policy this may become the norm.

It is difficult to predict whether and to what degree, the SEP policy will compromise the deterrence impact of the agency's enforcement programs. Some critics believe that firms will make a calculated decision to save money by not investing in pollution control or prevention because the financial risk of enforcement coupled with the "relief" offered through SEPs is less than the savings associated with non-compliance. Under this scenario, the research shows that these incentives for non-compliance should be weighed against incentives for compliance, such as:

⁸⁴ One firm, MFC, learned about SEPs after the EPA inspection and before the first settlement conference.

- a company's desire to avoid bad publicity and the associated negative outcomes from their geographical community, community of manufacturers, and current/potential customers
- a company's desire to avoid future regulatory scrutiny and the financial risk that such scrutiny poses
- a company's desire to avoid the expenditure on attorney's fees and staff resources in negotiating an enforcement settlement
- a company's desire to avoid closure costs for improper waste treatment operations
- the agency's right to refuse to negotiate a SEP based upon a company's prior non-compliance history or "bad faith" negotiating posture.

The collective experience of the case study firms illustrates a different scenario since these firms believed, through their ignorance or misunderstanding of the regulations, that they were in compliance. Thus, for them there is no balance sought between incentives for compliance and incentives for non-compliance; SEP policy would not be expected to encourage non-compliance.

17.0. OPPORTUNITIES FOR IMPROVED RESULTS: BARRIERS AND INSUFFICIENT INCENTIVES

From the perspective of the agency, the process of including pollution prevention in enforcement can be broken into two major categories: (1) creating the opportunity for a firm to consider pollution prevention either as injunctive relief or as a SEP; and (2) assessing, assisting with, and deciding on, a firm's proposal for a specific pollution prevention project and developing associated settlement terms (e.g., implementation schedule and penalty mitigation). Within these two steps, there are numerous actors and factors that contribute to the outcome of the process. The agency actors include: the Regional Administrator, division/branch managers, case officers, and regional attorneys. The factors influence both the opportunity for pollution prevention within each step and the willingness and capacity of the actors to seize this opportunity. The following are a subset of agency factors that arise from this research:

- Encouragement, support, and rewards from Regional Administrator and managers (i.e., opportunities created for case officers and attorneys to implement pollution prevention in enforcement settlements)
- Case officer's and attorney's desire (or willingness) to include pollution prevention in a settlement and to include projects in a settlement that entail some level of technical uncertainty or R&D
- Case officer's knowledge of pollution prevention (i.e., capacity to facilitate pollution prevention in a settlement)

From the firm's perspective, a different set of actors influence the process--owners, CEOs, line management, engineers, in-house attorneys, outside attorney, and technical consultants to the company. There is a set of firm-level factors that influence the outcome of the process; these factors may act synergistically with, or in opposition to, agency-level factors. Firm-level factors that are documented include:

- The firm's desire to mitigate the penalty
- The firm's view of pollution prevention generally, or the specific prevention project as being in the firm's self-interest
- Opportunity for pollution prevention capital projects (i.e., previously unexploited pollution prevention opportunity)
- Sophistication of the firm's technology and technical knowledge
- Availability and quality of external sources of technical information
- Willingness to implement a project with technical uncertainty (risk-taking vs. risk avoidance)

This section addresses the factors that emerge from this research as either hindrances to, or key ingredients for, the process of including pollution prevention in enforcement settlements.

17.1 Barriers and Insufficient Incentives Within the Agency

17.1.1 Pollution Prevention SEPs

a. Inappropriate performance evaluation criteria. Section 16 states that case officers and attorneys appear to be either hampered, simply allowed, or infrequently encouraged by their managers to pursue pollution prevention SEPs. On average, the environment for pollution prevention in enforcement can be described as tolerant. Perhaps the most important barrier to transforming this climate of tolerance into a climate of encouragement is the system of existing incentives that may act to discourage the inclusion of pollution prevention SEPs.

The existing institutional system for evaluating the success of regional, program, and individual efforts in enforcement does not formally reward efforts to include pollution prevention in settlements. The success of an enforcement program is currently evaluated on the basis of the numbers of plants inspected, numbers of cases settled, and dollars of penalties collected (or aggregate ratio of proposed penalty to final penalty collected). Programs and regions receive the same amount of credit for cases settled regardless of

whether or not the case includes a pollution prevention SEP, whether pollution prevention rather than pollution control is used as injunctive relief, or whether the technology adopted is innovative. While the agency's policy statements encourage pollution prevention in enforcement, the incentive system may actually encourage management to act otherwise.¹

Three specific ways in which this incentive system biases against SEPs--encouraging simpler, quicker and low-risk settlements--are discussed in the sections that follow.

b. Lack of individual motivation to include pollution prevention in enforcement: case officers and attorneys. Given the absence of a system of rewards for pollution prevention in enforcement and the resulting lack of managerial support, the individual motivation of case officers and attorneys has become a critical factor. Consequently, the absence of motivation--on the part of these actors--is a significant barrier to the inclusion of pollution prevention in enforcement.

Based on this research, it appears that a settlement has a significantly greater chance of including a pollution prevention SEP if the case is assigned to a case officer who is personally motivated to include a pollution prevention SEP.² A case officer's motivation

¹ This issue is raised in the October 15, 1992 memo from the Senior Policy Council SEP Workgroup which addressed barriers to pollution prevention in enforcement and recommendations for overcoming these barriers. The memo contains the following issue statements:

- "● Better need to articulate environmental/enforcement purpose/goals of SEPs and how much the Agency would like to encourage SEPs relative to other enforcement goals (e.g., deterrence).
- Regional perception of tension between aggregate enforcement numbers approach and complex settlement approach, including SEPs. Similar perception of mixed message regarding which is more important, i.e., complex settlements take resources away from aggregate numbers.
- Need more Agency systems for providing "credit" [for pollution prevention enforcement activity] and recognizing program performance, e.g., STARS, workload models, annual reports, etc."

² Enforcement cases are assigned to a team of one or more case officers and attorneys on the basis of workload and expertise.

seems to derive primarily from the personal satisfaction gained by facilitating pollution prevention and the ability to give firms an opportunity to turn a bad situation into a positive one. Personal motivation of attorneys is another important factor though it may not be as critical as that of the case officer. Most often, if a case officer decides to pursue a pollution prevention SEP the attorney will provide the necessary support. If the attorney assigned to a case has had experience with pollution prevention SEPs, and is enthusiastic about them, he or she can certainly facilitate the inclusion of a SEP. When, for example, a firm is interested in implementing a project that requires a relatively long implementation period, involves R&D, or a regulatory approval process (e.g., obtaining environmental permits or FDA approval), a motivated and creative attorney might be necessary to develop settlement terms that are mutually acceptable to the agency and the firm.

Some case officers and attorneys view SEPs as an unnecessary complication and are not motivated to include them in settlements; others believe that enforcement should be used only to punish non-compliers and not to leverage pollution prevention. Some case officers and attorneys view pollution prevention SEPs as a potential risk to their careers since projects may fail in the implementation phase and they may be blamed for approving the project. Given the current environment, it is unlikely that cases assigned to attorneys and case officers with these views will include pollution prevention SEPs. As a result, the lack of motivation on the part of these critical actors can be a significant barrier to the inclusion of pollution prevention SEPs.

If other barriers (such as penalty-based incentive systems) are overcome, and pollution prevention becomes the primary modus operandi in the enforcement arena, the degree to which a pollution prevention outcome is determined by one individual's motivation may be diminished, though it is always likely to be an important factor in determining overall success.

c. Lack of sufficient time: Real and perceived. If additional time is needed to negotiate and monitor a pollution prevention SEP, time constraints act as a barrier. Section 16.3.14 reports findings on the time needed to include pollution prevention in enforcement. It was concluded that time requirements can vary depending on many factors--in some cases little or no extra time is needed and in other cases additional time requirements may be significant. Consequently, if staff resources are not increased, it may be necessary to reduce the expected number of settlements per year if the number of pollution prevention SEPs is to increase. It is likely that as the regions gain more experience with pollution prevention SEPs, the time required to settle a case with a SEP and then monitor project implementation will decrease.

d. Inability to leverage entire penalty for SEP. As stated in Section 10.2, in exchange for a SEP, a portion of the gravity component of the penalty may be mitigated by an amount up to the net present after-tax cost of the SEP, depending on the environmental benefit of the SEP. Where a violation is found which did not confer significant economic benefit, e.g., a failure to notify, the settlement must include a penalty that at least captures a portion of the gravity component.³

Several EPA case officers and attorneys interviewed have been constrained in their ability to leverage pollution prevention SEPs as a result of not being able to reduce the economic benefit portion ("BEN") of the penalty. This is particularly problematic when proposed penalties (gravity plus economic benefit) are rather small--there is little financial incentive for the firm if a part of the economic benefit portion cannot be leveraged. This is generally not a problem in EPCRA 313 cases where the penalty consists only of a gravity component. In these cases, virtually all of the penalty can be used to leverage a SEP.

e. SEP policy nexus requirement. The SEP policy nexus requirement was described in Section 10.2.2. This policy is specifically designed to restrict the regions to SEPs that have

³ SEP Policy, page 10.

a reasonable connection to the source of the violation or to the type of harm that was done as a result of the violation. In their report "Pollution Prevention Through Compliance and Enforcement"⁴, OPTS reported the concern raised by their staff on the nexus requirement as a limitation on their flexibility to develop pollution prevention SEPs. The concerns were fairly general in nature.

The case study research did not reveal tangible evidence of the nexus requirement as a barrier since projects studied had successfully navigated through the nexus screening process. One can conclude that the nexus requirement was not a barrier to the rather rich array of projects studied here.⁵ One cannot, however, draw conclusions about the projects that did not materialize (i.e., the "missed opportunities") as a result of nexus requirements, although several observations will be presented.

The nexus requirement was raised as a barrier to pollution prevention SEPs by case officers, attorneys and management in two out of the three regions studied. In one region, a Division Manager stated that he can no longer leverage projects at another plant in another region, or leverage penalty monies to implement projects such as harbor dredging.⁶ In the other, an experienced pollution prevention SEP attorney stated that the nexus requirement is a barrier to the implementation of projects that reduce pollutants in a medium different from the medium that is the subject of the violation.⁷

In the third region, two attorneys who have negotiated many pollution prevention SEPs said

⁴ U.S. EPA, Pesticides and Toxic Substances, "Prevention Through Compliance and Enforcement, A Review of OPTS Accomplishments." January 1992.

⁵ On case study--Pump Service and Sales Company--included a SEP which involved the installation of semi-aqueous degreasing systems at the subject plant and at another plant in another region.

⁶ This is accurate if the other plant in the other region is a totally different type of facility than the one in violation. However, it is possible to negotiate a "multiple SEP" in which the defendant makes the same kind of changes at other plants similar to the violating facility.

⁷ The "horizontal nexus" provision in the SEP policy is designed to allow for cross-media remedies within the same facility.

only that they seek to avoid "labelling" pollution prevention SEPs as projects that fall under the horizontal (rather than vertical) nexus category because this designation requires Headquarters approval and guaranteed process delays of between 6-8 months. These attorneys expressed concern that since Headquarters is so "removed" from the substance of the case, it does not make sense for Headquarters staff to review the substantive elements of the SEP. Headquarters should conduct only a cursory review to see if the SEP meets basic policy guidelines.

f. Difficulty in negotiating projects that require multi-media institutional approaches.

Since none of the cases in this study involved multi-media enforcement efforts, it is not possible to provide a first-hand evaluation of the barriers to including pollution prevention SEPs in these types of cases. However, noteworthy is a set of comments made by an attorney active in pollution prevention SEP negotiations. This Attorney stated that it can be difficult to achieve consensus among two or more divisions with differing priorities. For example, if EPCRA is the lead on a case that involves Clean Water Act violations the Water Division does not always want to devote time and effort to devising a SEP, in part because the Water Division would not get credit for their efforts.

In other cases, there are disagreements, among the Divisions, over the environmental merit of the SEP. The Attorney cited an example where EPCRA and the Air Division disagreed over a SEP involving a switch from a lead dust-generating process to a process where lead would be fully encapsulated in a component material (and in the product). EPCRA argued that this project did not reduce or eliminate the use of lead and that the hazard may simply be shifted from the subject plant to the plant that produces the encapsulated lead material. The Air Division supported the project because it eliminated lead dust--a priority for this Division. Ultimately, the project was not accepted as a SEP.

Not all pollution prevention SEPs with multi-media payoffs require a multi-media institutional effort. Most pollution prevention SEPs negotiated under EPCRA, for example,

have multi-media payoffs but do not require the involvement of other programs.⁸

g. Lack of knowledge and expertise in pollution prevention. It is useful to begin this section with a short summary of a typical (though simplified) pollution prevention SEP process scenario, starting at the first settlement conference. This description is based on this case study research and is designed to illustrate the existing flow of pollution prevention/technical information within the region and between the region and the firm.

Once the regional negotiators raise the option of a pollution prevention SEP, case officers may provide an overview of the concept of pollution prevention and give examples of acceptable pollution prevention projects (e.g., aqueous-based cleaning systems). The region negotiators will then suggest that the company submit a technical SEP proposal, thereby relying on the company to develop and propose a specific project. When the proposal is submitted, the case officer will generally use his or her own technical knowledge and colleague's knowledge to evaluate the environmental merit and technical feasibility of the company's proposal and to monitor project implementation. If the case officer has questions regarding possible environmental impacts in another media, he or she might seek advice from a technical expert in another branch. Case officers typically do not seek out published material on pollution prevention, pollution prevention case studies delivered through electronic databases (e.g., PPEIS), or general technical information (e.g., texts or journal articles) on the specific industry involved.

It should be emphasized that not all cases or case officers proceed according to this scenario. However, it is a good working, base-line model upon which to elaborate the remaining discussion in this section.

We note five major activities within the pollution prevention SEP process where the case

⁸ For example, the elimination of a SARA Title IV organic solvent reduces worker exposure, air emissions and hazardous waste generation.

officer's knowledge of, and expertise in, pollution prevention can be an asset. The five activities are:

1. encouraging the firm to propose a pollution prevention SEP;
2. facilitating the development of a SEP proposal;
3. evaluating the SEP proposal;
4. monitoring the implementation phase; and
5. evaluating the success of the SEP.

Three types of pollution prevention knowledge and expertise appear to be important for supporting and enhancing these five activities: (1) a clear general understanding of the concept and benefits of pollution prevention, (2) a case officer's ability to ask exploratory questions that generate "pollution prevention thinking" on the part of the firm, and (3) a case officer's knowledge of pollution prevention techniques. This section addresses the lack of type 1, 2, and 3 knowledge and expertise as barriers to the performance of the five tasks listed above. In addition, barriers associated with building a pollution prevention knowledge and expertise-base within the regions are discussed.

In order to encourage a firm to propose a pollution prevention SEP, and to elicit a suitable project proposal, it is important for the case officer and attorney to clearly convey the concept and benefits of pollution prevention as well as the oft-mentioned list of pollution prevention strategies--process modifications, reformulation or redesign of products, substitution of raw materials, good housekeeping practices, etc.⁹ To the degree that this does not happen, the lack of knowledge about pollution prevention can serve as an important barrier. The case officers and attorneys interviewed evidenced a range of type 1 knowledge; some appeared fairly well versed and others had a very sophisticated

⁹ A 1992 Office of Pesticides and Toxic Substances study cited the inconsistent and inappropriate use of the term pollution prevention as an important issue in the implementation of pollution prevention SEPs ("Pollution Prevention Through Compliance and Enforcement, A Review of OPTS Accomplishments", January 1992).

understanding of pollution prevention concepts and benefits. This research does not permit me to determine how well versed the Regions are, on-the-whole, on the concept and benefits of pollution prevention. However, it is worth noting that inappropriate use of the term pollution prevention was found in the classification of SEPs reported by the Regions to Headquarters¹⁰. In some cases, SEPs involving removal of underground fuel storage tanks and PCB contaminated transformers were inappropriately labelled pollution prevention.

Beyond a general understanding of the pollution prevention concept and general prevention strategies, the case officer may be able to stimulate and direct a firm's "pollution prevention thinking" when the firm is beginning to consider a SEP proposal.¹¹ Using even a limited amount of information on the firm's technology--gathered during the inspection¹² or during subsequent discussions--a case officer can ask open-ended questions which may prompt the firm to recognize pollution prevention opportunities. Examples of open-ended questions are as follows: "why are you using a solvent in this process?" and "do you know the source of this contaminant?" Broad familiarity and experience with pollution prevention approaches is necessary to effectively use this approach, though this tact does not require specific expertise in the subject technology.¹³ In cases where the firm is unwilling to engage region negotiators in a discussion about their manufacturing processes (possibly fearing further incrimination), this approach may not be feasible.

¹⁰ These reports were submitted in accordance with the Office of Enforcement's May 18, 1992 memo (Assessing the Overall Value and Impact of Enforcement Actions) requesting information on, among other things, settlements containing SEPs.

¹¹ Most of the projects studied had been considered by the companies prior to the violation. In these cases, it is likely that companies will simply propose these familiar projects, particularly if they had already determined that the projects have technical and/or economic merit.

¹² The case officer can increase his or her knowledge of the facility (and potentially opportunities for pollution prevention) by conducting the inspection with pollution prevention as well as regulatory compliance in mind. This strategy was used by the case officer in the CMPM case.

¹³ Greiner, T.J., Richard, P.H., and Dillard, L.A., 1994, op.cit. pp. 45-54.

negotiating pollution prevention SEPs or, more likely, a barrier to fully exploiting the "pollution prevention potential" associated with a particular settlement. For this discussion, the definition of "pollution prevention techniques" is important. Used here, the term includes both "general" and "particularized" pollution prevention techniques. General techniques can be thought of as universal pollution prevention techniques that apply to many industries; examples are: switching from organic solvent to aqueous-based cleaners, solvent distillation systems, closed-loop cooling, etc.. The term particularized refers to those techniques that apply to a given manufacturing process; examples are: replacing solvent-based coatings with powder coatings in the coatings industry and switching from hexavalent to trivalent chromium in metal finishing. General and particularized knowledge are important for all five activities listed above. At minimum, case officers need to be able to determine whether the project is environmentally beneficial and whether there is unreasonable risk of failure (i.e., whether or not the project is on sound technical footing). Ideally, the case officer should be able to provide guidance; general ideas (if the company is open and receptive), constructive feedback on project shortcomings; and suggestions for project improvements during the SEP proposal development, evaluation and implementation stages (i.e., activities 2, 3, and 4 above). The post-implementation evaluation (activity 5) may require less technical expertise but can provide an excellent opportunity for case officers to learn about pollution prevention, and to critically evaluate the technological changes made and their associated environmental benefits.

As was seen in the case studies, the relative importance of a case officer's pollution prevention knowledge and expertise may be less critical to the success of a SEP negotiation if the firm is already well versed in pollution prevention, is technologically sophisticated/has retained a skillful pollution prevention technical consultant, and has a good "ready-waiting" pollution prevention project. Several of the more innovative or technically complex pollution prevention SEPs and the sole injunctive relief project in the sample were negotiated by case officers with little or no prior knowledge or experience in pollution

prevention.¹⁴ The companies involved in these cases were quite technologically sophisticated and/or had good technical consultants. In these cases, the technical challenge for the case officer was to apply good engineering judgement to determine whether the project seemed technically feasible and implementable within a given time period. However, there may have been missed, better opportunities stemming from the case officers' lack of pollution prevention expertise. Unfortunately, this type of missed opportunity is difficult to uncover in retrospective case study research.

This section has focused on the lack of pollution prevention knowledge and expertise as a potential barrier to including pollution prevention in enforcement settlements. Based on this research, it appears that there are also barriers to developing this knowledge and expertise-base within the regions.¹⁵ With regard to pollution prevention knowledge, there is little or no demand for either published information on pollution prevention (e.g., technical case studies or reports) or other data sources (e.g., TRI emissions for the plant) among the case officers interviewed. Case officers, for example, often either never heard of or never used, the Pollution Prevention Electronic Information System (PPEIS).¹⁶ Even the most

¹⁴ Industrial Coater, Metal Finishing Company, Medical Device Manufacturer and Bleached Kraft Pulp Manufacturer.

¹⁵ This issue was raised in the October 15, 1992 memo from the Senior Policy Council SEP Workgroup. The memo contains the following issue statement: "The Agency needs to make available more training in pollution prevention as a general approach as well as provide more technical expertise, training in, and examples of, cross-media and media-specific pollution prevention activities which enforcement personnel can use in negotiations." This memo was followed-up, in February of 1993, by a pollution prevention SEP needs assessment survey that was sent to all Regional Program Division Directors, Pollution Prevention Enforcement Contacts, and Counsels.

¹⁶ Those engineers who were interviewed that knew about PPEIS are not comfortable with PPEIS' electronic database delivery system, and they do not trust the accuracy or "freshness" of PPEIS information.

motivated case officers that were interviewed do not seek out these resources.¹⁷ Case officers do not seem to find much value in these modes of information transfer.

Pollution prevention technical *expertise*--either general or particularized--is gained primarily "by doing", by verbal information sharing/pooling among technical colleagues,¹⁸ and can probably be supplemented by effective training. As more and more case officers are given the opportunity to negotiate pollution prevention into enforcement settlements, the expertise base will grow. This process could be supported by encouraging and providing opportunities--formally and informally--for case officers to share knowledge and experience.

h. Reluctance to approve technically difficult or risky projects. Technically difficult pollution prevention projects, projects that require R&D, and technologically innovative projects can be particularly vulnerable to a subset of barriers listed above. These projects may require relatively long implementation periods, require fairly complex settlement terms (e.g., a complex schedule of stipulated penalties where R&D is required), and carry a higher risk of failure. However, these projects may generate environmental benefits in excess of low risk, diffusion-based pollution prevention projects at the subject plant. Agency barriers that may hinder the inclusion of these projects are those that reduce the willingness of agency negotiators to establish long implementation periods,¹⁹ "creative" or somewhat

¹⁷ This finding is consistent with research conducted on the ways that engineers in research and development organizations acquire technical information. One researcher, Tom Allen, showed that the engineer's favored source of information is colleagues in the same organization--in the same and in other groups (Allen, T., Managing the Flow of Technology. Cambridge, Mass.: MIT Press, 1977, Chapter 5). Micheal Tushman cites field studies indicating that engineers spend 50 to 75 percent of their time communicating with others. Tushman asserts that verbal communication for problem-solving is a more efficient medium than written or more formal media and permits timely information exchange, quick feedback, and critical evaluation. Research has consistently shown a link between verbal communication and individual as well as project performance. (Tushman, M.L.. "Managing Communication Networks in R&D Laboratories," Sloan Management Review. Volume 20 (2), 1979, pp. 37-49.)

¹⁸ According to one EPCRA case officer actively involved in pollution prevention SEPs, the group works effectively as a team, discussing projects and pooling their technical resources. This group is relatively small and this facilitates information sharing.

¹⁹ Implementation periods over a year are generally considered long.

flexible settlement terms, and risk-taking and risk-sharing.²⁰ Specifically, these barriers are: inappropriate performance evaluation criteria, lack of individual motivation, and lack of sufficient time, as discussed in the preceding sections.

Clearly, not all technically difficult projects should be accepted as SEPs. There are many concerns that case officers and attorneys have, beyond the barriers cited here, that need to be considered in a SEP decisionmaking process (e.g., if the company has not sufficiently demonstrated technical feasibility (i.e., is going on a "fishing expedition"), or if the time needed for implementation is so long that it creates a risk of either company personnel or EPA personnel changing). (The latter concern was cited by several case officers and attorneys as a reason why they prefer not to extend the implementation schedule beyond one year.)

17.1.2 Pollution Prevention Injunctive Relief

Since only one of ten cases studied here involved injunctive relief, the possibility of evaluating barriers to the use of pollution prevention as injunctive relief is necessarily limited. This section uses limited data and insights gained through the study of SEPs to discuss barriers to using pollution prevention to remedy a violation. This discussion should be considered a first step that should be expanded in future research efforts.

Many of the barriers discussed in the preceding section apply here, either directly or in slightly modified form. Therefore, the reader will frequently be referred to Section 17.1.1, above.

²⁰ "Risk-taking" in this context implies a strategy where the agency would agree to a pollution prevention SEP that involves a higher than average level of technical uncertainty if the short and long-term potential benefit associated with the project is great. "Risk-sharing" implies that the agency is sharing the risk (and very likely the cost) of developing and implementing a technically difficult/potentially high payoff project with the firm. Since pollution prevention SEPs are, by definition, supplemental and not designed to bring the company into compliance, there is less environmental and political risk associated with a SEP that fails as a result of technical reasons as compared to pollution prevention-based injunction relief. Therefore, within reasonable bounds, SEPs may be an ideal context for risk-sharing where a firm is a willing participant and has shown good faith.

a. Desire to bring company into compliance quickly and to avoid risk of return to non-compliant status. Unlike SEPs, the question of whether pollution prevention is included in a settlement as injunctive relief is typically a question of whether pollution prevention will be used instead of pollution control to bring the company back into compliance. In essence, the stakes for the agency are higher in this context--as compared to the SEP context--because the agency has a duty to the immediate and larger community to bring the violator into compliance and keep it there. In the case of SEPs, the inclusion of pollution prevention represents an extra benefit, albeit at the price of a reduced penalty. Therefore, where a firm is in violation of an emissions limit and must effectuate a technology-based remedy (rather than, for example, a paperwork filing response), the agency negotiators must agree to a technological response that has a low risk of failure and will bring the plant into compliance quickly. To the degree that an effective, established, and familiar end-of-pipe technology will achieve this objective, it will be an attractive choice. If a pollution prevention alternative is not well understood by the case officer, appears to have a higher risk of failure, or will take longer to effectuate, it will be a less desirable option.

The agency has tried to address this issue in its Pollution Prevention and Enforcement Policy. The Policy "grants" agency negotiators the flexibility to extend the average timeline for resolving the violation with a pollution prevention remedy, if: (a) the prevention option will produce an aggregate gain in pollution reduction over the pollution control option, (b) the prevention technology is reliable and available, (c) the prevention technology is applicable to other facilities, and (d) the prevention approach offers the best prospects for permanent return to compliance. The agency negotiators must make this determination. The degree to which this provision helps to even the playing field for pollution prevention is difficult to determine. However, without sufficient institutional encouragement (i.e., in the form of credit systems and managerial support) or personal motivation on the part of the negotiators (as discussed in Section 17.1.1), the safer pollution control option may often seem the better choice.

b. Lack of pollution prevention knowledge and expertise. Where both pollution prevention and control remedies exist, the pollution prevention option will be implemented only if the benefits associated with this choice are perceived to be superior by the firm and the agency to the pollution control strategy. In the Bleached Kraft Pulp Manufacturer (BKPM) case, the company determined that total chlorine elimination was environmentally (and possibly economically) superior to all pollution control strategies evaluated and was eventually able to gain approval from the region.

The conclusions drawn in Section 17.1.1 g above are relevant here. Pollution prevention knowledge and expertise within the agency are important to encourage and guide a firm to consider pollution prevention, as well as to evaluate the merits of the firm's pollution prevention injunctive relief proposal. The absence of such knowledge may be a barrier to either initiating a search for a preventative remedy or approving a prevention technology.

c. Lack of opportunity. Not all violations provide equal opportunity for firms to use pollution prevention as injunctive relief. Where a violation constitutes a failure to file (e.g., EPCRA 313), failure to label (RCRA), improper waste storage (RCRA), coming into compliance does not require a technological remedy. Therefore, in these cases, the inclusion of pollution prevention in the settlement will generally necessitate an inducement to the firm such as a penalty reduction (i.e., a SEP).

d. Inappropriate performance evaluation criteria. As mentioned above, the existing institutional system for evaluating the success of enforcement efforts does not formally credit efforts to include pollution prevention in settlements. The incentive system encourages simpler, quicker, and low-risk settlement conditions and may bias the agency negotiators in the direction of a well established pollution control strategy over pollution prevention.

The discussions in Section 17.1.1 b on lack of individual motivation to include pollution prevention in enforcement, and in c--lack of sufficient time seem to apply to pollution

prevention in injunctive relief as well. The reader is referred to those sections.

17.2 Barriers and Insufficient Incentives within the Firm

17.2.1 Pollution Prevention SEPs

a. Absence of support from top-level decisionmakers and change-agents. For pollution prevention SEPs to be included in negotiated settlements, firm owners, CEOs, or senior managers must be supportive of the SEP concept and must approve the use of resources--in-house staff, technical and legal consultants, and other development and implementation expenditures--to support the SEP process. A decision, by these actors, to pursue a pollution prevention SEP is typically based on some combination of a desire to mitigate the penalty and recognition of the benefits of the pollution prevention project to the firm. Top-level decision-makers typically desire to settle the case quickly to avoid a prolonged negotiation or "contractual relationship" with the agency and the accompanying added legal and financial uncertainty (unless the firm has a significant economic incentive to delay an expenditure for a remedial measure). Therefore, the desire to mitigate the penalty plus the perceived value of the pollution prevention project will have to outweigh the desire to settle quickly. To the degree that the former does not outweigh the latter, the firm will be unlikely to choose to implement a pollution prevention SEP.

From the case studies, it appears that the desire to reduce the penalty is based primarily on the degree to which the firm believes that it was unjustly penalized (i.e., level of outrage)²¹, the firm's ability to pay the penalty, and the size of the proposed penalty. With regard to the value of the pollution prevention project, it appears that the value is perceived to be higher if the project had been considered prior to the violation but not implemented because it could not be financially justified²², because of resource constraints (e.g. available capital,

²¹ This was particularly evident in the Metal Filing Furniture Manufacturing (MFFM) and Lid Manufacturer (LM) cases.

²² See the Lid Manufacturer (LM) case.

too few hands and too many projects), or a lack of a sufficiently powerful project champion²³. The penalty reduction, the ability to get a concession from agency negotiators (particularly when outrage is high)²⁴ and, more generally, the negative psychological impact of the enforcement process became the necessary impetus for the implementation of the project.

The firm's willingness and capacity to change its production system would be greatly facilitated by so-called "change agents" and "technical gate-keepers" within the firm itself. A change agent may be a technical or non-technical person that sees, and can champion, the benefits of pollution prevention within the firm. The technology innovation literature documents the importance of a technical gatekeeper to the innovation process. A technical gate-keeper is an individual that effectively brings into the firm, and disseminates within the firm, the technical information needed to fuel the research and development processes that are key to the creation and implementation of new technical ideas.²⁵

b. Lack of sufficient time for proposal development and implementation. Once the EPA negotiators offer or agree to allow the firm to submit a SEP proposal, the firm will need time for proposal development. The amount of time needed depends on many factors, including: whether or not the firm had considered or evaluated the project prior to the violation, the firm's familiarity with pollution prevention, the firm's technological sophistication, the decision to use a technical consultant, and the complexity of the project. The lack of sufficient time for a firm to develop a pollution prevention proposal may be either a barrier to implementing a pollution prevention SEP or may lead to a sub-optimal project proposal.

²³ See, for example, the Powder Metallurgy Manufacturing Company (PMMC) case.

²⁴ This was particularly evident in the Lid Manufacturer (LM) case.

²⁵ See for example, Chakrabarti, A.K. and Hauschildt, J., The Division of Labour in Innovation Management." R&D Management, Vol. 19, No. 2, 1989, pp. 161-171. and Allen, T., Managing the Flow of Technology. Cambridge, Mass.: MIT Press, 1977.

Earlier sections contain a discussion on agency-level barriers to establishing relatively long project implementation periods (i.e., over one year). From the firm's point of view, getting enough time to implement the pollution prevention project is a critical part of the negotiation process. While the firms interviewed seem to be fairly sympathetic to the agency's desire to keep the implementation period short, some firms were either uncomfortable with the timeline that they were able to negotiate or felt time pressure to complete the project(s) during the implementation period.²⁶

From this research, time limits were most problematic for firms that agreed to implement technically difficult or innovative projects--Industrial Coater (IC) and Casted Metal Products Manufacturer (CMPM). It was not possible to determine the extent to which SEP negotiations breakdown over an inability to gain consensus over implementation periods.

c. Inadequate knowledge and expertise: within the firm and on the part of hired consultants. Firms come to the negotiation table with vastly different levels of pollution prevention knowledge, expertise, and general technological sophistication. Larger companies tend to have greater in-house technical and regulatory resources and therefore are more likely than smaller companies to have prior knowledge of pollution prevention. Larger companies are also more likely to have one or more pollution prevention projects "in the wings" at the time of the violation; making the task of proposing a SEP to the agency negotiators somewhat simpler.

For smaller companies with little or no prior knowledge and experience in pollution prevention, the pollution prevention SEP process presents many challenges, including: learning the pollution prevention concept and how the techniques can be integrated into their existing manufacturing processes, developing a SEP proposal that is acceptable to the

²⁶ In one case--Industrial Coater--the company stated that they felt pressure from EPA negotiators to choose the shorter time line and they agreed to it despite their reservations about their ability complete the rather complex project. As a result of difficulties in the implementation stage, the company was unable to meet the SEP deadline.

regional negotiators, and instilling confidence in the regional negotiators with respect to their ability to execute the project. All of these challenges must be met in the context of an oftentimes threatening enforcement situation. To meet these challenges, small firms tend to rely on outside technical consultants. Outside consultants not only fill a need for additional technical expertise, as was heard in several company interviews, the consultants also help to build confidence for the SEP proposal in the regional negotiators (whether the technical ideas originated by the firm or the consultant). Therefore, smaller firms may face a barrier to SEP inclusion if they do not use a technical consultant.

The small firm's choice of consultant will, in part, determine the type of project proposed. If the company hires a consultant to assist in correcting the violation, one could expect that the consultant will be retained to develop the pollution prevention SEP proposal.²⁷ Few environmental consulting firms, i.e., those firms that have traditionally focused on compliance audits, design and implementation of pollution control systems, and other regulatory services, have experience in assisting firms to implement pollution prevention. Many environmental consulting firms have strong incentives to recommend capital intensive pollution control projects to solve environmental problems, since these firms derive a large share of their income from pollution control system design and construction (not recommending that firms redesign their production processes or to switch to a new process chemical).²⁸ In addition, these consulting firms (particularly the larger firms) prefer to recommend and install the same pollution control system as often as possible since it is cost effective to duplicate plans and specifications (e.g., recommending a cyanide chlorination system rather than cyanide elimination).²⁹ Consulting arms of equipment vendors have great incentive to sell their equipment or chemicals and will tend to solve problems accordingly

²⁷ See Metal Filing Furniture Manufacturing (MFFM) and Casted Metal Products Manufacturer (CMPM) cases.

²⁸ See the Casted Metal Products Manufacturer (CMPM) case.

²⁹ Personal conversation with Daryl Beardsly, pollution prevention consultant, August 4, 1993.

(see for example, the Metal Machining Company (MMC) case).³⁰

Increasingly, environmental consulting firms are upgrading their services to include recommendations and design services for waste minimization techniques. For example, the environmental consultant hired by the Metal Filing Furniture Manufacturer (MFFM) recommended and facilitated the installation of a solvent recycling system, a baffle collection system for paint overspray, and several other paint and solvent waste minimization systems. The type of knowledge needed to recommend these waste minimization options is analogous to the "particularized" pollution prevention knowledge that was discussed (in the context of the EPA case officer) earlier.³¹ The consultant that assisted the development and implementation of the gasket reformulation project at the Lid Manufacturer (LM) plant, was an engineering consultant (not an environmental consultant) who had good knowledge of environmental regulation. The company was very pleased with her performance.

d. Lack of capital or financial incentive. Parallel to the discussion in Section 17.1.1 d, regarding the inability of the agency to leverage entire penalty for a SEP, where the capital cost of the project is high, the financial payback of the project is low, and the penalty reduction is relatively small (as a percentage of capital cost), the firm may have little financial incentive to implement a pollution prevention SEP or may have difficulty raising the necessary capital (particularly in the case of small firms). None of the case study firms faced this barrier as such, therefore, it is not possible to assess the number or type of SEP opportunities that were missed for this reason. As discussed in Section 17.1.1 d, several

³⁰ Alternatively, a firm that hires a consultant with pollution prevention expertise may constrain the consultant's ability to propose certain projects either by giving them a fairly narrow compliance problem to solve, requiring a quick-fix solution, a low-risk solution, or a "low maintenance" solution (e.g., a metals precipitation system as opposed to a recommendation that the plant optimize their production process to reduce metals dragout which may require operator education and training and may at times affect product quality). (personal conversation with Joseph Conzano, Case Officer, EPA Region I.

³¹ The small consulting firm, or the one or two-person operation, with pollution prevention knowledge and experience (of which there are a few) are less likely to be encumbered by the issues raised in this paragraph.

EPA case officers and attorneys interviewed stated that their inability to reduce the economic benefit portion of the penalty has constrained their ability to leverage pollution prevention SEPs.

e. Lack of good legal support. Several firms stated that their outside attorney was instrumental in negotiating the SEP. In these cases, the attorneys had prior experience with environmental regulatory settlements or with the SEP process specifically. In one case--Casted Metal Products Manufacturer (CMPM)--the firm representatives stated that their attorney had no previous experience with environmental law and that they felt disadvantaged in the negotiation process. I conclude, therefore, that an attorney with little or no experience in environmental settlements may be a barrier to negotiating a pollution prevention SEP, particularly where the nature of the technological change or the firm requires complex settlement terms.

f. Opportunity for pollution prevention capital projects (i.e., previously unexploited pollution prevention opportunity). One EPCRA case officer stated that in some instances where a company is particularly aware and active in the area of environmental management, few or no pollution prevention SEP opportunities³² may be available. In these cases, there may be a lack of opportunity for a firm to receive a penalty reduction in exchange for a pollution prevention SEP.³³

17.2.2 Pollution Prevention Injunctive Relief

As discussed in Section 17.1.2 above, this thesis is limited in its ability to evaluate barriers to the use of pollution prevention as injunctive relief since only one of the cases involved

³² For the purposes of this discussion, it is important to note that this case officer tends to view the SEP context as appropriate only for pollution prevention projects that pose low-risk of technical failure, and require relatively short implementation periods.

³³ On the other hand, there are firms that have a history of poor environmental management where there are many "low-hanging fruit" pollution prevention opportunities. The case officer that raised this point was concerned that the "laggard" companies would, in a sense, be rewarded with a penalty reduction in excess of the "leader" companies given the greater number of pollution prevention opportunities for the "laggards."

pollution prevention as a means to come into compliance. This section, draws on limited data and insights gained through the study of SEPs.

Many of the barriers discussed in the preceding section apply here, either directly or in slightly modified form.

a. Lack of pollution prevention knowledge and expertise. When a technology-based remedy is necessary to come into compliance, a pollution prevention technological response can only be considered if: (a) the firm itself, its consultant or the agency recognizes an opportunity to use pollution prevention as injunctive relief, and (b) if the benefits associated with the prevention choice are perceived to be superior by both the firm and the agency. For example, in the Bleached Kraft Pulp Manufacturer (BKPM) injunctive relief case, the mill recognized that they could meet the requirements of the Clean Water Act by totally eliminating chlorine from their bleaching process, they determined that this option was environmentally (and possibly economically) superior to all pollution control strategies evaluated, and the Regional Office accepted this compliance strategy. Leaving aside the agency's role, one can conclude that if the firm has no familiarity with, or no experience in, implementing pollution prevention; and if the firm's consultant is also inexperienced or has an incentive not to recommend a pollution prevention remedy, then a pollution prevention remedy will not be considered. Furthermore, if a pollution prevention remedy is considered, but the benefits (including cost) of pollution control appear to outweigh the benefits of prevention, the control option will be selected.³⁴

³⁴ One important consideration is the way in which the firm and/or the consultant evaluates the costs and savings of the pollution prevention option compared to the pollution control option. Current financial analysis practices tend to skew investment choices in the direction of pollution control technologies because preventative strategies tend to yield benefits in many indirect ways and over longer periods of time, and include numerous contingency savings (e.g., avoided Superfund liability or fines) in the spectrum of benefits that they create. (White, A., Becker, M. and Goldstein, J. "Total Cost Assessment: Accelerating Industrial Pollution Prevention through Innovative Project Financial Analysis, with Applications to the Pulp and Paper Industry." A report to the U.S. Environmental Protection Agency, Office of Pollution Prevention and Toxics. May 1992.)

The discussion in Section 17.2.1 c concerning the role of the environmental consultant, is particularly important here and should be referred to in the context of injunctive relief. It is not repeated here.

b. Fear of technical failure. When considering technology options for injunctive relief, the firm has great incentive to pick an option that is perceived to have a low risk of failure since, if the project fails to meet the regulatory requirement, the firm will incur: additional cost in developing and implementing another technical option, additional legal and administrative costs, as well as prolonging the uncertainty associated with a pending enforcement case. Therefore, where pollution control and prevention options exist, if a pollution control option appears to have a lower risk of failure, it will have greater appeal to the firm.

18.0 POLICY RECOMMENDATIONS FOR INCREASING THE SUCCESS OF EPA EFFORTS TO INCLUDE POLLUTION PREVENTION IN ENFORCEMENT SETTLEMENTS

The previous section identified barriers, inadequate incentives and inappropriate incentives for incorporating pollution prevention in enforcement agreements, that were suggested from our research. This section addresses the important determinants of success for pollution prevention in settlement agreements which are particular to the Agency and to the firm, and those important to both. This section contains both empirically-derived determinants of success--specific to our case studies and from general interviews with agency personnel--and determinants that were not derived empirically but that are considered to be important based on prior research conducted by the author and by other researchers.

18.1 Enforcement Policy and Practice

In order for the agency to succeed at promoting pollution prevention in enforcement agreements, it needs to integrate pollution prevention as the preferred response into all relevant enforcement policies and practices. The bulk of enforcement activity is organized around securing compliance for single-medium regulatory requirements. Superimposed

upon this inherited fragmented structure is the "Interim Policy on Pollution Prevention in Enforcement" which states that pollution prevention shall be the favored means of achieving and maintaining compliance.³⁵ Despite this statement of agency preference for pollution prevention, the policy is simply one of the options that enforcement personnel may utilize; on the other hand it may be ignored. Critical to translating this policy into enforcement activities is a concern within enforcement programs for the means as well as the fact of compliance, i.e., an articulation of pollution prevention responses within enforcement programs as the preferred means to achieving compliance. This concern appears to be missing and its absence may be the reason why, in particular, only one case of pollution prevention injunctive relief was reported.³⁶

To promote pollution prevention SEPs, the agency should articulate within the SEP policy a preference for pollution prevention over other types of SEPs. One attorney active in negotiating pollution prevention SEPs encourages violators to propose pollution prevention, rather than other types of SEPs, by advising companies that they will receive greater penalty mitigation for pollution prevention.

The agency has taken a first, and important, step by issuing the "Interim Policy on the Pollution Prevention in Enforcement" and the "SEP policy." It appears that these policies have been successful in providing administrative support and guidance for motivated individuals and branches within the regions, however, greater effort is needed to overcome the disjuncture between what the agency articulates as its philosophy and what it directs its agents to do in enforcement of environmental requirements. As stated by one case officer,

³⁵ SEP Policy, page 1.

³⁶ Administrator Browner's reorganization of the new Office of Enforcement and Compliance Assurance could result in a more integrated enforcement program which should address many of the issues raised in this section. The principles underlying the reorganization include measuring enforcement success through improvement in compliance rates and environmental results, rather than through an exclusive reliance on the "number" of enforcement actions, as well as instituting a "multi media," "whole facility" compliance and enforcement approach organized around major sectors of the economy. This approach could result in more "particularized" sector expertise within the Agency, which will enhance the use of pollution prevention and other innovative techniques in the enforcement program.

agents to do in enforcement of environmental requirements. As stated by one case officer, enforcement personnel should abandon their current approach of asking "is the firm out of compliance? and what should the penalty be?" and ask instead "if the firm is out of compliance, is this an opportunity for pollution prevention?"

18.2 Design of Agency Personnel Incentive Systems

Perverse incentives facing agency personnel need to be eliminated, especially those relevant to performance reporting and evaluation. The opportunity cost for agency participants to involve themselves in pollution prevention SEPs/injunctive relief must be recognized and accommodated. More specifically:

- (1) Participation in pollution prevention enforcement activities should be made an explicit part of performance evaluation at lower and middle levels of management.
- (2) Participation in pollution prevention SEPs/injunctive relief should be reported alongside of traditional enforcement activities.
- (3) Performance evaluators should avoid setting "case equivalents" (e.g., counting a pollution prevention case as equivalent to two traditional enforcement cases).
- (4) Quantitative measures of pollution prevention case success should be avoided (e.g., success measured by dollars of capital investment) as well as other "mechanical" evaluations.
- (5) Evaluations should include the numbers and percentage of cases with pollution prevention SEPs/injunctive relief (both successes and failures).
- (6) The agency participants involved in pollution prevention implementation and evaluation should participate in the development of the criteria for success.

Positive incentives creating opportunities and rewards for participation by case officers and attorneys need to be instituted, particularly encouragement, support, and acknowledgement from regional administrators and managers. Improving the individual motivation of potential participants will necessarily involve designing an appropriate performance evaluation scheme, but more is required:

- (1) Case officers and attorneys should be made aware of the indirect economic and other benefits that can accrue to a firm from pollution prevention and, for SEPs, be encouraged to communicate to the firm that choosing to implement pollution prevention offers a great deal more than just a penalty reduction.
- (2) Sufficient agency resources must be available to accommodate the increased time and attention that pollution prevention enforcement activities require.
- (3) Opportunities need to be created for the case officers and attorneys to engage in multi-media enforcement activities, as well as to fashion multi-media responses on the part of the firm.
- (4) Innovative, but risky projects require a safe environment for case officers and attorneys to take risks.
- (5) Encourage and utilize agency staff who are particularly well-suited and motivated to do pollution prevention. Also, consider establishing, on an experimental basis, a pollution prevention SEP/injunctive relief team of attorneys and case officers who do only pollution prevention settlements or creating the position of "pollution prevention specialist" who consults within the agency.³⁷

Obviously all this requires a major commitment from regional administrators and managers.

18.3 Multi-media Approaches and Multi-Media Pay-offs

While there were several cases of multi-media improvements (including worker health and safety) in the case studies, none involved multi-media settlements. However, as recommended by the TIE Committee's 1993 report on pollution prevention in permitting and compliance policy³⁸, the adoption of pollution prevention technologies with multi-media environmental benefits may be facilitated by a shift, wherever possible, from single-medium enforcement strategies to a multi-media approach. Multi-media inspection and enforcement

³⁷ The Multi-Media Division, which is part of the Office of Regulatory Enforcement in the newly reorganized Office of Enforcement and Compliance Assurance, would be the appropriate "home" for this expert team.

³⁸ U.S. EPA, NACEPT, TIE Committee, 1993. *op.cit.*

enforcement strategies to a multi-media approach. Multi-media inspection and enforcement can provide an opportunity for single-medium technical experts within the agency to pool their pollution prevention know-how to create multi-media pollution prevention expertise within the agency. Particularly in the context of injunctive relief, where a multi-media pollution prevention response can be identified, the firm may be more economically attracted to this option--than to a single-medium pollution prevention project or pollution control--because a single production change may solve several problems simultaneously.

18.4 Education and Training

The agency must create attitudinal changes toward pollution prevention and create confidence and knowledge among staff involved in negotiating settlements. There are many different modes of providing education and training for both agency personnel. The agency should approach these activities on an experimental basis. Specific options include:

- (1) Give consideration to the existence and need for different levels or types of knowledge and offer or target specialized training based on these different categories. Consider hiring and/or creating industry experts within the regions that can act as a source of technical knowledge on general technologies and pollution prevention approaches within a type or a related group of industries. Specialized expertise on pollution prevention generally, or pollution prevention within an industrial sector can be deployed for both compliance assistance (i.e., outreach to the regulated community) and enforcement activities.
- (2) Provide team (i.e., case officer and attorney) training so that not only is knowledge imparted, but also training in working together toward a pollution prevention goal in the context of a SEP/injunctive relief settlement.
- (3) Build internal capacity within EPA's Office of Research and Development's Research Triangle Park and Cincinnati Labs to support the development or review of pollution prevention projects within enforcement settlements. Improve communication and coordination with RTP and Cincinnati on critical pollution prevention technology areas. Rotate case officers through ORD facilities.

- (4) Rotate state or federal case officers through a one-year detail with States' Offices of Technical Assistance (pollution prevention engineering services).
- (5) Educate technical consultants (who serve the private sector) in pollution prevention approaches to compliance and in pollution prevention in general, so that the firms can have access to better technical advice and be apprised of the pollution prevention SEP/injunctive relief options. This could easily be done at technical conferences on environmental technologies and compliance, especially those at which agency personnel are often invited to present.
- (6) Educate environmental attorneys in the pollution prevention SEP/injunctive relief option. This could easily be done at the many conferences that are put on in environmental law and litigation at which agency personnel are often invited to present.
- (7) Establish outreach programs to firms, delivering information and making use of showcase examples and demonstration projects discussed above.³⁹

18.5 Incentives for Firms

Even though the agency should ensure that the penalty mitigation conferred does not exceed the direct economic benefits to the firm, the agency should exploit and leverage the substantial indirect economic and other benefits that accrue to firms undertaking a significant technological transformation. Firms are motivated by hard economic factors (e.g., material, energy, water, and waste disposal cost reductions) and soft economic factors (e.g., improved future compliance/liability position, improved rapport with agency, public image, etc.). Where economic benefits are direct, traceable, and quantifiable, agency negotiators should not, and tend not to, confer significant credit in penalty reduction. Where benefits are indirect, difficult to trace, and to quantify (e.g., longer-term benefits such as avoided future liability), agency negotiators should be, and tend to be, willing to confer these benefits upon the firm through penalty mitigation. The cases and general

³⁹ The three sector divisions in the newly reorganized Office of Enforcement and Compliance Assurance would be an appropriate place to house outreach programs.

interviews demonstrated that agency negotiators are generally prudent in determining the appropriate level of penalty mitigation--they are willing to provide incentives for pollution prevention but are not willing to subsidize those projects with sizable direct economic benefits.

Providing penalty mitigation for a pollution prevention project can be used to "reward" those firms that have a history of compliance, employ good environmental practices, have shown good faith in coming into compliance and in settlement negotiations, and in cases where the violation or its impact are not egregious (e.g., failure to submit a Form R under EPCRA).

18.6 Timing and Time Allowed for Pollution Prevention Responses

The timing of the agency's recommendation that the violator pursue pollution prevention for compliance or the timing of the agency's "offering" of a SEP option may be particularly important. The suggestion or offer should occur early enough in the agency-company dialogue to receive serious consideration by the firm and not too far along such that the interaction becomes too adversarial. The firm should be granted adequate time for proposal development and implementation.

Because more innovative and comprehensive technological changes are difficult, the policy should be open to extending the time frame for completion--beyond the usual period of about one year--for innovative and/or significant technological changes with multi-media environmental benefits.

18.7 Provision of Information to the Company

It is important that the agency give pollution prevention/enforcement policy and SEP policy information to the company early on in the process and to stress that pollution prevention responses are at the top of the EPA hierarchy. Policy information can be delivered, as done by several attorneys, by giving the violator copies of the actual policies. Ideally, industry

should be provided with a handbook on pollution prevention in general and in the context of an enforcement action.

18.8 Structuring the Negotiation Process

The negotiation process itself should be specifically designed to encourage and accommodate pollution prevention SEPs and injunctive relief in the context of the particular situation facing the parties, rather than letting an *ad hoc* process evolve. For example, when violators have little or no familiarity or experience with pollution prevention, pollution prevention audits should be encouraged and the cost of these audits should be considered in the determination of the appropriate level of penalty mitigation (particularly for smaller firms).

For both the agency and the company, the different roles of the technical and legal participants must be carefully delineated. It may be difficult to have a constructive technical discussion in a charged atmosphere characteristic of the adversary process. Preparing ahead of time and charting the evolving roles of the various players would be worthwhile. Furthermore, because the interactions of the parties will continue over a year or more, continuity of personnel assigned to a particular negotiated settlement is important.

Where innovation rather than diffusion-driven technological solutions offer the greatest environmental benefit, if necessary, the pollution prevention agreement should contain appropriately flexible terms and conditions to permit some experimentation and technology development. The Medical Device Manufacturer (MDM) settlement contained such terms. In this case project milestones and stipulated penalties were structured to allow the firm to test and develop the deionized water degreasing system before committing to purchase the equipment. These types of settlements should be reserved for those firms that have demonstrated good faith.

The agency should re-examine pollution prevention SEP/injunctive relief policy in the context of the small firm. There are two distinctly different types of small firms: (1)

entrepreneurial, highly innovative "technology-based firms", and (2) "Ma and Pa" firms that are using old technology (often the firm is privately owned or family run). In case of the former, if the firm is interested in and capable of fostering technological innovation, consideration should be given to a significant reduction in penalty for undertaking the development of technically risky, but potentially significant technology. In case of the latter, significant penalty reduction should be considered to encourage the firm to adopt (or adapt) proven, "off-the-shelf" process/product technology. Thus, the agency could encourage innovation-driven pollution prevention in the first case and diffusion-driven pollution prevention in the second.

Highly successful projects could be advertised as "showcase" examples and some settlements could be designed to contain demonstration projects from the start, with joint continuous input from the agency and the firm. Demonstration projects can encourage other companies with similar problems and/or technologies to consider implementing pollution prevention, within or independent of, the context of an enforcement action. Additional penalty reduction could be considered for these projects.

18.9 Technical Knowledge and Expertise Within the Company

It appears that while the provision of technical information or suggestions by the agency to the company can help secure success, it is particularly advantageous if technical expertise in pollution prevention approaches exists within the company itself. In-house technical sophistication might be expected to lead to more innovative (and environmentally beneficial) results, since the company is most familiar with its own technology and (usually the) sources of environmental problems. In the CPM case, where the case officer had substantial knowledge of pollution prevention and provided numerous ideas and information, the pollution prevention project development process was very time and resource intensive--for both the agency and the firm.

If the company lacks in-house expertise, a second best scenario would be for the company to have access to a good consultant. The use of technical consultants by the company can

add significantly to both the initial negotiation of a pollution prevention settlement and to its successful implementation. As discussed previously, consultants skilled in pollution control are not necessarily the best positioned to offer pollution prevention advice. Private consulting firms are only recently beginning to develop this expertise, and where it exists it tends to focus on proven pollution prevention techniques that can be purchased "off-the-shelf". Thus, tailor-made changes that are optimal for a given production situation are unlikely to be suggested from sources outside the firm. These changes are generally too risky for the pedestrian consultant to undertake.

18.10 Project Monitoring

Obviously, adequate monitoring of project progress is essential for a variety of purposes: to keep sufficient pressure on company to pursue and complete the project, to ensure continuing agency interest and support, and to promote both agency and firm learning in the implementation process. Settlements with pollution prevention SEPs generally have more milestones than the usual settlements. Regions are beginning to implement Local Area Network-based computer tracking systems to follow compliance milestones--these systems can ease somewhat the additional monitoring burden associated with SEPs.

19.0 CONCLUSIONS

My research points to numerous barriers--within the agency and firms--to increasing both the number of pollution prevention SEPs and injunctive relief settlements and to including innovative pollution prevention conditions. Barriers within the agency include: inappropriate performance evaluation criteria internal and external to enforcement programs, lack of individual motivation, lack of time and technical resources, and a reluctance to approve technically difficult and risky projects. Barriers within firms include: a desire to settle the case quickly, little or no perceived value in pollution prevention, lack of time to develop the project proposal and implement the project, and inadequate knowledge and expertise (in-house and consultant's). These barriers, coupled with the agency and firm's desire to resolve the enforcement settlement quickly, appear particularly significant in the

context of injunctive relief, as evidenced by the dearth of pollution prevention injunctive relief cases reported by the regions.

Despite these barriers, this study of ten enforcement settlements containing pollution prevention conditions has documented many successful outcomes of agency endeavors to promote the use of pollution prevention in enforcement. These successes can be measured directly by changes in firm technology and associated environmental and human health benefits, as well as by the many tangible and highly valuable indirect benefits realized both within the firms and the agency. Within the firms, indirect environmental, health, and economic benefits were derived from the transfer of SEP technology to other processes in the subject plant or to other plants owned by the firm; organizational changes that led some firms to view and address pollution sources in a more holistic fashion; further implementation of other pollution prevention projects; and changes in vendor/consultant relations that will facilitate future adoption of preventative rather than control strategies. Furthermore, all of the firm representatives interviewed saw the opportunity to implement pollution prevention--either as a SEP or as injunctive relief--as a way to turn a negative situation into a better or positive situation for themselves, for their firm, and for their relationship with the agency.

The case studies are also illustrative of the ways in which the agency can--and to a limited extent does--translate its stated preference for pollution prevention into action (within the context of enforcement). The cases revealed that the opportunity to negotiate pollution prevention into enforcement agreements provides both personal and professional satisfaction for the agency negotiators involved and, where there is managerial support, motivates these negotiators to seek out further opportunities to facilitate pollution prevention. Additionally, pollution prevention knowledge and skill--gained by case officers and attorneys in the course of negotiating and monitoring pollution prevention SEPs and injunctive relief--helps to build the agency's overall base of prevention expertise which can be leveraged in standard setting, permitting, and inspection activities as well as in industry outreach programs. Furthermore, this study indicates that the use of pollution prevention in

enforcement is unlikely to compromise the deterrence impact of the agency's enforcement programs, particularly given the limitations contained within the policy guidelines.

A subset of cases studied demonstrate that enforcement settlements can be structured to facilitate the adoption of innovative pollution prevention technology, and by doing so, push the "technological frontier" to help overcome tough technology-based environmental problems. Although the enforcement setting, with its adversarial backdrop and somewhat rigid legalistic framework, is a challenging setting within which to facilitate innovation, evidence from the cases demonstrates that the enforcement context has two distinct advantages. First, firms can be motivated to innovate, i.e., to overcome the barriers to pollution prevention innovation that often exist in firms, through penalty reduction, improved relations with the agency, and improved public relations (via publicity through press releases). Second, since the firm has committed to implement the innovative project in its consent agreement with the agency (or to pay stipulated penalties), there is a strong incentive to stick with the project even when technical difficulties arise. Enforcement thus creates a "window of opportunity" in which options for technological change receive more serious consideration than usual.

In conclusion, it appears that many of the barriers that act to discourage the use of innovative pollution prevention in enforcement settlements are likely to be at issue in the case of another important innovation-promotion mechanism available to EPA--innovation waivers. (This instrument was discussed in Section 5.3.) Specifically, agency performance evaluation criteria that do not encourage or reward efforts to promote innovative outcomes, lack of staff time and technical resources, and a reluctance to approve technically difficult and risky projects are likely to be problematic in the area of innovation waivers as well. Firm-level barriers found in this study of enforcement, including little or no perceived value in pollution prevention, lack of time to develop the project proposal and implement the project, and inadequate knowledge and expertise (in-house and consultant's) may play a role in discouraging industry to take advantage of the waiver provisions. Therefore, the agency will need to address these issues if it seeks to use waivers as a mechanism to achieve the

goals stated in the Technology Innovation Strategy.

As a policy tool to promote cleaner technology innovation, however, innovation waivers may have several distinct advantages over enforcement mechanisms. First, waiver provisions were explicitly designed to encourage investments in innovative technology, while enforcement mechanisms are not specifically targeted at stimulating innovation. As a result, waiver provisions can more easily accommodate the long timelines that may be necessary to translate a new technical idea into a commercial reality. Furthermore, negotiations between EPA and the firm is likely to be less adversarial in the innovation waiver context compared to the enforcement settlement process. Therefore, the waiver policy may offer more opportunity for cooperation between the agency and the firm. EPA should reexamine and revitalize the innovation waiver as a useful tool for promoting cleaner technology innovation.

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APPENDIX A: QUESTIONNAIRES FOR UNSTRUCTURED INTERVIEWS

A-1. Questionnaire for Unstructured Interviews with EPA Regions

A-2. Questionnaire for Unstructured Interviews with Case Study Firms

A-1. QUESTIONNAIRE FOR UNSTRUCTURED INTERVIEWS WITH EPA REGIONS

A. GENERAL QUESTIONS ON POLLUTION PREVENTION IN ENFORCEMENT

1. Generally, do you favor certain types of pollution prevention projects over others (e.g. product reformulation vs. recycling vs. process redesign; innovative projects vs. off-the-shelf technology)?

Do firms tend to favor certain types of projects?

2. On average, how much extra time/resources are required to (1) include and (2) to monitor a pollution prevention SEP in an enforcement agreement (legal and technical staff)? Is special or additional technical support ever needed?

3. Has the inclusion of pollution prevention in enforcement had an effect on inspection strategies in general or on the use of inspection resources (e.g., reducing inspection frequency for a plant that has implemented pollution prevention, targeting certain facilities to promote a certain type of PP technology or to promote change within a certain industrial sector)?

4. Are there any elements of the "Interim Policy on the Inclusion of Pollution Prevention and Recycling Provisions in Enforcement Settlements" (Feb. 25, 1991) that constrain your ability to (1) incorporate pollution prevention into settlements or (2) incorporate innovative (rather than off-the-shelf) pollution prevention projects?

5. Are there elements of the Interim Policy that act as barriers/disincentives to more innovative approaches (e.g., the reinstatement of the "relieved" portion of the penalty if the project fails)?

6. What type of technical information do you use to identify/evaluate pollution prevention options? Where do you get this information?

What additional technical information would be useful?

7. What type of guidance documentation on including pollution prevention in enforcement would be useful to you (e.g., identification of projects that facilitate long-term compliance, evaluating the economic benefit to the company of project, establishing implementation schedules, determining penalty mitigation)?

B. QUESTIONS ON EACH SETTLEMENT:

1. Who initiated the SEP process and suggested the specific project: EPA engineer, attorney, company?

Where did engineer/attorney/company get the information/know-how about the technology (e.g. in-house, equipment vendor, chemical supplier, state technical assistance office, pollution prevention information clearinghouse)?

2. Why was this particular project chosen?

3. Were other projects suggested? If so, why were they not chosen?

4. How was the implementation schedule established?

5. Does this project enhance the company's ability to comply with regulations?

6. Was the company considering this project prior to the violation? If so, would they have eventually implemented it? If not, why not?

7. Does the project have the potential to be implemented in other parts of the plant, or at other locations? Was that a factor in choosing the project?

8. Was this the first time the company implemented a pollution prevention project?

9. Did the company make changes to its organizational structure or change any policies or procedures as a result of the SEP (e.g., changes in capital budgeting/planning, institute an environmental auditing program, include environmental personnel in production decisions)?

10. Did the company perceive an economic/regulatory benefit from the project beyond the reduction in penalty?

11. Do you think that company is likely to implement other pollution prevention measures as a result of the SEP?

A-2. QUESTIONNAIRE FOR UNSTRUCTURED INTERVIEWS WITH CASE STUDY FIRMS¹

A. QUESTIONS ON THE SEP PROCESS:

- 1. Did EPA have sufficient latitude to consider the pollution prevention proposals that your company developed?**
- 2. Was your company given sufficient encouragement and incentive to consider pollution prevention projects?**
- 3. What were the key aspects of the negotiation process that led to the incorporation of a pollution prevention project into the settlement?**
- 4. What concerns do you have, if any, and what suggestions do you have to improve the negotiation process with respect to the inclusion of pollution prevention projects?**
- 5. What concerns do you have, if any, and what suggestions do you have to improve the monitoring process with respect to the inclusion of pollution prevention projects?**

B. SPECIFIC QUESTIONS ON THE POLLUTION PREVENTION SEP

- 1. Could you describe the general nature of the technical changes that were made?**
- 2. Do you think that EPA staff understood/were able to evaluate the technical details of the project?**
- 3. Where did you get the idea and the information about the technology (e.g. in-house, consultant, equipment vendor, chemical supplier, state technical assistance office, pollution prevention information clearinghouse)?**

Had you suggested other projects?

- 4. Did the Agency provide any technical knowledge that was useful in developing or executing the project?**

¹ Slight modifications were made to this questionnaire for our interview with the sole injunctive relief case study firm--BKPM.

5. Was the implementation schedule reasonable?
6. Does the project have the potential to be implemented in other parts of the plant, or at other locations? Was that a factor in choosing the project?

Would you have adopted a different approach if more time were allowed?

7. Does this project enhance your company's ability to comply with environmental regulations in the future?
8. How has your Company measured the environmental benefits of implementing the prevention project?
9. Had the company previously implemented a pollution prevention project on its own? or as a result of state requirements?
10. Did you perceive an economic benefit from the project beyond the reduction in penalty?

How has your Company measured the economic costs and benefits of the project?

Do you see long term savings associated with this project?

C. QUESTIONS RELATING TO ORGANIZATIONAL CHANGE

1. Did you make changes to your organizational structure as a result of this project?
2. Did you make any changes to policies or procedures as a result of the project (e.g., changes in capital budgeting/planning, institute an environmental auditing program, include environmental personnel in production decisions)?
3. Do you think that company is likely to implement other pollution prevention measures as a result of the project?

D. GENERAL QUESTIONS

1. If asked by another company, would you recommend that they include a pollution prevention project in their settlement?

APPENDIX B: DETAILED CASE STUDIES

A. Supplemental Environmental Projects

Casted Metal Products Manufacturer (CMPM)

Industrial Coater (IC)

Lid Manufacturer (LM)

Medical Device Manufacturer (MDM)

Metal Filing Furniture Manufacturer (MFFM)

Metal Finishing Company (MFC)

Metal Machining Company (MMC)

Powder Metallurgy Manufacturing Company (PMMC)

Pump Service and Sales Company (PSSC)

B. Injunctive Relief

Bleached Kraft Pulp Manufacturer (BKPM)

CASTED METAL PRODUCTS MANUFACTURER (CMPM)

I. Case Overview

Violation (Law and Date): CWA. Failure to file a Baseline Monitoring Report. September 1989.

Date of Consent Agreement and Order: August 1992.

Description of Company:

The Company produces casted ferrous metal products using a variety of operations, including: wax pattern and sand/plaster mold production; mold dewaxing with heat; acid and caustic cleaning, degreasing, bluing, phosphate coating, and tumbling of metal parts. CMPM has approximately 1,200 employees and 3 buildings at the subject facility. The Company owns two other plants; one plant makes similar products, another produces only aluminum products.

Date of Project Completion: September 1994 (original completion date was September 1993, region granted a one-year extension of time)

SEP Costs: Not available

Original/Final Penalty: \$95,000/\$30,000

II. Description of Pollution Prevention SEP

The SEP has two parts. The first part consists of already identified process and facility modifications to be made by the Company to reduce water and chemical use and wastewater and hazardous waste generation. The second part consists of a Water Use and Wastewater Reduction Program designed to identify further measures to reduce water use and wastewater generation.

I. By September, 1992, the Company shall:

- A. Reduce flow in its dewax cooling plates to reduce non-contact cooling water to the maximum extent safely possible.
- B. Implement the following measures in the acid cleaning process:
 1. Install a countercurrent rinse tank following the Hydrochloric Acid baths; and

2. Route caustic rinse water as a reactive rinse to the countercurrent rinse tank.
- C. Implement the following measures in the acid cleaning area:
1. Eliminate the use of Nitric Acid;
 2. Install countercurrent rinse tanks following the Sodium Hydroxide bath and the caustic neutralizer baths;
 3. Route water from the countercurrent rinse tank following the caustic neutralizer bath to the cold water rinse following the Hydrochloric Acid bath; and
 4. Route the water from the cold water rinse following the Hydrochloric Acid bath to the countercurrent rinse following the Sodium Hydroxide bath.
- D. Implement the following measures in the bluing area:
1. Install a two-stage bluing bath on the electric bluing line;
 2. Install flow control devices;
 3. Investigate during summer shutdown, and if doing so will not negatively impact product quality or manufacturing efficiency, route rinse water from the cold water rinses following the bluing tanks in both lines to the cold water rinses following the caustic cleaner baths; and
 4. Investigate during summer shutdown, and to the extent doing so will not negatively impact product quality or manufacturing efficiency, reduce flow in all process lines.
- E. Implement the following measures in the phosphate coating area:
1. Replace caustic water rinse with a dead rinse and a countercurrent rinse;
 2. Use rinse water from the dead rinse as make-up water for caustic cleaner;
 3. Use a single cold water rinse following the phosphoric acid solution;

4. Use a cold water rinse following the phosphoric acid solution bath as a reactive rinse for the countercurrent rinse; and
 5. Install a timer or conductivity flow controls to limit flow to after usage necessary for product quality or manufacturing efficiency.
- F. Install flow control devices as appropriate in the tumbling area of Building C to reduce water use to the maximum extent possible without negatively impacting product quality or manufacturing efficiency.
 - G. Take measures necessary to see that all employees are properly replacing lids on baths not in use to reduce evaporation.
 - H. Eliminate the use of perchloroethylene, Freon, and nitric acid in those processes discharging wastewater. (Perchloroethylene was replaced with an aqueous detergent; Freon was replaced with a citrus-based aqueous cleaner.)
 - I. Reduce the use of 1,1,1 trichloroethane and isopropyl alcohol to the extent possible. (1,1,1 trichloroethane was replaced with a citrus-based aqueous cleaner.)
- II. The Company shall implement a Water Use/Wastewater Reduction Program designed to reduce the Facility's water consumption and wastewater generation to the maximum extent practicable without negatively impacting product quality or manufacturing efficiency as follows:
- A. The Company shall complete and provide to EPA a Water Balance Survey of the Facility and a report describing all sources and amounts of intake water, all points of wastewater discharge, including evaporation, and a description of the Facility's processes and activities that generate wastewater, including contact and non-contact cooling water. The report shall include a water balance schematic diagram illustrating the above information, including daily volumes of water used and wastewater generated.
 - B. The Company shall complete and provide to EPA a Water Use/Wastewater Reduction Study for the Facility. The Study shall include plans and a schedule for, facility and process modifications that the Company will implement to minimize the Facility's water use and wastewater generation to the maximum extent without negatively impacting product quality or manufacturing efficiency.

- C. The Company shall implement those plant and process modifications identified in the Water Use/Wastewater Reduction Study to minimize the Facility's water consumption and wastewater generation to the maximum extent without negatively impacting product quality or manufacturing efficiency.

The SEP also includes a time extension provision:

If measures identified in the Water Use/Wastewater Reduction Study cannot practicably be implemented prior to September 1, 1993, the Company may request an extension of time for completion of such measures.

In addition, it requires that all reports submitted in accordance with the SEP reporting requirement include schematic diagrams illustrating any process or facility modifications completed as part of the SEP.

Many components of the SEP were completed before the CA/FO was signed. In December of 1990, the Company had submitted a letter to the Region detailing process changes that they had or were in the process of implementing; these included: installation of water flow control devices, elimination of Nitric Acid, replacement of a Perchloroethylene vapor degreaser with an aqueous/citric acid-based cleaning system, and reduction in overall organic solvent use by 80%. Some of these process change ideas came from the recommendations of the Company's environmental consultant. The letter also contained three changes that the Company was in the process of investigating: the installation of countercurrent rinse tanks in the acid cleaning areas, spray rinse equipment, and reuse of non-contact cooling waters.

In January of 1991, the Case Officer wrote and sent to the Company, an 11 page letter (including 4 pages of process schematics) containing detailed comments on, and suggested modifications to, the Company's December 1990 letter and Consultant's recommendations in addition to further recommendations for process modifications. In June of 1991, at the request of the Case Officer, the Company submitted to EPA an Environmental Program Summary (EPS) which contained a detailed account of the Company's activities regarding environmental quality and compliance. The EPS included a description of the Company's efforts to implement water use and waste reduction process modifications and to identify and evaluate the feasibility of additional measures. The technical ideas for process modifications were in part based on the recommendations contained in the Case Officer's letters and ultimately these modifications became part of the SEP.

III. Analysis

EPA Perspective

EPA's inspection of CPM in 1989 was part of a regional enforcement sweep of companies that were required to pretreat wastewater before discharging to POTWs. The Company is a large employer/economic force in the area.

The Case Officer and Attorney decided early on, based on the Case Officer's initial inspection of the facility, that this would be a good case to include pollution prevention because the company was generating large quantities of hazardous waste and using water inefficiently. At the time, pollution prevention in enforcement was a new idea for the Agency. The Case Officer had just returned from a year-long detail with a State Pollution Prevention Technical Assistance Office.

To obtain information about the Company's manufacturing processes, the Case Officer modified the Region's standard CWA Section 308¹ information request letter asking the Company for more than the usual information, including schematic diagrams of water and wastewater flows and descriptions of the industrial process operations at the facility, and all chemicals used (including chemical composition of process solutions).

The Case Officer asked the Company to come up with a wastewater reduction plan. The Company, in turn, gave this task to their environmental consultant. The Consultant put together a plan that involved the construction of a \$250,000 pretreatment plant to remove chromium from combined wastewater streams from all process, and a series of flow reduction measures that involved conventional water conservation techniques (e.g., flow restrictors). The Company submitted this plan to the Region. The Case Officer asked the Company to look closely at each process, develop mass balances, and generally to develop a better understanding of how materials were being used and wastewater generated in each process before choosing to implement the combined wastewater pretreatment plant.

During this investigation, the Company realized that their chromium discharge came from only one process--metal molding and stripping--and that a \$60,000 pretreatment plant for only one wastewater stream would be sufficient to effectively minimize chromium discharge.

The Case Officer wanted to take a proactive role, to work with the Company on developing pollution prevention measures for inclusion in the enforcement agreement; he could see that the Company had the technical ability but needed help in "harnessing" this

¹ Under Section 308 of the Clean Water Act, 33 U.S.C. §1318, EPA is authorized to require the submission of any information necessary to determine whether any person is in violation of an effluent or pretreatment standard promulgated under the Clean Water Act §1251.

ability to apply it to pollution prevention objectives. He concedes that the Agency was sending mixed messages to the Company, and the Company was initially confused about the Case Officer's role--Regulator or Technical Assistance Provider?

He sought to win the trust of the Company to encourage them to consider his technical advice. By suggesting the "close look" at their processes that ultimately led to their abandonment of the large pretreatment plant, the Case Officer began to win their confidence on his technical approach and expertise. The relationship between the Company's Environmental Engineer and Case Officer evolved to a point where the Engineer began to call the Case Officer to solicit his advice on projects--even those that were being considered outside of the enforcement context. The process was an education for the Environmental Engineer who had little practical experience before starting the job. The Company now has the capacity to pursue pollution prevention on their own, and they are.

The process was also a learning experience for the Case Officer and Attorneys who were involved in the settlement process. To some extent, the EPA negotiators were experimenting with pollution prevention in enforcement. The Case Officer sees this case as a success in terms of the technical measures that were implemented and the organizational change that the Company underwent. However, success came at the price of a protracted negotiation process which required significant resources on the part of the Region and caused the Company some discomfort and confusion.

The key elements of success were: The ability of the Case Officer to take the time to understand the Company's processes and to work with the Company to develop technical ideas, the ability of the Case Officer to show a level of "sensitivity" to the technical needs and constraints of the manufacturing processes, and the support of the EPA Attorney for this proactive, technically involved approach.

To assist the Company in generating technical ideas, the Case Officer consulted with a State Pollution Prevention Technical Assistance Office, read pollution prevention case studies, and talked with Plant Operators to find out how the processes worked, to solicit their ideas, and to get their opinions about the technical options that he was considering. He applied the technical strategy that he had learned during his detail at the State Pollution Prevention Technical Assistance Office.

The Case Officer believes that the approach used by EPA for this Company may not be appropriate in all cases. A Case Officer must win a company's trust in order to play a technical assistance role, there must be potential for pollution prevention in the plant, and the Case Officer must have sufficient time and support from the case Attorney. The additional time required to settle and monitor the case may make it difficult for a Case Officer to perform his or her other duties.

The Case Officer believes that state offices of pollution prevention technical assistance should be brought into enforcement cases to conduct a pollution prevention assessment. The results of the assessment should be given to EPA and the Company. In addition, the Case Officer thinks that it would be very valuable for EPA Case Officers to spend one year at a state office of pollution prevention technical assistance.

He suggests that Case Officers consider early on in the inspection stage whether the potential exists for a pollution prevention settlement, e.g., whether the process is inefficient, whether waste generation and water usage rates are high, whether the company is unaware of pollution prevention, companies that are medium-sized and have a diverse array of operations--and begin to plan a pollution prevention enforcement strategy at the outset. Asking for process flow diagrams in initial information requests can help determine the potential for pollution prevention.

Company Perspective

Background

Prior to EPA's complaint, the Company realized their water usage costs were high and that they should reduce water consumption. They had not, however, made efforts to do so. EPA conducted their inspection in 1989, sampled wastewater streams and found that the Company had not submitted a Baseline Monitoring Report to the POTW nor EPA, as required by the Clean Water Act at least as of 1986. The Company was in compliance with Town/POTW requirements for wastewater discharge and thought that meeting POTW requirements was all that was necessary. Neither the town nor the State were aware of the Baseline Monitoring Report requirement.

During a two year negotiation period, EPA put pressure on the Company to provide, under extremely tight timelines, a variety of information on their operations (process flow diagrams, historical operations data, material balances, wastewater sampling and analysis, and metering of water usage) and to institute waste and water reduction projects. During this period, the Agency would neither tell the Company whether they were in violation of other regulations nor the expected magnitude of the fine. They were told, however, that if they cooperated with the Agency, their "good faith efforts" would be taken into consideration.

Finally, EPA assessed a penalty of \$125,000 for failure to submit the Baseline Monitoring Report and borderline violations of discharge limits for metals. The Company felt it had not exceeded discharge limits and was very surprised at the magnitude of the penalty considering all they had done to show good faith. The Case Officer and Environmental Engineer developed the SEP proposal and the Agency agreed to reduce the fine to \$30,000 for the SEP.

The Company developed a constructive relationship with the Case Officer from the start; he was sympathetic to the company's constraints and limitations. He sought to develop a cooperative relationship between the Company and EPA but was constrained by the EPA attorneys who both wanted to maintain an adversarial relationship and were eager to close the case in time for the end of their fiscal year. While the Case Officer's intentions were good, and while he provided good technical advice to the Company, he did not initially understand the production processes and needed time to study them. This slowed the process.

The Company's outside attorney was unfamiliar with environmental regulations and agencies and this was a disadvantage to the Company in the settlement negotiation process. They were also dissatisfied with their consultants--a geotechnical/environmental engineering consulting firm. In the course of the negotiations, the Consultants recommended a large and expensive treatment plant that the Company realized was not needed. They contributed to some degree with process change ideas--by reviewing and modifying recommendations from the EPA Case Officer--but largely recommended traditional technical problem-solving approaches. The EPA attorneys, however, trusted the consultants, and therefore, the consultants helped to win Agency approval of the technical changes that the Company sought to implement. The consultants were "educated" in the course of this process and they now use the company as a reference for their pollution prevention work. The Company would be hesitant to use them again.

The Environmental Compliance Officer proposed an unconventional CO₂ pH treatment plant to EPA; he had read about the technology and thought it would be appropriate and better than conventional systems. The Company had installed this system at another one of their plants. EPA was not familiar with the technology and was reluctant to consider it. Ultimately the Agency accepted the plant proposal and it has been working very well.

EPA compelled the Company to implement water-use reduction measures far in advance and in excess of what they would have done without the enforcement action. In addition, the Company has implemented some waste and water reduction measures in another plant. The enforcement action highlighted the need for a proactive approach to environmental issues.

CMPM believes that it was wise to mitigate the penalty with an SEP; they think in general that the SEP policy is a good one. However, they strongly believe that EPA needs to adopt a new, non-adversarial, cooperative approach in dealing with companies. They found the process to be unreasonably adversarial, extremely costly (legal and technical costs) and inefficient.

SE Project:

Some of the technical ideas for the SEP came from the EPA Case Officer, who obtained insight and project ideas from the shop floor, particularly from the Line Supervisors. Often, when the Case Officer had a question about a process, he was invited to talk to the Supervisors for explanations and suggestions.

The solvent elimination projects were motivated by a desire to eliminate SARA 313 chemicals and improve worker health and safety. The source reduction projects have had positive effects on worker health and safety--fewer bath changes, tank cleaning and sampling has led to less worker exposure. Nitric Acid was replaced by a weaker acid. None of the projects represent a modification to the basic technologies or operations used by the company to manufacture their products. Some projects suggested by the Company were rejected by EPA because the Agency viewed them as too profitable for inclusion in an SEP.

The SEP consisted of projects that the company had implemented both during the period between the inspection and finalization of the consent agreement, and after consent agreement finalization. The Company has completed all but one project under the SEP; they required more time to complete the remaining project and the Agency granted them a one-year extension.

The average payback period of all the SEP projects implemented is 5 to 8 year. While the company's hurdle rate is one year, they believe that the projects were in their best interest--economically and environmentally. They have realized water savings of about 100,000 gallons per day and energy savings from close-looping water cooling processes. Their ultimate goal is to close-loop the entire plant to reduce water usage and eliminate wastewater discharges (i.e., to achieve a "zero-discharge plant").

Organizational Change:

Prior to the complaint, the Company had one person in charge of environmental compliance, and compliance was only one of his many responsibilities. Today, there are four people with environmental compliance responsibilities in addition to the Compliance Officer--one full-time Engineer and three part-time Technicians.

The Company now sees the connections between all of their emissions/waste compliance obligations and source reduction activities; they have "tied it all together." They will not allow any new chemicals into the plant without prior approval from the Environmental Engineer or the Compliance Officer.

The Company tried recently to send lead waste to a secondary lead smelter for recycling. After some delay, their state and the receiving state's environmental agencies blocked the transaction because of concerns over slag from the smelter. The Company thought

this was unreasonable since these agencies are promoting recycling and the material was no different than the raw material typically used by the smelter.

Analysis:

Given the way that the case was handled by the Region, the Company had a significant amount of incentive to implement pollution prevention as well as comply with the unusual requests for detailed information about their manufacturing practices. The Region withheld judgement, for a long period of time, on the specific violations and potential penalty that the Company would face. Therefore, the Company had a strong incentive to cooperate with the Agency in the hopes that their good faith efforts would be taken into consideration.

Given the number and nature of process modifications undertaken, and the fact that the Company was "starting from scratch" in thinking about and applying, pollution prevention to their processes, time was a key element in this case. Time was needed for the Company and the Case Officer to educate themselves about the way in which water is used and waste is produced and the ways in which the two could be reduced without adversely affecting product quality and productivity.

Pollution prevention knowledge was another key element. As the Case Officer stated, the Company had in-house technical capabilities, but did not know how to direct those abilities toward pollution prevention. The Case Officer introduced both a new mode of technical inquiry (e.g., how and why is water being used in this process, and how can water use be reduced) and transferred his knowledge of basic pollution prevention techniques; in effect, he played the role of a "pollution prevention consultant". Because the Company did not initially have the capacity (i.e., mode of inquiry and knowledge of basic techniques), it was necessary for the Case Officer to take a very technically involved role in the process. Today, the Company does not need an external actor to play this role, they now have the in-house capacity to pursue further pollution prevention.

The role played by the Case Officer, could have largely been played by a good pollution prevention technical consultant or a state office of pollution prevention technical assistance. The Consultant or State Technical Assistance Provider would have reduced significantly the time spent by the EPA Case Officer--the Case Officer could have used his knowledge to review and react to the proposals drawn up by the Company/Consultant/Technical Assistance Provider instead of educating himself on the Company's processes and developing the pollution prevention ideas--and the confusion over the role of the Agency (i.e., enforcer or technical assistance provider) would have been diminished. In this case, the Company's Technical Consultant did not have the capacity to play this role. However, it is not clear that a Consultant/Technical Assistance Provider could have achieved the same results in a shorter amount of time.

The early decision by the Case Officer and Attorney to include pollution prevention in the settlement was another important element. By requesting process information in the initial stages, the Case Officer was able to determine the particular areas within the plant where prevention potential existed and by encouraging the Company to look closely at their water use wastewater generation activities, the Company was able to avoid the large and unnecessary expenditure on a combined-flow pretreatment plant. If the Company had invested \$250,000 in this plant to treat all their wastewater, they would have had much less incentive to pursue pollution prevention either during or after the settlement negotiations.

Through process modifications, the Company has reduced wastewater discharges by approximately 100,000 gallons per day (approximately 75% reduction) and has reduced energy consumption by close-looping water cooling processes. The SEP will leverage additional wastewater and energy reductions since the Company's ultimate goal is to close-loop the entire plant. The following table illustrates chemical use reductions made by the Company from the period of 1989 to May of 1991.

Chemical Use Reduction
(Pounds Purchased, 1989 to 1991)

	<u>1989</u>	<u>Pounds</u> <u>1990</u>	<u>1991*</u>
Freon	55,280	51,060	0
Perchloroethylene	35,700	14,000	0
1,1,1-Trichloroethane	30,000	27,000	9,000
Nitric Acid	2,275	3,500	0
Isopropyl Alcohol	32,485	24,525	4,683

*Amount of chemicals purchased from January 1, 1991 through May 31, 1991.

Source: CPM's Environmental Program Summary, June 1991.

While the changes made by the Company are significant, they have not fundamentally changed their core manufacturing processes.

INDUSTRIAL COATER (IC)

I. Case Overview

Violation (Law and Date): EPCRA 313, August 1989 The company failed to file Form R for toluene and methyl ethyl ketone.

Date of Consent Agreement and Order: March 1992

Description of Company: Industrial Coater manufactures coated plastic film. In 1989, Industrial Coater had projected sales of 20 million dollars and employed 150-170 people. The company is a wholly-owned subsidiary of a foreign corporation. This parent corporation operates a coating research and development facility at the same site. The research facility provides R&D support to Industrial Coater.

Date of Project Completion: CA/FO date - 12/31/92. (Company was not able to complete the project by this date and decided to pay the stipulated penalty. See Company Perspective below.)

SEP Costs: \$54,200 (CA/FO estimate).

Original/Final Penalty: \$50,000 / \$30,000

II. Description of Pollution Prevention SEP

The project involves the reformulation of a toluene-based coating to a low or non-solvent-based coating and alteration of the production process used to apply this coating to plastic film. The settlement requires the Company to commence the project within 30 days of the signing of the CA/FO and, by December 1992, reduce by 90% the concentration of toluene (as compared to dry chemical) in the coating and reduce by at least 50% the ratio of methyl ethyl ketone used to production volume.

The CA/FO stipulated that the Company shall expend not less than \$25,000 on the project and contains the following reporting requirements:

"Respondent shall submit an Interim Project Report to EPA by September 30, 1992 and a Final Project Report by December 31, 1992. The Interim Project Report shall contain the following information:

- (i) A description of the progress made in completing Phases I and II of the Project.

(ii) A description of Project system operation and performance, any operating problems encountered and the solutions thereto.

(iii) Itemized costs of implementing Phases I and II, documented by copies of purchase orders and receipts or cancelled checks.

The Final Project shall contain the following information:

(i) A detailed description of the installed system.

(ii) A description of system operation and performance, including monitoring data and documentation of reduction in levels of toluene and methyl ethyl ketone used in the Process, and a description of any operating problems encountered and the solutions thereto.

(iii) Itemized Project system cost, documented by copies of purchase orders and receipts or cancelled checks."

The current process of applying a coating to film involved the liquefaction, floating or dissolving of a dry chemical in a solution with the solvent toluene. The resultant coating solution (comprised of the dry chemical and toluene) can then be flowed onto a web of plastic film on an industrial coating and laminating machine. Once the coating solution has been flowed onto the film, the film and the coating are passed upward and through a closed tunnel oven.

The oven is divided into three sections, each with a different function and each set at a different heat level. The first two sections, with increasing heat, further flow the chemicals while removing, by evaporation, successively greater amounts of toluene, the fumes from which are gathered and burned in a thermal oxidizer. The last section of the oven removes the small residual amount of toluene and stabilizes the coating, keeping it hot as it passes on past the ultra violet (UV) curing lamps, where the coating is cured onto the film with UV rays.

The new process will use a heat source to melt the dry chemical mix to a point where its liquefaction will be sufficient for it to coat the film without the use of toluene. The coated film will then be passed through the ovens at a low heat, keeping the coating stable and warm until just prior to the UV lamps. At that point, the coated film will pass by a bank of high intensity infrared heat lamps, which will flow the coating to an even mix across the web and heat the material for curing. Next the coated film passes by another bank of infrared lamps, which quickly heat it again for final stabilization and drying once cured.

The Company expects the new infrared heat lamps to dry the product more quickly thereby allowing them to increase the speed of the coating machine. With increased

speed, the Company can produce the same quantity of product during fewer production runs. Fewer runs means fewer clean-ups; IC estimates that this change will enable them to reduce its use of MEK by an estimated 50% of current levels, from 4,600 to 2,300 pounds of MEK per million feet of product.

The current solution of dry chemical and toluene applied as a coating consists of approximately 70% toluene and 30% dry chemical. Approximate levels of use in 1991 were 24,000 pounds of dry chemical and 56,000 pounds of toluene. The proposed change to the process would, assuming a constant level of production, reduce the level of toluene used by 90%, to 5,600 pounds annually. The amount of dry chemical used would remain the same.

The coating process currently uses an estimated total of 3,683,925 Btus per hour, of which an estimated 525,000 Btus come from burning solvent and the balance (3,158,925 Btus) from natural gas. Approximately 3,500 cubic feet per hour of natural gas are currently used in the process. The process also uses approximately 9.7 kw per hour of electricity. The project is expected to eliminate the use of natural gas and the burning of solvent in the coating process. It will, however, require an increase of approximately 190 kw per hour of electricity to operate the infrared heaters. Because the project is expected to reduce gas and solvent energy use by the equivalent of 1,080 kw per hour, the project is projected to reduce net energy use by 890 kw per hour.

The total cost of the project was projected at \$54,000, including \$5,000 for development of the new coating formulation done under contract by a consultant (Phase I), \$25,200 for installation and testing of new infrared lamps (Phase II), \$19,000 for installation and testing of new coating heating unit (Phase III).

III. Analysis

EPA Perspective:

Since the pollution prevention project included in this case constitutes both process and product redesign and is innovative, regional staff involved in negotiating the case view it as highly successful model of a pollution prevention SEP. The EPA engineer responsible for reviewing the company's technical proposal thought that it was adequate as submitted. She was concerned, however, that the IR heat lamps may cause an occupational hazard. Upon conferring with the region's radiation expert, she determined that the radiation was not hazardous.

Company Perspective:

The SE Project:

After EPA negotiators suggested that the company pursue a SEP, the company sought to develop a project that had a large environmental benefit and one that would be on their critical technology path. The subject project, proposed by the company, met these criteria and was considered to be both innovative and cost effective. While solventless coating technology is not new in other industrial applications, to the company's knowledge, this was the first attempt at solventless coating in this niche of the coatings industry.

The company estimated the payback for this project to be 6 months to 2 years, including approximately \$800 saved per day in energy conservation alone. A similar project had been under consideration prior to the SEP but its concept and implementation had been accelerated through the SEP process, in two principal ways: the project was initiated sooner and it maintained high priority status despite difficulties in development and pilot testing. Although not part of the SEP, the company hopes to apply the principles of this project to further reduce or eliminate its use of solvents in other manufacturing processes.

The SEP Process:

The SEP implementation deadline established in the SEP was based on what the company considered to be the earliest possible date for completion, rather than on a reasonably achievable time frame. The company felt pressure from EPA negotiators to choose the shorter time line and they agreed to it despite their reservations about their ability to complete this rather complex and somewhat technically uncertain project in the time allotted.

In developing their SEP proposal, the company had assumed that they could use their existing coating equipment to apply the new formulation. During pilot testing, they experienced problems with this equipment and sought alternatives. They were unable to meet their product specifications with either new/"off-the-shelf" equipment or custom-designed/manufactured application equipment, and therefore were not able to switch to the new formulation in time to meet the SEP implementation deadline. The company asked for an extension and EPA granted one. However, the company found it necessary to pay the penalty and table the project because of seasonal, high production demands. Furthermore, by continuing the SEP process the company would incur additional administrative costs and inconvenience from "unnecessary pressures of time deadlines." They have already incurred administrative costs for SEP development and oversight in excess of the penalty reduction. They are planning to re-initiate the project in the near future since they consider it to be a "bonefide win-win situation for the environment and [their] enterprise."

The company was disappointed that the press coverage that it received for its violation did not mention that they implemented an environmentally beneficial SEP. Rather, the coverage mentioned only that their penalty had been reduced.¹

Industrial Coater's Operations Manager believes that EPA should take a more proactive role in promoting pollution prevention (to help companies stay in compliance) by instructing companies on how and why pollution prevention makes economic and environmental sense, particularly when companies are acting in good faith. In addition, he suggested that EPA could provide companies with information on the laws that they need to comply with, before they are enacted, so that it is easier for companies to understand what is required of them.

The Company has used the services of the state technical assistance office and was very pleased with their service and the fact that they are separate from the regulatory process. They use the state office for technical advice and a private consultant for compliance audits.

Analysis

The major elements that led to the success of this project were: (a) the company's desire } to choose a project that had significant environmental benefit and one that would contribute to the technological progress of the company, and (b) the willingness of the Region to accept a project that had some level of technical uncertainty and risk.

The company's assessment of uncertainty and risk of failure may have been too optimistic. This observation is based on the absence of any discussion of uncertainty or risk in the company's proposal or in the CA/FO, and subsequent discussions with the company about their expectations for their existing coating equipment. Mention of uncertainty/risk may have been deliberately left out of the CA/FO, by the company/EPA/both, to avoid raising doubt or suspicion over a project that all were enthusiastically supporting. The CA/FO contains a provision that allows the company to only pay 85% (rather than 100%) of the forgiven penalty if the project failed to meet the established success criteria. While this can be considered a fail-soft mechanism, the actual incentive associated with this provision seems very small considering the magnitude of the project.

The environmental benefits from this project derive from reductions in toluene and MEK use. Based on the CA/FO Scope of Work, the quantity of MEK used would be reduced by 50%, or 2,300 pounds of MEK per million feet of product. Since the

¹ In an earlier article, the EPA Case Officer was quoted as saying, "the fine could significantly be reduced if the company were to develop a new, environmentally safer production system, or if it were to stop using the two solvents altogether."

CAFO did not contain an annual production figure, we are unable to estimate MEK reductions in pounds per year. Assuming a constant level of production, toluene use would drop from 56,000 to 5,600 pounds annually--a 90% reduction. The amount of dry chemical used would remain the same.

Fugitive toluene and MEK air emissions are released into the plant and to the outdoor environment in virgin and waste material handling and storage. Fugitive toluene emissions (i.e., emissions not captured by the thermal oxidizer) are also released from the coating process. Toluene emissions from the coating operation may not be completely combusted in the thermal oxidizer or may react under high temperature with other volatile materials in the coating to form toxic substances. These emissions are released into the environment. Waste MEK solvent from cleaning activities and waste coating containing toluene is sent to a hazardous waste incinerator.

By reducing the use of toluene and MEK, both fugitive and point source emissions from the thermal oxidizer will be reduced. A reduction in fugitive emissions inside the plant will reduce exposure of workers to these solvents. The reduction of MEK and toluene waste will result in reduced hazards associated with transport of waste as well as reductions in emissions from hazardous waste incineration.

LID MANUFACTURER (LM)

I. Case Overview

Violation (Law and Date): CAA, Section 133d. The Company applied coatings containing VOCs in excess of limitations set forth in the federal revisions to the State Implementation Plan and failed to certify to EPA that its coating lines would either be exempt or in compliance with SIP emissions limitations. Complaint issued in July 1992.

The subject plant is located in a non-attainment area for VOCs.

Date of Consent Agreement and Order: December 1992

Description of Company: The subject plant is one of several owned by a large manufacturing company. The plant employees approximately 200 people in the production of metal lids with gaskets on four production lines.

Date of Project Completion: May, 1993 (with 4 month grace period), per CA/FO.

SEP Costs: \$298,000 (October 1992 Company estimate)

<u>Original/Final Penalty:</u>	Original penalty	\$130,312
	Recalculated penalty	\$123,947 (disputed fines)
	Penalty after good faith	\$ 76,000
	Final penalty after reduction for SEP	\$ 38,000 (final penalty)

II. Description of Pollution Prevention SEP

Prior to the implementation of the SEP, the Company produced a gasket material by blending rubber, heptane and other substances (the mixture is referred to as "compo"). Compo was coated onto a metal lid and sent through curing ovens to drive off the heptane and form the gasket. The heptane vapors were pulled into a recovery system. Since this system operated at approximately 76% efficiency, almost a quarter of the heptane emissions (VOCs) were released to the environment.

The SEP consisted of a conversion of one of four production lines (constituting 1/3 of total lid production) from the rubber and heptane-based gasket formulation to a new material containing: PVC, BaSO₄, dioctyl phthalate (DOP), soybean oil, CO₂, and carbon black (the mixture is called Plastisol). DOP--20% of the new formulation--is an organic plasticizer and is not listed as a toxic substance under the Clean Air Act Amendments of 1990. The formulation does not contain VOCs other than soybean oil which has a negligible vapor pressure.

The conversion requires the modification of the gasket coating applicator and purchase of a new curing oven. The Company elected to equip the new process with a thermal oxidizer (afterburner) to control air opacity if the Plastisol smokes in the drying oven. It was not necessary to modify its coating formulation process or change its operation of the gasket coating process. The SEP cost was estimated at \$298,381 and includes the purchase price of the curing oven, thermal oxidizer (18% of the total cost), and lid curing trays; in addition to oven installation, lid curing tray R&D, modifications to and relocation of the dryer front.

The SEP requires the following steps, as outlined in the CA/FO:

- a. application for necessary air permits,
- b. design engineering of a new dryer oven,
- c. installation of a natural gas dryer supply line,
- d. removal of the old dryer oven,
- e. purchase and installation of a new dryer oven,
- f. installation of a new gasket material supply line,
- g. production test run, and
- h. full-scale operation.

The Company estimated that heptane usage would decrease by 203 tons per year, resulting in a reduction in VOC emissions of 50 tons per year. They projected a potential emissions rate of particulates from manufacturing, natural gas usage and oven emissions of 3.65 tons per year, and less than 1 ton per year of each NO_x, CO, HC and SO₂ from the new process.

III. Analysis

EPA Perspective

The company had considered reformulating the gasket prior to the violation but had rejected the idea because the capital cost was high and the plant is old--they did not want to invest in the plant at that time. The company agreed to reformulate the gasket and redesign the process for only a part of their production capacity because the project cost was high and they wanted to evaluate the plastisol system before deciding to expand to other lines.

Even though the SEP dealt with a process (gasket forming) that was different from the process for which the fine was levied (VOCs from coating of metal lids), the SEP resulted in VOC reduction and was considered a vertical nexus. The company reformulated their coating to reduce VOC emissions in response to the enforcement action, but this was not included as an SEP.

The time frame for project implementation was not an issue in this case. The Case

Officer inquired about the chemical constituents of plastisol and in response, the company provided information on the chemical make-up of plastisol and certified that there were no VOC emissions from the process. The Case Officer did not investigate the environmental or health impacts associated with plastisol constituents.

The Regional negotiators thought the Company showed good faith in negotiating the settlement. They used an outside attorney who understood the SEP policy well and was very proactive. In the SEP negotiations, the Region considered their role to be one of a "responder", rather than "initiator".

Company Perspective

EPA introduced the concept of an SEP during pending negotiations with the Company. LM saw the SEP option as an opportunity to reduce the penalty, as an alternative to litigation over the penalty amount, and to spending additional money on attorney's fees. The SEP saved time for both parties in negotiating an agreement. While the Agency did not introduce the SEP option at the beginning of the negotiation process, this was not considered to be a disadvantage because the Company was able to discuss the appropriateness of each component of the original penalty before exploring options for mitigating it. Overall, the negotiation process was considered worthwhile and successful since the Company and EPA were able to come to mutually agreeable terms which included mitigation of the penalty through an SEP.

The SEP provided an impetus to undertake the gasket reformulation project. The project was costly, but it was considered to be a "good business decision" from regulatory compliance, technical, and economic standpoints. The project had been considered before the SEP and may have otherwise been implemented. While the \$38,000 reduction in penalty is small compared to the total cost of the project, and was not considered to be a significant financial incentive for the investment, it allowed both parties to leave the negotiating table with the knowledge that they had achieved an agreeable concession.

LM was convinced of the superiority of Plastisol to compo, from an environmental standpoint, because the new material contained no VOCs. Its only concern was that Plastisol would smoke in the curing oven, potentially creating an opacity problem. They addressed this potential problem by including a thermal oxidizer in the project design. If Plastisol does not smoke, the Company will not utilize the device, thereby conserving the energy needed to operate it. Wastes generated by both the new and former processes are considered non-hazardous and the quantity of waste generated will not be affected by the switch.

After investigating the technical details of the project, the Agency negotiators considered the Plastisol project appropriate for an SEP. The implementation schedule established in

the SEP was acceptable to the Company and, in retrospect, was sufficient for the completion of the project.

The Company is currently in the start-up phase of the new process. At some point in the future, LM may switch their other compo coating lines to Plastisol if the process proves itself technically and economically.

The Company utilized a technical consultant who is a former employee of the state environmental agency. Her knowledge of environmental regulations and the materials and techniques that satisfy regulatory requirements was extremely beneficial to the Company. Her main focus was technical assistance for compliance, but she assisted in the design of the new system as well.

The Company is working to insure that all of their plants are in compliance with environmental regulations. It held a compliance workshop for representatives of each plant to stress the importance of environmental compliance. LM has a Corporate Environmental Manager and each plant has an on-site person who is responsible for plant environmental compliance.

Analysis

The environmental benefit of the project is the elimination of 203 tons per year of heptane usage, resulting in a reduction in VOC emissions of 50 tons per year. The subject plant is located in a non-attainment area for VOCs. The conversion may increase the plant's particulate emissions by 3.65 tons per year from manufacturing, natural gas usage and oven emissions, and less than 1 ton per year of each NO_x, CO, HC and SO₂.

Plastisol contains PVC. Thermal decomposition products of PVC have been shown to cause "asthma"-like symptoms in workers who were heat sealing PVC films, although proper ventilation and worker protection have eliminated toxic effects.¹ This may be a concern in the subject facility since the Plastisol gaskets are dried with heat.

Diocetyl phthalate (DOP) is one of a number of commonly used organic plasticizers which have shown a low order of acute toxicity in laboratory animal trials². In studies of teratogenic effects, DOP and other esters of Phthalic Acid showed deleterious effects on the developing embryo and/or fetus although DOP was considered one of two of the

¹ Caserett and Doull's Toxicology: The Basic Science of Poisons. Doull, J., Klaassen, C.D., and Amdur, M.O. (ed.) New York, New York: Macmillan Publishing Co., Inc., 1980, page 551.

² *ibid*, page 547

least toxic esters of the eight phthalate esters evaluated in this study.³

Barium sulfate, an insoluble form of barium metal has been found to be non-toxic owing to its inability to be absorbed by the body.⁴

While it is not clear that there would have been a better alternative than the Plastisol material that the Company chose, the question of safety of Plastisol ingredients was worthy of the Case Officer's investigation.

³ *ibid*, page 549.

⁴ *ibid*, page 438.

MEDICAL DEVICE MANUFACTURER (MDM)

I. Case Overview

Violation (Law and Date): EPCRA, 313, April, 1991 (issuance of complaint). The company failed to file Form Rs for xylene, trichloroethane and trifluoroethane.

Date of Consent Agreement and Order: April 1992.

Description of Company: The Company is a medical device manufacturer that is highly regulated by the FDA. In 1991, MDM generated more than \$50,000,000 in annual sales from several manufacturing facilities. Today, through acquisition of several small companies, sales are considerably greater. At the time of violation, the subject plant employed approximately 100 people.

Date of Project Completion: September 1, 1993 (Per CA/FO)

SEP Costs: \$10,000 for R&D, \$65,000 for equipment purchase (see below)

Original/Final Penalty: \$31,350/\$24,000. Original penalty reflects reductions for submittal of reports during the settlement process and good faith.

II. Description of Pollution Prevention SEP

After manufacture, medical devices are degreased and sterilized using freon. The company agreed to engineer and test deionized water degreasing machinery to determine if deionized water can be used in place of freon. If the testing demonstrates that the new machinery is effective, the company will purchase, install and calibrate the machinery. If the new machinery is not effective, the company will either stop manufacturing products that require the use of freon, or pay an additional penalty. The company uses approximately 16,000 pounds of freon per year.

The SEP consists of the following components:

<u>Project Description</u>	<u>Capital Cost*</u>	<u>Deadline</u>
(a) engineering and testing of deionized water process machinery to replace freon as a degreaser, and	\$10,000	May 1, 1992
(b-1) purchase, installation and calibration of the deionized water process machinery,	\$65,000	September 1, 1993**
<u>OR</u>		
(b-2) stop manufacturing all products that use freon degreaser in the manufacturing process,		September 1, 1993

*From CA/FO. Costs could exceed, but not be less than cost indicated.

**The expenditure of this money is phased in from September 1, 1992 to September 1, 1993.

The CA/FO established a schedule of stipulated penalties for failure to carry out items (a), (b-1) and/or (b-2) above.

III. Analysis

EPA Perspective

The company was very eager to find a way to mitigate the penalty. EPA negotiators informed them about the SEP policy and encouraged them to look for options to reduce the use of a 313 chemical. The Company submitted to the Agency a description of several pollution prevention initiatives that it was undertaking as part of its pollution prevention program. These initiatives included the replacement of freon used in degreasing with a deionized water process and the reduction of xylene use in a thinning operation. The EPA negotiators felt that the freon project was acceptable from the standpoint of the SEP policy since it reduced the use of a 313 chemical (i.e., it met the nexus requirement). The xylene reduction project was not accepted by the EPA negotiators. The Company had identified three potential alternatives to xylene but had

not begun to evaluate their feasibility. EPA was concerned that the time it would take to identify, test, and implement an xylene alternative would be too long and the outcome would be too uncertain for inclusion as an SEP. While the freon project too would require some testing, the company had already identified a feasible alternative.

The company is regulated by the Food and Drug Administration (FDA) and requires FDA approval prior to changing their manufacturing process. This requirement complicated the negotiation process--the company was able to test the new process but had to submit the test data to the FDA prior to implementation and then wait for FDA approval. This additional step made it difficult for the company and EPA to develop the implementation schedule and generally to structure the overall agreement. The CA/FO had to be designed to give the company an alternative to implementing the deionized water process in the event that: (a) the tests were unsuccessful, (b) their process change proposal was rejected by FDA, or (c) FDA approval was not received prior to the SEP deadline. In addition, the time line had to be sufficiently long and structured in several steps to allow for the FDA approval process.

The company stated that a 16 month time line (established in the CA/FO) would be sufficient for testing, approval and implementation. The EPA Case Officer was willing to accept this--despite the fact that 16 months is relatively long for an SEP timeline--in consideration of the FDA approval requirement. The EPA attorney was reluctant to establish a 16 month timeline because it is considered rather long for administrative cases, could raise concerns within the Region, and may increase the risk that the company defaults on the CA/FO. Ultimately, he agreed to accept the timeline given the innovative nature of the SEP and the associated environmental benefits.

In March of 1993, the company sent a letter to the Region stating that they will not incur the agreed upon expenses for the machinery prior to the deadline and therefore have chosen to pay the stipulated penalty. They also stated that they are continuing to work on the deionized water process and intend to implement it in the future. The EPA attorney stated that they had the option to request a time extension and did not know why they chose not to exercise it.

The company was permitted to apply both capital costs and reasonable costs for labor (in-house or contract) to the SEP expenditure agreement.

The Case Officer did not need or obtain any additional information on the technical feasibility of the proposed project. Drawing on his 35 years of experience in the chemical industry, he determined that this was a reasonable approach.

Based on a letter submitted to the Region at the outset of the negotiation process, the company had implemented measures prior to this violation to reduce use of xylene, ethylene oxide, and other solvents.

Company Perspective

Background

MDM is in a state of transition. The Company had undergone substantial growth during the late 1980's through the acquisition of several small companies. The subject product is in the midst of a second phase FDA regulatory approval process that began prior to the issuance of the EPA complaint. In addition, the Company decided to move its operations to another site in early 1994; this decision was made after the CA/FO was finalized.

All MDM's plants have a person in charge of environmental compliance. The Corporate Attorney deals with corporate and plant environmental compliance matters.

Prior to EPA's issuance of the complaint, the State enacted a hazardous waste reduction law that requires companies to develop a hazardous waste reduction plan. The Manager of Manufacturing Engineering considers this law to be the best initiative to come from the State environmental agency. The law motivated the Company to reevaluate their approach to environmental compliance and led them to a better understanding of the "true costs" of the materials they use. The Manager of Manufacturing Engineering estimated that it costs the company 50% of original material cost to handle wastes generated from material use (e.g., solvents for degreasing). This estimate is used as a rule of thumb for allocating the cost of waste management to material use.

In the late 1980's, in consideration of the CFC phase-out under the Montreal Protocol, the Company began to scrutinize and seek reductions in its use of freon. Freon is used to degrease products prior to shipment. They began by instituting freon conservation measures through good housekeeping practices. They made further reductions by installing a freeboard chiller on the freon degreasing system to reduce both loss of material and freon emissions¹. These measures reduced freon emissions from 15,000 lb to 4,000 lb/year.

Negotiation process

Along with their outside counsel, the Company's Attorney and Manager of Manufacturing Engineering had the most involvement in the settlement negotiation process. The Manager heads the Manufacturing Engineering Group and is responsible for environmental compliance for the plant.

The Company's Attorney gives substantial credit for the successful inclusion of the SEP

¹ A freeboard chiller is a series of refrigerated coils that form a cold air blanket in the top portion of the degreaser. This blanket serves as a barrier to escaping freon. The payback for this project was 8 months.

to their outside counsel. The idea of an SEP came out of an initial meeting between EPA negotiators and the outside attorney. The outside attorney conveyed to the company that EPA was very interested in including a pollution prevention SEP in the settlement and asked the Company if they had an appropriate project. The attorney was both assertive and creative in his dealings with both the Company and EPA and he managed to work out an agreement between the two parties despite the difficulties that arose over the implementation schedule.

The Company wanted to resolve the complaint through a settlement rather than court process (for business reasons) and was eager to include a project that they considered beneficial to their operation.

The EPA negotiators wanted the Company to agree to a one-year implementation schedule. The Company knew that this would not be a sufficient amount of time given the FDA approval requirement and necessary approvals from the local building department. The Company projected that they would need three years to complete the project. The outside attorney suggested a milestone approach to address the uncertainty associated with the FDA approval process. The Company's attorney understood that the EPA attorney needed to wrap up the case within a reasonable amount of time.

The Company felt that the EPA negotiators understood the technical aspects of the project.

SE Project

In the months prior to the complaint, the Company explored the possibility of eliminating freon use in degreasing. They considered substituting an ultrasonic cleaner using isopropyl alcohol (alcohol is a commonly used cleaner in this industry) but rejected this alternative because it would result in airborne emissions of alcohol. The Manager of Manufacturing Engineering learned of a deionized water degreasing system from an advertisement in a trade journal. He sent product samples to the vendor for a first-stage evaluation of the performance of their equipment on the Company's products. The results were very good from the standpoint of both cleanliness and sterility.

The deionized water system uses a two-step cleaning process. First the product is washed with deionized water and detergent; second, it is rinsed with deionized water in an ultrasonic bath. The vendor has sold this system--with and without ultrasonic cleaners--for degreasing computer chips in clean room environments.

The cost of the project is approximately \$80,000 including second-stage testing, design engineering, and equipment purchase. The project is not considered to be economically beneficial to the Company; it is, however, favorably regarded by the Division Head for its environmental rather than economic benefits.

The Company undertook the second stage evaluation, as outlined in the SEP, and considered the new system to be a technical success. They have chosen not to purchase the equipment for two reasons. First, prior to the finalization of the CA/FO, the Company submitted a premarketing approval (PMA) request to the FDA. FDA's approval is in part based on a detailed description of the manufacturing process. The Company expected a decision from FDA prior to the SEP implementation deadline, but FDA has not yet ruled on this submission. During the waiting period, if the Company chooses to modify their production process they are required to conduct additional testing and submit a substantial amount of additional paperwork to FDA. FDA would then decide whether the Company is permitted to change their submission or whether they must modify and resubmit the entire PMA. Since a switch from freon to deionized water cleaning could impact upon product sterility, this change would trigger this process and would pose risk of additional cost and PMA process delay.

In addition, the subject facility is scheduled to close in February of 1994. The company is moving its operations to another plant. Given the FDA approval process and the impending move, the Company has chosen not to implement the deionized system in the subject plant. They have paid the stipulated penalty for not completing a portion of the SEP.

The Engineering Group has moved the deionized project to a point where they have shown that it can work well on their products. The Engineer that had worked on this project in the subject plant will be transferred to the new site and will work to secure FDA approval for the deionized system on that production line. This line will use a freon-based degreasing system until FDA makes a decision.

While the Company would have pursued this project even without the SEP, the inclusion of the project in the SEP has accelerated the R&D process. The Company considers the SEP process to be worthwhile alternative. It sends a message to a Company that while you are in violation, we will recognize your efforts to make improvements. This approach seemed particularly appropriate given that the fine arose out of a recordkeeping violation. The SEP also sends a message to employees that the government recognizes that they are doing something positive and therefore the penalty is being reduced.

General

The company would have been receptive to EPA guidance on SEP policy and referrals for technical assistance although they think that this information would be a greater asset to smaller companies with fewer technical and legal resources.

Analysis

Since the respondent was pursuing the Freon elimination project prior to Region's complaint, and since the Region was ultimately willing to agree to extend the timeline beyond one year, the Company had sufficient incentive to include the Freon project in the agreement. The Company was not, however, given sufficient incentive to include the xylene reduction project. The Region considered the inclusion of a xylene project in a settlement to be too premature since the Company had not yet found a single feasible alternative; they considered the uncertainty of a successful outcome too high.

According to the Region's negotiators, the key aspects of the process that led to the inclusion of the Freon project were the Company's desire to mitigate the penalty and the Region's ability to extend the timeline beyond one year. The Company gives substantial credit to their outside Attorney who was assertive in encouraging the Company to pursue an SEP and creative in designing the milestone approach that gave the Company some flexibility in case the final R&D stages were unsuccessful.

If the Company had implemented the deionized water system in the subject plant, the SEP would have accelerated the elimination of Freon in this facility. The Company, however, is planning to pursue FDA approval for the deionized system in their new facility, based in part on the research and development conducted under the SEP. The SEP, therefore, may have had the effect of accelerating Freon reduction in the new facility. Additionally, the deionized water equipment vendor may be able to use the results of its evaluations on the Company's product in other applications and for other Companies. To this extent, there may be technology transfer benefits associated with this project.

METAL FILING FURNITURE MANUFACTURER (MFFM)

I. Case Overview

Violation (Law and Date): RCRA, Company treated hazardous waste without a permit. October 1991.

Date of Consent Agreement and Order: May 1992.

Description of Company:

At the time of EPA's inspection, this plant was one of two small manufacturing plants owned by the company.¹ MFFM employs 65 factory workers in the manufacture of steel filing equipment and steel shelving, using a thermal setting paint resin on an automatic, electrostatic paint line. Paint overspray is captured by filters and cardboard on the floor of the spray booths. This waste and straight paint waste are considered hazardous wastes. When these wastes are dried in a curing oven they are no longer considered hazardous waste; just as the products painted and dried are not considered hazardous waste. Therefore, this company and many others like it sought to reduce their hazardous waste disposal costs by drying their paint wastes. Under RCRA, this activity is considered waste treatment and the company was fined for conducting this activity without a waste treatment permit.

Date of Project Completion: November 1992 for equipment installment and May 1992 for written documentation of pollution prevention program implementation (per CA/FO).

SEP Costs: \$218,000

Original/Final Penalty:

original penalty-	\$360,000/
first reduction-	\$330,000 (downward recalculation of willfulness/negligence component of penalty)
final penalty	\$ 93,130 (plus \$218,000 SEP offset)

II. Description of Pollution Prevention SEP

The Company proposed to select from among the following, and investigate and, insofar as practicable, implement the following pollution prevention measures in an amount not

¹ The company has since closed the plant that is not the subject of this case study.

less than \$218,000.

I. Administrative Measures

- A. Development of Pollution Prevention Policy,**
- B. Promotion of Plant Engineer to Vice President for Manufacturing and Environmental Quality to carry out Pollution Prevention Policy and Program,**
- C. Train all plant employees on pollution prevention strategies and opportunities for waste reduction,**
- D. Attendance by management personnel at pollution prevention seminars for the industry,**
- E. Research the environmental and economic costs of waste producing technologies,**
- F. Develop an inventory control system to minimize the amount of hazardous, materials on-site at any given time. (This includes purchasing in appropriate quantities, timing of waste transport off-site and scheduling of orders to minimize paint changes)**
- G. Evaluation of and decision on operation, administrative, production process and raw material changes other than those listed in II, III and IV, below, to minimize waste production.**

II. Operational Changes

- A. Implementation of an on-site solvent recycling system,**
- B. Implementation of a baffle collection system for paint overspray in the Ransburg electrostatic sprayer,**
- C. Implementation of improved paint collection systems in paint bays and Ransburg electrostatic sprayer to prevent overspray from collecting on floor, and**
- D. Implementation of paint drum agitators and pumps for nonstandard color paint transfer**

III. Production Process

- A. Improve the spray efficiency of the Ransburg electrostatic sprayer and the hand held spray guns through parts replacement and equipment adjustments, and**
- B. Continuous training of painters and operators in efficient painting techniques.**

IV. Raw Materials

- A. Purchase and test an alternative cleaning solution for the metal furniture**

- parts, and
- B. Continue to monitor the development of water-based and other coatings to obtain a suitable cost effective alternative.

The projects were to be implemented within a period of 180 days after signing of the CA/FO. Within one year, the Company was required to submit written documentation that the program implemented pursuant to the SEP is operating so as to prevention pollution to the maximum extent attainable.

According to the Company's June 1993 progress report, the Company had reduced its paint use by 20% as a result of improved painting methods and installation of efficient paint nozzles. Paint drum agitators have reduced spillage and employee exposure. The Company also indicated that it had implemented a measure not included in the SEP-- replacement of cleaning solvents with citrus-based solvents. This measure reduced the company's solvent purchases from 21,000 in 1990, to 12,000 lbs in 1992, resulting in a material costs savings of 40%.

III. Analysis

EPA Perspective

After original penalty was assessed, the Company asked how it could mitigate the penalty. The Case Officer gave the Company a copy of the EPA's *Interim Policy on the Inclusion of Pollution Prevention and Recycling Conditions in Enforcement Settlements*. The Company had a good outside attorney with experience in environmental litigation and an Environmental Consultant. The Attorney and Consultant were instrumental in crafting the Company's SEP proposal.

The Regional negotiators suggested the 180 day schedule for project implementation and a one year follow-up reporting requirement. The Company was amenable to this schedule.

The Region was favorable toward structuring the SEP to allow the Company some flexibility in its expenditure of the \$218,000. The Case Officer thought that all the options that the Company could choose from (i.e., the items listed above) were good technical ideas. The Company was at minimum committed to implementing the four changes listed in Section II. Operational Changes (The penalty offset was based on the estimated cost of these changes, which totalled \$218,000). If the company came up with another project not listed in the CA/FO, it would have had to renegotiate the CA/FO.

The CA/FO required monthly progress reporting including certifications of compliance and documentation of money spent on the SEP. The certification was prepared by the

Environmental Consultant who assembled all the necessary material. This process made monitoring compliance simple, particularly since the Company agreed to implement many administrative measures for which there were no capital expenditures.

The Case Officer is very satisfied with the Company's performance; the plant looks much neater and cleaner now. She attended one of its pollution prevention training sessions and was very impressed, particularly because the company had to train in three languages--English, Spanish and Romanian.

The Case Officer did not require any technical assistance for this SEP. She has 22 years of engineering experience in the U.S. military. The Base she worked on had a plating, stripping and painting shop and she was familiar with the technology that Company proposed--she knew it made sense. The Case Officer is wary of any attempt by the Region to set up a formal technical review process for SEPs because it would slow the negotiation process. The Case Officer received helpful assistance from the EPA's Office of Waste Programs Enforcement in Washington. Her contact helped the Case Officer to understand the SEP policy and whether the project that the Company proposed was suitable.

The Case Officer considers the success of the settlement to be primarily a result of the "direct" and "up-front" approach that he took with the Company, in particular by giving the Company a copy of the Agency's policy on pollution prevention in enforcement so that the Company knew exactly what the Agency is looking for and what is and is not allowable. Also, the Case Officer credits the Company's outside Attorney for contributing to the success of the negotiation.

Company Perspective

Background

The steel filing cabinet manufacturing industry is very competitive. Several years ago, the state mandated that coaters switch to high solids paint to reduce VOC emissions. This put the company in a difficult competitive position vis-a-vis the company's competitors outside of the state. At the time, high solids paint technology was relatively new and the company experienced significant problems in obtaining and applying the new paints.

MFFM is small and relatively unsophisticated, according to the President, and they rely heavily on its suppliers for technical information. It was a supplier who recommended that the company bake its cans of paint waste, paint-soaked filters and cardboard, to "convert" these materials into non-hazardous waste. The supplier told the company that most of its competitors do this to reduce cost, that it is "standard industry practice."

EPA, from the beginning, took a very adversarial approach. The reports that appeared in the newspaper made the company look terrible. EPA's position was that since they cannot catch everybody, when they catch someone, they want to make an example of them. The company felt that this was inappropriate because they did not intentionally break the law.

SEP Process

The company hired an outside environmental attorney who had been part of the RCRA Office in Region II. MFFM's attorney, not EPA, initiated the discussion about an SEP. At the recommendation of its law firm, MFFM engaged an environmental consulting company. The environmental consultants came up with the SEP proposal with minimal input from the plant. The President stated: "our people are not experts in [pollution prevention], our people manufacture furniture."

EPA was very receptive to MFFM's SEP proposal because the consultant had prior experience with this process, they knew what would be acceptable to EPA, and they had developed a very detailed plan. According to the President, this was critical to the success of the SEP. If he brought only his manufacturing people to the negotiations, he does not think that EPA would have been at all receptive to its proposal. The company came in so well prepared with a proposal that it did not need nor did it seek input from EPA on the technical aspects of the SEP.

EPA developed trust in the consultants and, as a result, were willing to build some flexibility into the agreement by structuring the CA/FO to include a long list of projects that the company would evaluate and then choose among to expend not less than \$218,000. While this feature gave the company some additional time to evaluate its options, it still felt under-the-gun to spend \$218,000--on projects that EPA would approve--within a specified period of time. It did not have the time to do a thorough evaluation of each option before choosing which to implement.

Neither the company nor its consultant quantified the economic or environmental benefits of the manufacturing changes prior to proposing them to EPA or prior to implementation. The consultant told the company that it did not know the extent to which these changes will reduce pollution or cost, but that they were sure to have some impact. If it had more time, the company would have done a better job of quantifying the costs and benefits of each project. However, the President was sympathetic to EPA's desire to limit the implementation period.

After the CA/FO was signed, the EPA Case Officer left and another was assigned. The company thought that the new Case Officer was extremely fair and reasonable. For example, the company experienced a delay in hooking up its solvent recovery system because the equipment arrived damaged. The EPA Case Officer was very reasonable in

granting the company extra time to implement this part of the SEP.

The company with assistants from its consultant provided EPA will monthly documentation of implementation progress. Since the company does not have the expertise to provide proper explanations of implementation progress, the process would have been burdensome without the services of its consultant. EPA was very receptive to the monitoring reports.

The company examined water-based coatings and powder coatings--two options listed in the SEP--as substitutes for its solvent-based paints and rejected both. Water-based coatings do not work in an electrostatic painting system. Powder coatings are not practical because the company offers 31 different colors and custom matches others regularly. Powder coatings take too long to change (approximately 15 minutes) and are appropriate only when there are long production runs with the same color. In addition, if powder coated products are scratched in the assembly process, they can not easily be touched up. Workers would have to sand them down first and this is not considered to be cost effective. Components painted with its current system can be easily touched-up, allowing the company to salvage scratched products.

The company estimates that it cost over \$550,000 to settle the complaint. This estimate includes legal and technical consultant fees, penalty, closure of the ovens, and SEP costs. This cost almost "wiped out" the company.

Through the use of its consultant, the company found other areas where it was out of compliance and it has addressed these areas. The company would be willing to implement further pollution prevention measures if they can be proven to have an economic payback.

SE Project:

All capital projects implemented under the SEP were completed in beginning of June. It is too early to tell whether the projects are economically successful. The President has not seen any payoffs so far from these changes although he thinks they may payoff in the future. He thinks that they are reducing pollution to a small extent..

The President is strongly in favor of putting penalty monies into productive/pollution reduction SEPs.

Small companies are in a difficult position because environmental laws are very complex and difficult to understand. EPA needs to make companies more aware of what the laws are and to provide technical advice on how to comply. EPA in this situation took a much more "police-style" role than a role designed to "help" the company "abide by the law."

Companies now know that if you break the law you are personally on the line; you can no longer hide behind the corporate shield. Given this, EPA no longer needs the stick to enforce environmental laws. While there are some who deliberately break the law, the majority do not fall into this category.

METAL FINISHING COMPANY (MFC)

I. Case Overview

Violation (Law and Date): RCRA. Violations included: failure to properly close storage containers of hazardous waste (oil and alkaline solutions from machine shop and chromic acid from plating area); failure to label hazardous waste containers (lead contaminated polishing dust, mixed oil and alkaline solutions, chromic acid) and cyclone collection hoppers containing lead contaminated polishing dust.

Date of Consent Agreement and Order: July 1992. (Inspection June 1991, complaint issued February 1992).

Description of Company:

The company manufactures solid cast brass nuts and bolts and chrome plated tubular plumbing supplies. In 1991, they employed approximately 80 people and sales were in the range of \$18 million. The company operates one nickel and chrome plating line. They discharge directly, after treatment, to a canal with low water flow.

Prior to the SEPs, the company generated a variety of hazardous wastes: metal hydroxide sludge (F006) and spent alkaline solution (which were manifested as characteristically hazardous for chromium and lead), lead contaminated polishing waste and spent chromic acid. The facility is a RCRA treatment, storage and disposal facility (TSDF).

Date of Project Completion: September 1992

SEP Costs: The settlement contained two SEPs. The pollution prevention SEP was estimated to cost \$170,000 (based on company estimate in SEP proposal, includes capital, design and engineering labor costs, and construction labor), and actually cost \$244,110 (per company documentation sent to EPA case officer). The non-pollution prevention SEP was estimated at \$5,400 and actually cost \$5,173.

Original/Final Penalty: Proposed penalty was \$325,000 (per Complaint). Company provided information and affidavits for certain violations and was reduced to \$150,900. Final penalty reduced to \$23,300 for implementation of the SEPs.

II. Description of Pollution Prevention SEP

This settlement contained two SEPs. The first SEP (that we will refer to as the "pollution prevention SEP") consists of significant modifications to the company's automatic plating line. The second SEP is a measure designed to more effectively collect polishing dust waste.

Prior to the SEPs, the company generated 77 cubic yards of polishing dust waste annually. Polishing dust is generated when brass tubing parts are polished to improve surface finish in preparation for chromium plating. To reduce polishing dust waste, the company replaced the existing nickel tank with a longer tank. The longer tank, plus an increase in the part cycle time, is designed to improve the surface finish of the part so that a larger percentage of parts do not need polishing to achieve satisfactory chrome plating. The reduction in polishing was designed to reduce generation of polishing dust by 65 to 85%, and to decrease the lead content in the dust. The change was projected to increase the company's use of nickel by 130%, from 5,500 to 12,650 pounds per year.

The company generated 16,700 gallons of F006 metal hydroxide sludge from its nickel and chromium plating operation prior to the SEP. To reduce the generation of this sludge, the company proposed to convert the chrome bath from hexavalent chromium to trivalent chromium. This modification was designed to significantly reduce the company's generation of F006 wastes--the trivalent chromium process would pass substantially less chromium to the rinsewater, prior to wastewater treatment, than the hexavalent chromium plating bath. The company projected that this change to reduce the proportion of solids in the waste stream (metal hydroxide sludge) by 33% and reduce metal hydroxide sludge generation by 5,500 gallons per year.

Prior to the SEPs, the company generated approximately 330 gallons of chromic acid waste per year during their annual clean up and disposal of the chrome plating tank--a source of one violation alleged in the complaint. The switch to trivalent chromium eliminates this activity and the resultant wastestream. In addition, the elimination of hexavalent chromium decreases their use of sulfur dioxide which is used to reduce hexavalent chromium in the waste water treatment process.

The company estimated that the lengthening of the nickel tank and conversion to trichrome would cost \$167,149, take two to four weeks to implement, and would require that the company to invest \$70,000 in inventory to supply their customers while the conversion is under way. The company is required to spend not less than \$165,000 on these two components of the pollution prevention SEP.

The company projected a net yearly positive operating cash flow of \$4,000 in the first year of full operation.¹ This includes a reduction in hazardous waste disposal costs of approximately \$29,000 per year and a reduction in chromic acid costs of \$1,000 per year. Increased nickel and utility costs (100% increase due to increased cycle time and size of nickel bath) were projected at \$38,000 and \$2,000 per year, respectively. By planning to reconfigure product holding racks, the company did not project a slow

¹ This calculation included depreciation. However, the agreement subsequently reached prohibited the company from depreciating its capital costs for the SEPs. When recalculated, omitting depreciation, the net yearly operating cash flow is reduced to -\$10,000.

down in output or increased labor costs.

Finally, at the request EPA, the company agreed to the second SEP which constituted a modification to their polishing dust collection system by the construction of a fixed sheet metal waste collection unit that, when closed, provides secondary containment around fifty-five gallon storage drums. This system is intended to provide additional protection to the environment which is beyond the requirements of existing law and regulations. The company was required to spend not less than \$5,000 on these modifications.

III. Analysis

EPA Perspective

During their inspection in June 1991, the EPA inspector noted that the company: (a) did not employ state-of-the-art technology, (b) employed "sloppy" hazardous waste management practices, (c) had poor personnel training and record maintenance procedures, (d) had an under-experienced and over-worked individual assigned to manage environmental compliance.

During an inspection at the end of 1992, the same inspector noticed: (b) improvements in hazardous waste management practices, (b) better personnel training, and (c) a new, more experienced engineer in charge of environmental compliance.

The Negotiation Process:

At the settlement conference in February of 1992, the company said that they wanted to include an SEP in their settlement, and they specifically wanted the SEP to consist of the nickel tank extension and chromium conversion. The company had already run a pilot test of the new process and determined that it would be technically feasible. By April, they had submitted a cost analysis and schematics to EPA.

The EPA Case Officer surmised that the company saw the SEP as an opportunity to upgrade their equipment while mitigating the penalty. During the negotiations, the company said that they did not have sufficient capital to implement the project and pay the full penalty.

The company's outside Attorney was formerly with the U.S. Attorney General's Office and had worked on EPA settlements in that capacity. She was very familiar with the settlement process and this made the negotiations much smoother. EPA considered this to be a contribution to the success of the SEP negotiation.

The EPA Attorney considers the 70% penalty reduction given in this case as "unusually high." However, she believes that the reduction is warranted since each component of

the SEPs constitutes a vertical nexus, the company agreed not to depreciate the capital costs of the project, and the pollution reduction levels were substantial.

The Case Officer checked plating periodicals in the course of evaluating the company's proposed SEP. He was not familiar with PPEIS or other pollution prevention literature.²

Company Perspective

Prior to the EPA inspection, the company had received information on trivalent chromium ("trichrome") plating systems from a chemical vendor. The company had looked at the process, but there were no plans to convert the system to trichrome at that time because the system produced an unacceptable cosmetic appearance on the plated parts. The supplier was marketing the system as a more environmentally benign process than its hexavalent counterpart. At this time there were companies in the U.S. that were using the trichrome system, but none of these companies were making products similar to MFC's. When the company converted to trichrome, they became the first in "their industry" to move to this system.

After the EPA inspection, the V.P. of Operations learned of EPA's SEP policy in a class that he attended on environmental compliance and pollution prevention. This class is sponsored in part by the state's technical assistance program. He decided to propose an SEP to EPA that would eliminate the activities that contributed to the company's violations. He considered projects in the context of the question: "where do we want to be 10 years from now?" The company proposed the pollution prevention SEP, complete with plans, at the first settlement conference. They stated "this is what we are willing to do."³

Since one of the violations dealt with improper storage and labeling of hexavalent chromium waste, the company decided to eliminate hexavalent chromium. They were able to switch to the trichrome system at this time because the process had been improved and the cosmetic problem had been solved. Currently, their trivalent chromium bath is 1/30 as strong as their former hexavalent bath and is considered about 1/10 as toxic. In addition, the trichrome process has decreased their F006 metal hydroxide sludge generation by about 2/3.

To address polishing dust waste, they chose to redesign their plating system to minimize waste generation. The pollution prevention SEP promised a 65 to 85%

² Researchers found an extensive case study on substitution of trivalent chromium to hexavalent chromium in PPEIS.

³ The dust collection SEP was developed later in conjunction with EPA.

minimize waste generation. The pollution prevention SEP promised a 65 to 85% reduction in the generation of polishing dust waste. The company has cut its waste by 83 - 85%.

Taken together, the switch from hexavalent to trivalent chromium and the lengthening of the nickel tank represent a significant redesign of their plating process. The changes required a significant amount of planning and preparation and required that the entire plating line be shut down to institute the changes. The company typically shuts down for two weeks in July, however, given the delivery schedules for new equipment needed to implement the SEP, they had to move their annual shut down to August.

While product made with the new process does not match the exact cosmetic appearance of product made prior to the changes, the company considers the product made with trichrome to be acceptable.

The company thinks that the change to trivalent chromium is in their long term interest. They believe that regulations are getting tighter and that all companies will eventually be required to eliminate hexavalent chromium from their process. They feel that they have an advantage over companies who have not yet made this change--trivalent technology may get more expensive and they will have the experience of operating the system.

SEP Process:

Although the company felt that the size of the original penalty was extremely high, given their violations, they thought that the settlement negotiation process went well. They believe that the primary reason that the SEPs were negotiated successfully was because they were assertive about stating that they wanted to include an SEP right from the outset of the process (i.e., at the first settlement conference). In their words, they "put it up front", by saying "this is what we want to do."

EPA did not tell the company about SEPs. They think that it would be useful for EPA to inform company's about the SEP policy and to suggest that they contact their state technical assistance program for technical support in developing SEP proposals.

During the settlement process, the company received no technical input from EPA. They had submitted technical proposals and plans and received approvals without any suggestions for changes, or rejections. They do not see this as a drawback.

Other Pollution Prevention Activities

Prior to the SEPs, in an effort to eliminate lead from their production processes, they had switched from a lead to an antimony-based soldering material and had installed energy efficient light fixtures. They also made a change to their process to capture the

zinc that is carried over from the soldering process to the plating process to reduce the quantity of zinc in their metal hydroxide sludge.

Organizational Change

The company instituted three major changes in its operating procedures as a result of the enforcement action and SEPs. First, they set up a chemical laboratory to monitor and maintain proper plating bath chemistry. Second, the Vice President takes an "environmental compliance" tour of the facility every six weeks; the President participates in every second tour. Third, the company will not bring new chemicals into the plant without: a thorough review of the Material Safety Data Sheet (MSDS), consideration of the type of waste that will be created by the use of the material, and consideration of how the waste will have to be handled if the material is used. If the material will pose problems in waste management and/or disposal, the company will not purchase the material.

While the company did not use the state technical assistance program prior to or during the SEP process, they are working with them now and are satisfied with their assistance.

Analysis:

The company used the opportunity of the SEPs to upgrade their production process with an eye toward the future of environmental regulation. While they knew about the trichrome system prior to the violation, the SEP vehicle was an incentive for them to seriously consider, and then ultimately implement it. It seems unlikely that they would have made these changes on their own, at least within the foreseeable future, if it were not for the SEP.

By reducing the generation of lead contaminated polishing dust and the lead content in the dust, the SEPs reduce worker lead exposure and disposal of lead and nickel waste generation. However, the company accomplished this by increasing its use of nickel and electricity and consequently their associated environmental and resource utilization impacts.

The switch from hexavalent chromium to trivalent chromium, results in several environmental and worker health and safety benefits. First, less chromium is used in trivalent chrome systems than in hexavalent systems (trichrome baths are operated at lower concentrations and less chromium is dragged out). This has the benefit of reducing environmental, public and worker health and safety impacts all along the lifecycle of the product: chromium extraction, processing, transportation, use in plating, and ultimate product disposal.

Hexavalent chrome has been shown to cause adverse health effects in workers. While hexavalent is considered more harmful, health effects from trichrome have not been well researched or documented. Trivalent baths have a higher pH than hexavalent and thus pose less of an acute hazard to workers when bath materials are handled. In addition, trivalent chromium systems produce less hazardous chromium hydroxide sludge waste, eliminate the need for annual cleanup and disposal of chromic acid bath, and elimination of use of sulfur dioxide in wastewater treatment.

METAL MACHINING COMPANY (MMC)

I. Case Overview

Violation (Law and Date): EPCRA 313, March, 1989 (inspection), April 1990 (filing of complaint). Company failed to file 1988 Form R's for: phosphoric acid; 1,1,1 trichloroethane; xylene; methyl ethyl ketone

Date of Consent Agreement and Order: October, 1991 (signature date)

Description of Company: MMC is a plant owned by a multinational corporation; the plant employs 1,000 people and generates sales of about \$200 million per year. The company produces engineered pump components from metal and ceramic materials using machining and lapping¹ equipment.

Date of Project Completion: September, 1991 (per CA/FO). As a result of a protracted negotiation process, the company initiated and completed prior to actual signing of the CA/FO.

SEP Costs: \$201,000 (company must spend no less than this amount, per CA/FO)

Original/Final Penalty: \$76,000/\$11,400. Final penalty based on Company's good faith and inclusion of SEP.

II. Description of Pollution Prevention SEP

Prior to the SEP, the company utilized 1,1,1 trichloroethane (abbreviated 1,1,1) solvent immersion cleaning units for the majority of both in-process and final cleaning operations. Cleaning is done for both functional and aesthetic reasons. The SEP consists of several changes to a subset of the company's parts cleaning systems that are designed to reduce the amount of 1,1,1 used by 130,000 pounds per year. The Company agreed to spend no less than \$201,000², by September 30, 1991, on the following:

1. Retrofit 1,1,1 degreaser used on non-metal lapped parts, to reduce solvent emissions and use (estimated reduction in use of 1,1,1 of 3,000 gallons per year). Retrofit consists of: freeboard extension, cover and freeboard chiller.

¹ A process designed to accurately refine the surface of parts using abrasive, rotating plates.

² Eligible expenses are: purchase of equipment, labor (excluding fringe benefits) for installation and testing, and materials directly associated with installation and testing. Expenses associated with project feasibility research are expressly excluded except insofar as the use of the ultrasonic testing unit identified below.

2. Purchase, install and test the following equipment to switch from solvent to aqueous-based cleaning of ferrous and non-ferrous metal parts:
 - a. two heated and agitated immersion systems for final part cleaning,
 - b. one ultrasonic test cleaning unit for use in cleaning trials,
 - c. minimum of six in-process cleaning units,
 - d. one holding tank,
 - e. one belt skimmer to skim oil off aqueous cleaning liquids,
 - f. two evaporator units to evaporate the water portion of spent aqueous cleaning liquids to reduce the volume of this waste to the relatively small amount of free oils and precipitated solids,
 - g. one portable retrieval unit, and
 - h. four chemical mixing systems.

III. Analysis

EPA Perspective

Both the Case Officer and Attorney on this case changed mid-stream. The Plant Engineer, largely in charge of SEP development, was hired by the Company after the enforcement action had begun. He had a personal goal of ridding the plant of 1,1,1 for environmental and health reasons. The Company and the Region reached an agreement on the SEP and then the Company sought and received approval from its foreign owner.

The Company conducted a "cleaning study" (i.e., a study of cleaning needs and alternative, non-solvent cleaning alternatives) in response to the enforcement action; it was completed in October of 1990 (i.e., prior to the signing of the CA/FO). EPA and the Company met several times to consider technical options. The amount of time that the Agency gave the company to evaluate and choose projects was considered unusually long, but this phase included a period of little progress when both Agency and Company personnel changed and while there were disagreements over specific violations. The Regional representative thought that the Company was given sufficient time to develop their strategy.

The Company has completed their SEP, has been inspected by Agency, and has demonstrated their systems to other companies.

Company Perspective

SE Project:

While at the time of their inspection the company was in compliance with VOC emissions, EPA negotiators put pressure on them to reduce their use of 1,1,1 trichloroethane. Therefore, the focus for the SEP quickly became 1,1,1 reduction in parts cleaning.

The Manufacturing Engineer was given the task of evaluating cleaning alternatives under a tight timeline. At that time, there was very little information on aqueous and semi-aqueous systems. He compiled information from technical journals, trade shows and conversations with suppliers. Suppliers, however, seemed to know relatively little about what would and would not adequately clean the parts manufactured by the company. The Engineer produced a comprehensive report of cleaning alternatives and a set of proposals for the SEP. The SEP chosen came from this report.

According to the Plant Engineer, the return on investment (ROI) for the project is good, particularly given the rising cost of 1,1,1³. 1,1,1 use in the plant has been reduced from 30,000 to 17,000 gallons per year.⁴

Currently, the company no longer uses 1,1,1 in cleaning of stainless and forged steel parts. They have not been able to find a replacement for 1,1,1 in cleaning phenolic (carbon/ceramic) parts where 1,1,1 is used to remove lapping oil--an oil used as a lubricant in a process designed to accurately refine the surface of parts using abrasive, rotating plates. The company has been looking, but has not found either an aqueous or semi-aqueous replacement for 1,1,1 to remove the lapping oil, nor have they found a non-oil lapping material that could be cleaned with an aqueous cleaner.

SEP Process:

It took about two years from the time the complaint was issued to the time the CA/FO was signed. The original Plant Engineer at Crane was not knowledgeable in compliance issues and the original Attorney at EPA left the Agency. These factors caused delay and animosity between EPA and the Company.

The current Plant Engineer was hired slightly less than two years after the complaint

³ 1,1,1 trichloroethane is an ozone-depleter and is being phased-out under the Montreal Protocol. Phase-out is scheduled to begin in 1994 and prices for this widely-used solvent have been escalating.

⁴ This converts to approximately 300,000 and 170,000 lbs per year (based on a specific gravity of 1,1,1 of 1.3390), for a reduction of 130,000 lbs per year of 1,1,1 trichloroethane.

was issued. He had previous experience with environmental compliance and had a personal goal to eliminate 1,1,1 and other solvents from the plant. By the time that he joined the company, the plant was under a great deal of pressure to propose an SEP for 1,1,1 reduction. Despite their requests for assistance, neither EPA nor the state environmental agency would offer technical ideas (the state did not have a technical assistance office at this time).

While not part of the SEP, EPA encouraged the Plant Engineer to replace MEK used in cleaning with acetone. The Engineer went along with this but did not think it was sensible because he has simply traded one risk for another: acetone is a solvent and is flammable.

The company's overall opinion of the SEP process is that it was worthwhile. While they would have eventually moved to eliminate their use of 1,1,1, particularly given the increasing cost of the material, the SEP process was a stimulus.

Organizational Change:

There are about 43 other MMC plants and maintenance shops. All of these plants are moving to eliminate the use of 1,1,1, in part because of the work done at the subject plant. Other plants have contacted the subject plant's Plant Engineer for information on alternatives. Some plants have already eliminated 1,1,1.

The company has recently engaged the services of a consulting branch of a solvent manufacturer to help them convert their remaining 1,1,1-based cleaning systems over to non-solvent systems. They chose this company because they are a manufacturer of 1,1,1 and other solvents used for cleaning and they specialize in cleaning operations. The Manufacturing Engineer, however, is not satisfied with the consultants. They proposed a very expensive new cleaning system and the Engineer does not trust that they are providing complete information. Therefore, he is doing his own investigation of the systems that the consultants have suggested as well as other alternatives.

Analysis

The primary environmental benefit of this project is the reduction in the use, emission and disposal of 1,1,1 trichloroethane--an ozone depleting substance. 1,1,1 is also a central nervous system depressant⁵ and is therefore hazardous to workers. Since emissions within the plant will be reduced, the project will have a positive effect on worker health. Since 1,1,1 is slated for phase-out under the Montreal Protocol, this

⁵ Casarett and Doull's Toxicology: The Basic Science of Poisons. Doull, J., Klaassen, C.D., and Amdur, M.O. (ed.) New York, New York: Macmillan Publishing Co., Inc., 1980.

and many other companies have been working toward the elimination of this ubiquitous and effective cleaning solvent. The SEP has accelerated the Company's reduction and ultimate elimination of this substance.

In addition, the Company conducted extensive evaluations of aqueous and semi-aqueous cleaning systems at a time when there was relatively little field experience with this technology. This project has paid-off in several ways: in-plant 1,1,1 reductions; transfer of knowledge and experience to other parts of the plant, other plants, and repair shops owned by the company; transfer of knowledge and experience to other companies invited to examine the equipment and talk to plant technical staff; and education of the manufacturers and vendors of cleaning systems that plant personnel dealt with during the course of their cleaning system evaluations.

The company has chosen not to filter and discharge the aqueous cleaners to the sewer. Therefore, unlike many other firms using aqueous cleaners they will not create a new wastewater discharge. Instead, they chose to install an evaporation system to minimize waste volume and disposal costs. They will dispose the residue of this system as a hazardous waste. The constituents of this residue are unknown. They will also increase electricity usage for evaporator operation.

POWDER METALLURGY MANUFACTURING COMPANY (PMMC)

I. Case Overview

Violation (Law and Date): EPCRA 313, the company failed to file Form R's in 1987 for copper, chromium, trichloroethylene, and ammonia. September 26, 1989.

Date of Consent Agreement and Order: January 1992.

Description of Company: Powder Metallurgy Manufacturing Company (PMMC) occupies a 28,000 square foot plant that has operated since 1955; today PMMC plant has 50 employees and sales of between \$5 - 6 million per year. PMMC uses brass, steel, stainless steel, and metal alloy powders to produce machine screw nuts, steel structural and special parts, and steel fasteners. Powder metallurgy technology produces precision parts that require little or no secondary machining. Prior to the SEP, production of a finished part typically included the following steps:

1. compacting - metal powder is placed in a mold and compacted into "green" parts with a mechanical press.
2. sintering - "green" parts are sintered in electric ovens at a temperature just below the metal's melting point. The sintering process occurs in either a disassociated ammonia (hydrogen-nitrogen) or methanol/nitrogen atmosphere to prevent oxidation and corrosion.
3. burnishing - cooled parts are either rotated or vibrated with a ceramic medium to remove excess metal and provide a smooth finish.
4. brightening - brass parts are placed in a chromic acid, "Brite-Dip" bath to brighten the surface.
5. drying - parts are dried in an oven to prevent corrosion.
6. resin impregnation - some parts that are shipped off-site for plating or difficult to machine are placed in a resin impregnation bath under vacuum.
7. tapping - brass parts are machined or tapped (thread cutting) using a water soluble cutting fluid. Steel and stainless steel parts are tapped using a heavy black sulfur oil cut with kerosene.
8. water wash - brass parts and nuts from the tapping operation are placed in a water wash to remove the tapping fluid.

9. vapor degreasing - steel and stainless steel parts and nuts are placed in a vapor degreaser using trichloroethylene as the degreasing agent.

The company is a member of the Metal Powder Industrial Federation--a federation of four trade associations. There are about 140 similar companies in the country.

Date of Project Completion: January 1993

SEP Costs: \$78,299 (CA/FO estimate)

Original/Final Penalty: \$76,000/\$30,550. Penalty reduction for SEP and other considerations.

II. Description of Pollution Prevention SEP

The SEP consisted of five components:

<u>Project Description</u>	<u>Capital Cost*</u>
(a) an environmental audit	\$4,350
(b) the implementation of a blended hydrogen/nitrogen sintering atmosphere system which eliminated the use and storage of anhydrous ammonia,	\$50,598
(c) the decontamination and replacement of an existing 10,000 gallon anhydrous ammonia storage tank, with a 1,000 gallon tank. This project eliminated a source of ammonia emissions,	\$2,400
(d) the elimination of a trichlorethylene vapor degreaser which eliminated trichloroethylene waste generation and fugitive air emissions. This was accomplished by switching from an oil-based tapping fluid--which required solvent degreasing--to a water-based alternative--which can be removed via water washing, and	\$500
(e) the implementation of a closed loop cooling system for non-contact furnace water which will reduce the discharge of non-contact cooling water to the POTW and conserve water.	\$20,451

*From CA/FO. Costs could exceed, but not be less than cost indicated.

The company was required to implement all components of the SEP within a 360 day time line.

By switching from ammonia to blended hydrogen/nitrogen gases, the company eliminated the use of 1.5 million pounds per year of ammonia and the threat of a catastrophic release of ammonia gas. Prior to the SEP, the company released 26,860 pounds of fugitive trichloroethylene to the air. Trichloroethylene is an ozone depleter and is targeted for phase-out under the Montreal Protocol. These emissions were eliminated under the SEP. In addition, the company significantly reduced its generation of waste oil by switching to a water-based coolant. The company generated 1,600 gal per year of waste oil prior to this change.

While not included as part of the CA/FO, the company also eliminated their chromic acid-based brightening process. This action eliminated the chromic acid treatment sludge generated in this process. This was done for brass parts only, since these parts turn dark after sintering. The company switched to a new burnishing compound that produced a finish on the brass parts that was acceptable to their customers. EPA did not grant any penalty reduction for this process change.

III. Analysis

EPA Perspective

At the time of the inspection, the company, along with other companies in the region, had come under regulatory scrutiny in an effort to reduce emissions in the area. At the first settlement conference, the company started the meeting with a review of their production process and passed around samples of their products. The EPA attorney suggested that they conduct an audit to identify compliance issues and SEP ideas.

Company Perspective

SE Project

The projects implemented under the SEP policy had been proposed by various members of the Company (in manufacturing) prior to the issuance of the complaint. The SEP process was the impetus for their implementation.

The Plant Manager advocated a switch from dissociated ammonia to a blended hydrogen and nitrogen system prior to the issuance of the complaint. While they had only one ammonia release in 35 years of operation, he was concerned about the potential for a future catastrophic release. The company did not implement the blended system because they could not justify the capital expense. In addition, while the blended system requires less energy and produces better quality product than the dissociated ammonia system, it costs more to operate.

The company knew that they would eventually have to eliminate their use of trichloroethylene and were considering alternatives prior to the complaint. Once they

committed to switching, however, it took 14 months to find a water-based coolant that would be adequate. The company relied heavily on the technology and advice of their suppliers, who had professional chemists on staff. During the past 6 months, the workers--whose hands are constantly immersed in the coolant--have developed dermatitis. The plant project engineer is in the process of resolving this problem.

The closed-loop non-contact cooling water system project idea was generated within the plant. The project had a significant payback and conserves approximately 750,000 gallons of water per month.

SEP Process

The company President expressed his displeasure over the magnitude of the original penalty¹ and the low rate of penalty relief granted for the SEP. However, he stated that the EPA negotiators were reasonable and not antagonistic. He thought that the company was given a "fair" implementation schedule and he believes that the negotiators would have granted the company more time if it were needed.

The company's outside counsel was very helpful in negotiating the SEP, particularly in establishing the implementation schedule. The company procured approximately \$44,000 of legal services from their law firm.

According to the Project Engineer, during the settlement process EPA did not encourage the company to propose an SEP. In addition, EPA provided very little technical assistance. The Project Engineer stated that he would be hesitant to ask for EPA's technical advice because he does not want to "invite" visits by EPA representatives. He is not familiar with the State's technical assistance program, but was interested in finding out about it. The President prefers to obtain and transfer technical information through one-on-one contact with other powder metallurgy company representatives and suppliers.

The company has chosen not to publicize their SEP experience, either through contact with other companies or through their trade association. The Project Engineer likened this to "airing their dirty laundry." EPA sent out a press release on the fine that was levied against the company. The story was picked up in the popular and trade press. The company received a letter from one of its customers stating that they do not do business with companies that are not in compliance with environmental laws. By explaining that the violation was for a reporting requirement, the company was able to retain the customer's business.

¹ The company had 51 employees at the time of the complaint which put them into the 50+ employee category for purposes of penalty calculation. If they had 50 or fewer employees the fine would have been \$30,000 rather than \$76,000. They were placed in the same penalty category as a medium-sized corporation. The President stated that the fine policy should be more sensitive to small companies.

The President suggested that a regional committee be established to provide support for companies on pollution prevention in general, and in the context of enforcement. He also suggested a televised broadcast of a discussion of these topics by a panel of businesspeople.

Organizational Change

Through the process of implementing "environmental investments" under the SEP, the company President has "changed his thinking" about "environmental investments." He realized that environmental standards are going to get tighter and decided that instead of trying to keep up with them, it is better to lead them. He decided to eliminate trichloroethylene, chromic acid and ammonia. While it has not been easy, the company has been able to move away from certain hazardous operations and these changes have been economically and environmentally sensible for the company. The projects implemented under the SEP are expected to payback in the "long run"--5 to 7 years (not the 3 to 4 year time frame that small companies tend to set as a hurdle rate). Through a series of energy conservation projects, the company has cut its energy costs by \$4,000 per month.

The President believes that a vision of cultural change must come from the top. He is trying to apply TQM principles to productivity, quality, environment and worker health and safety.

PUMP SERVICE AND SALES COMPANY (PSSC)

I. Case Overview

Violation (Law and Date): EPCRA 313. The Company failed to file a Form R for Freon 113, March 1990.

Date of Consent Agreement and Order: October 1991. (Company initially proposed, and began to undertake, SEP in September of 1990.)

Description of Company:

The subject facility is one of several owned by a large, diversified holding company. The plant markets, sells and services pumps manufactured by a sister plant. Pumps received for repair by the plant must be decontaminated and degreased for service and testing. Prior to the complaint, the Company was using freon for decontamination and degreasing.

The plant's Facilities Manager is responsible for environmental and occupational health and safety compliance.

Prior to the SEP, the Company used Freon 113 for pump decontamination and degreasing. The Company had begun efforts to reduce Freon use in late 1988 with the purchase of a soap and water-based spray washer for some decontamination of its pumps.

Date of Project Completion: December 1991

<u>SEP Costs:</u>	Equipment -	\$56,475
	Labor Installation -	<u>13,000</u>
	Total -	\$69,475

Original/Final Penalty: \$17,000/\$8,500

II. Description of Pollution Prevention SEP

The Company agreed to reduce by not less than 66% by December of 1991 its December 1990 freon use rate in connection with its pump repair processes at the subject facility and at the second facility.

The SEP consisted of two phases: the first phase consisted of the installation at the subject facility of two semi-aqueous cleaning units, each of which includes an in-line particulate filtration system, and the conversion of the facility's existing ultrasonic finishing system from a freon-based system to an agitation/filtration system utilizing a

biodegradable cleaning agent.

The second phase consisted of the installation at a second facility, in a different state and EPA Region, two semi-aqueous cleaning units of the same type as described above.

The semi-aqueous cleaner is biodegradable, specifically formulated to displace petroleum-based oils, greases and machining fluids from metal substrates. The cleaner is a displacement cleaning agent, so called because it displaces rather than emulsifies the oil. The system is designed to skim the oil from the cleaning liquid and recycle the regenerated liquid back into the cleaning tank. Displacement cleaners generate less hazardous waste and require less virgin product replenishment than emulsifying cleaning agents by allowing regeneration/recycling of the cleaning agent and fewer wash tank dumps.

According to the Material Safety Data Sheets (MSDS) for the cleaning agent, it contains: 1-T-Butoxy-2-Propanol, Dipropylene Glycol Monoethyl Ether, and Monocyclic Terpene Hydrocarbons.

III. Analysis

EPA Perspective

The Regional Attorney and Case Officer knew that the Company was considering the elimination of Freon for cleaning, at both the subject facility and at the second plant, but they considered the environmental benefit to outweigh concerns of it being a good business practice.

Company Perspective

Prior to EPA's complaint, the Company recognized that they needed to reduce or eliminate their freon use; they were spending \$150-\$180,000 per year on freon. During the negotiation process, they began to investigate alternatives to freon by sending parts to several aqueous and semi-aqueous degreasing system manufacturers. Only one vendor, the one ultimately chosen, responded with good results. The company proposed the Freon elimination system to the agency as a SEP.

Through the SEP, the Company has completely eliminated their freon use. The project had an 8 month payback period and the Company estimates that it has saved them between \$300-\$400,000 over the past four years.

The SEP did not accelerate the process of implementing the aqueous degreasing system. The Company would have implemented the project, on roughly the same schedule, without the SEP.

The Company considers the project a benefit to workers because they no longer have to breath freon vapors. While the state environmental agency stated that the Company could discharge the spent aqueous cleaner to the POTW, the Company has chosen not

to. Rather, they dispose of spent cleaner as hazardous waste, generating approximately 5 barrels per year.

The Facilities Manager feels that EPA should better inform companies of their obligations under environmental regulatory programs and educate companies on how to come into compliance. He suggested that EPA publish concise notices of upcoming compliance deadlines in trade journals. The Manager reads environmental and occupational reporters but still finds it difficult to keep abreast of the numerous environmental and occupational safety and health regulatory requirements.

The Company was recognized by the Regional Office of EPA for eliminating their use of Freon in cleaning processes. The Regional Administrator and the State environmental agency head toured the subject facility. The Company publicized EPA's commendation in their newsletter.

Analysis

The environmental benefits associated with the project is the elimination of the use of Freon 113, an ozone depleting chemical, at two plants--the subject facility and another facility in another state and EPA Region. While the Company agreed to a 66% reduction in Freon, the project resulted in the complete elimination.

According to the Company and the Regional negotiators, the Company would have implemented the project even without the SEP. Given the very favorable economic return, it was certainly in the Company's best interest to do so. However, their agreement to include the project as an SEP might have expedited their implementation.

According to the Material Safety Data Sheets (MSDS), the cleaning agent contains: 1-T-Butoxy-2-Propanol, Dipropylene Glycol Monoethyl Ether, and Monocyclic Terpene Hydrocarbons. While animal studies conducted by NIOSH has found that certain glycol ethers¹ are fetotoxicants, such evidence has not been found for Dipropylene Glycol Monoethyl Ether. Monocyclic terpene hydrocarbons are a class of plant-based materials which many companies are turning to as an alternative to chlorinated solvents. Results of manufacturer's studies of health effects associated with the use of semi-aqueous cleaners suggest that the risks are low. EPA has not fully studied these materials. Limited testing of a terpene called d-limonene has shown positive carcinogenicity in male rats. The strong odor of terpenes may be offensive to workers, requiring adequate ventilation.²

¹ Ethylene glycol monomethyl ether (EGME), ethylene glycol monoethyl ether (EGEE) and their acetates. Based on evidence of fetotoxicity in animals, for these glycol ethers, OSHA has proposed a downward revision in the TLV for certain glycol ethers from 100 to 0.1 ppm.

² U.S. Environmental Protection Agency. "Guide to Clean Technology: Alternatives to Chlorinated Solvents for Cleaning and Degreasing." July, 1992.

BLEACHED KRAFT PULP MILL

I. Case Overview

Violation (Law and Date): CWA, violation of NPDES permit's effluent limits for chronic toxicity and narrative standards protecting recreational users of receiving waters. Complaint issued in September 1989.

Date of Consent Decree and Order: July 1991, modified in September 1992

Description of Company: The subject facility is a manufacturer of bleached kraft pulp from woodchips.

In July 1991, the Company entered into a Consent Decree with EPA and a citizen's group to come into compliance with chronic toxicity limits under the Clean Water Act and to minimize potential impacts of effluent on recreational users. The Consent Decree required the Mill to:

- (a) construct an outfall extension pipe capable of ensuring that the surf zone will be essentially free of mill effluent;
- (b) study and propose to EPA (by a date certain) an effective outfall pipe length;
- (c) study the effectiveness of a range of potential remedial measures (including effluent treatment systems and in-plant process changes) that could achieve compliance with chronic toxicity limits¹; and
- (d) propose to EPA (by a date certain) a remedial measure(s) to bring the Mill into compliance with chronic toxicity limits.

The mill conducted a variety of effluent treatability studies, trials involving different levels of chlorine dioxide substitution and use of hydrogen peroxide, and five full-scale trials of totally chlorine-free (TCF) bleaching. The mill assessed the environmental benefits (e.g., chronic toxicity, dioxin levels and AOX²; and effluent color), pulp quality, and production cost differentials during each trial. Based on information generated during treatability studies and bleaching trials, chose to propose the TCF pollution prevention project highlighted here. This remedial measure, as well as the construction of an extended outfall pipe and a system for steam stripping of condensate

¹ The Consent Decree stated that the Mill "shall, at minimum, evaluate the following wastewater treatments: biological treatment, chemical coagulation and precipitation, ultrafiltration, carbon adsorption, steam stripping [of condensates from the kraft recovery system], chemical oxidation, ozonation, enhanced oxidation using ozone and hydrogen peroxide, and enhanced photooxidation using ultraviolet light and hydrogen peroxide."

² A measure of chlorinated organic compounds.

from digesters and black liquor recovery system³ was agreed upon, in a second Consent Order (signed by company in September 1992), as the means by which the Mill would come into compliance with the chronic toxicity limit established in the Clean Water Act and improve surf zone water quality for recreational use.

Date of Project Completion: Scheduled for September 1995

Pollution Prevention Project Costs: not available

Original/Final Penalty: no change

II. Description of Injunctive Relief Pollution Prevention Project

The Pollution Prevention Project consists of the total elimination of chlorine in pulp bleaching (referred to as totally chlorine-free (TCF). The Mill will eliminate their use of both elemental chlorine and chlorine dioxide and substitute other process steps.

The existing bleaching operation consists of the following steps:

1. oxygen delignification;
2. exposure to chlorine and chlorine dioxide;
3. lignin extraction with sodium hydroxide, hydrogen peroxide, and oxygen;
4. exposure to chlorine dioxide;
5. lignin extraction with sodium hydroxide and hydrogen peroxide; and
6. final exposure to chlorine dioxide.

The mill will make the following modifications to its processes to switch to TCF bleaching:

1. addition of anthraquinone to the digester to increase lignin removal in digestion;
2. substitution of the chlorine and chlorine dioxide step (2 above) with a chelant step to bind metal ions that would otherwise impair hydrogen peroxide activity;
3. substitution of the chlorine dioxide step (4 above) with an alkaline hydrogen peroxide bleaching step;
4. Replacement of the second extraction stage (5 above) with a second alkaline hydrogen peroxide bleaching step;

³ Condensates contain toxic materials that, in part, end up in discharged effluents. Steam stripping removes most of these materials for wastewater streams.

5. substitution of the final chlorine dioxide stage (6 above) with a third alkaline hydrogen peroxide bleaching step;
6. addition of a sodium bisulfite stage to neutralize the remaining peroxide and stabilize the pulp pH.

In the new process, the pulp will be bleached with hydrogen peroxide and oxygen, rather than chlorine and chlorine dioxide. The Mill's conversion to chlorine-free bleaching will also include the re-routing of bleach plant wastewater from the sewer to the oxygen delignification system and ultimately to the black liquor recovery cycle and incineration in the recovery boiler⁴. As a result, the organic materials (BOD) in the bleach plant effluent will be removed from the wastewater stream and burned for energy in the recovery boiler.

The conversion requires the construction of new chemical storage tanks and replacement of certain equipment such as pumps, chemical mixers, piping and possibly corrosion-resistant linings in retention towers (to handle different bleaching chemicals).

III. Analysis

EPA Perspective

The Mill's proposal to convert to TCF pulping came after a lengthy, adversarial negotiation process with region and DOJ negotiators. The Mill made the initial proposal to headquarter's Pulp and Paper Cluster, and not to the regional negotiators, because the Mill thought that the cluster would be more favorably disposed to this non-conventional strategy (given the adversarial relationship between the Mill and the Region). The Mill's initial proposal included conversion to TCF pulping, a one year compliance extension, and the elimination of requirements for the construction of an extended outfall pipe and any other remedial measures.

The region viewed the TCF conversion as an option that offered certain important benefits, such as the elimination of dioxin and furan (that appeared to be bioaccumulating in local marine populations) and a dramatic improvement in receiving water discoloration stemming from effluent discharge. It was not clear, however, from TCF trial runs that TCF alone would solve the chronic toxicity violations and adverse impacts on recreational uses--the primary bases for the enforcement action. Moreover, while the environmental benefits of reducing chlorinated organics in the Mill's effluent were clear--from a regulatory and legal standpoint--the chronic toxicity violations arguably more significant given that the Mill did not have an effluent limit for dioxin or

⁴ Wastewater from oxygen delignification is recycled to the brown stock washers. Wastewater from the brown stock washers is recycled to the pulp digester. Spent chemicals from the pulp digester are sent to the black liquor recovery system.

furan (and therefore was not in violation of such a limit). The Region had more evidence that the end-of-pipe treatment options, studied pursuant to the first Consent Decree, would bring the Mill into compliance with its chronic toxicity limit, compared to the available evidence for the TCF option. Finally, the Region was concerned about allowing the Mill to have an additional year to come into compliance with the Clean Water Act.

Despite these concerns, the Region accepted the Mill's proposal for two reasons. First, the Region viewed the Mill's demonstration that the TCF process is a feasible alternative to the use of chlorine bleaching to produce bleached pulp as a very important national precedent. Second, the Mill agreed to additional measures that increased the chances that the TCF process would bring the Mill into full compliance with the Clean Water Act. Specifically, the Mill agreed to include steam stripping of condensates and to extend its ocean outfall pipe. The former removes "pre-bleaching" toxic material from wastewater and substantially reduces surf-zone odor; the latter improves the quality of surf zone waters where recreation occurs by removing effluent from the area and increasing effluent dilution. Furthermore, the Mill agreed to conduct an additional toxicity reduction evaluation if these measures alone proved insufficient to bring them into full compliance with its chronic toxicity limits. Given these additional measures, the Region accept the TCF process, despite the fact that there was some uncertainty as to whether the TCF alternative would be as effective as conventional end-of-pipe treatment methods.

Region negotiators believe that the Mill proposed the TCF project knowing that they were going to have to reduce dioxin emissions under forthcoming CWA 304C regulations. By switching to TCF pulping, the Mill will not have to build a secondary treatment system in order to meet the performance standards established in the Consent Decree. Furthermore, they believe that the eventual outcome of the case was unaffected by the involvement of the Pulp and Paper Cluster (except that this extra step might have delayed the final settlement). None of the Cluster members were involved in settlement negotiations.

When the Mill proposed the TCF project, the Case Officer consulted with EPA's pulp and paper technical expert.

Company Perspective

Background:

In 1980, the Mill began to recognize that there were opportunities for improving the efficiency of their operations. They began to evaluate their brown stock washing system and realized that washing efficiency had an effect downstream in the bleach plant and ultimately in the wastewater. Furthermore, operations upstream of the washers--chip pile operation and pulp digesting--affected washing operations. Through

the 1980's, the Company made several significant process changes to increase delignification prior to the bleach plant, thereby reducing bleaching chemical and energy consumption as well as reducing the BOD⁵ load to the receiving waters of the Pacific Ocean. This included many changes to the digester, screening room, and, in the late 1980's, the installation of an oxygen delignification system and the elimination of the hypochlorite bleaching stage.⁶

The Mill does not have secondary treatment. While secondary treatment of pulp mill effluent is effective for reducing effluent BOD, these systems are not effective for reducing effluent color or chlorinated organic material, and secondary treatment creates significant quantities of solid waste (activated sludge), foam, odor and fog. In addition, secondary treatment systems require large tracts of land (except for high efficiency plants which produce more solid waste). In general secondary treatment seemed like "transplanted technology" that was not an appropriate solution to the problem of pulp mill effluent; the Mill thought that they could be more successful by attacking the problem within the plant. This idea had been suggested, in the late 1970's, by a consulting engineer who thought that the best way to operate a secondary treatment plant is to minimize the quantity of material that is put into it. The Mill tried to use this advice to make changes in the plant so that if the ultimate decision or need was to install secondary treatment, they would have significantly reduced pollutant loading to the treatment plant. As the Mill began to make changes in the plant, management began to see more and more opportunities for improvement.

Pollution Prevention Project

When considering how to meet the wastewater toxicity limits in the Consent Decree, the Company initially considered changes that were common to the industry such as wastewater treatment techniques and greater ClO₂ and hydrogen peroxide substitution. The Company also evaluated non-traditional technologies such as: coagulation/precipitation; ultrafiltration; catalyzed ultraviolet light treatment and other technologies. They subsequently realized that the elimination of chlorine and recycling of bleach plant effluent (i.e., recovering it in the black liquor recovery system) was the best approach to substantially reduce environmental impacts and to meet the requirements of the Consent Decree. From the Mill's standpoint, the advantages of eliminating chlorine were improvements in environmental quality, occupational health and safety, public health and "psychological comfort". This strategy results in

⁵ Biochemical oxygen demand. A measure of the organic content of effluent, and an indication of the oxygen depleting impact of the effluent on the receiving waters.

⁶ By installing oxygen delignification and eliminating hypochlorite, the Mill reduced their chloroform emissions by approximately 60%. The Company exceeded their emissions reduction commitment under the 33/50 Program ahead of the program schedule.

maximum reductions in chlorinated organic compounds, color, foam, and contact irritation for a wide array of Mill constituencies: beach walkers, surfers, kayakers, and anglers.⁷

When the Mill conceived of the TCF project, it was not immediately apparent that worker benefits would be significant. During the first trial they realized that the Mill was a more hospitable place without the use of chlorine and chlorine dioxide. This translates into worker health and safety improvements (e.g., eliminating the occasional acute hazard of inhalation of high concentrations of chlorine and chlorinated byproducts) and reduced public health hazards associated with the elimination of chlorine transport and storage.

The Mill will benefit economically from TCF pulping through savings in such things as: worker safety training and safety equipment purchases (e.g., self-contained breathing apparatus), expensive metals needed to provide resistance to the corrosive properties of chlorine), expensive corrosion-resistant plastic, and paint films (chlorine is inhospitable to paint).

The Mill was particularly well-suited for a transformation to TCF pulping: they had already implemented oxygen delignification, their Kaymr digester is relatively well suited to the wood they use, they have a new and oversized recovery boiler (which enables them to recover their bleach plant effluent), and they have highly efficient black liquor concentrators. This Mill was a "natural" candidate for this change over; other mills may be less well suited.

The Mill has moved from the "trial" to "production run" stage and considers the TCF product fairly well developed. During a recent two-week run, the Mill saw improvements in operating costs, but it is still more expensive to product TCF pulp than the normal chlorine bleached product.

A key factor in considering chlorine elimination was market demand for TCF pulp. The mill is not able to achieve maximum pulp brightness, as seems to be required by a large share of the bleached kraft pulp market. In some U.S. markets, in Germany, and in other parts of the world, TCF pulps are in demand because of the environmental concerns associated with chlorine bleaching. The Mill has not fully developed a marketing strategy. They have located end-users for whom chlorine use or chlorine

⁷ Steam stripping of wastewater streams that originate from the pulp digestion and black liquor recovery processes--another component of the Consent Decree--will result in reductions in wastewater odor and toxicity. Reduced sulfur compounds and methanol stripped out of the wastewater, will become part of a non-condensable incineration network. Energy will be recovered from the Methanol fraction and a portion of the sulfur will be recovered and reused in the process.

content in the final product is a concern. They are promoting the use of TCF pulp to governmental and institutional purchasing agents.

Negotiation Process

The Regional Office granted the Company one additional year to come into compliance with a specific toxicity test. As part of an effluent improvement project, the Mill chose to propose the TCF project to members of the Pulp and Paper Cluster at EPA in Washington. They found that this group was interested in this technology and both understood and were supportive of the Mill's proposal.

The implementation of TCF technology was to be complete in 3 years. The Mill was satisfied with the implementation schedule; however, in retrospect, they would like to have had more time in light of the delays that have resulted in the getting necessary permits. The Mill required DOJ and the Region, on a number of occasions, to intervene/speed up the permitting processes in order for the Mill to meet their injunctive relief implementation deadlines. DOJ and the Region was instrumental in removing permitting roadblocks. Part of the problem was in the lack of integration of Federal air and water permitting processes which had different procedures and requirements (i.e., lack of coordination among many of the Federal, State, Regional, and Local agencies governing air, water, wildlife, etc.).

The Mill believes that the Region recognizes the "magnitude" of the changes that they are making. The Case Officer was quoted in a journal article saying that "we applaud them for boldly going where no mill has gone before", and "this was an aggressive solution on their part and we realize that they are taking a huge business risk by revamping their process and product line".

Two factors are primarily responsible for the successful inclusion of the TCF project in the settlement: The Mill's ability to win approval for the TCF project as facilitated by the interest of the previous and current EPA Administration's interest in pollution prevention, and the culture of innovation and risk taking in the Corporation as well as Board of Director's support for the project.

Organizational Change

As a result of this experience, the Company has changed the way it approaches regulatory matters. Although they have traditionally involved technical personnel early in the process, they will seek to involve these personnel in initial discussions with Regulatory Agencies and bring attorneys in later on in the process. In this way, the Company believes that they can have more productive discussions about the technical aspects of the project and then negotiate a final agreement.

The Regional Office of EPA recently conducted a Chemical Safety Audit; they reviewed and made recommendations on process chemical and hazardous material

handling. The Mill thought that the auditors were very knowledgeable and provided useful information to the Mill.

Analysis

From the Mill's viewpoint, the support of the Pulp and Paper Cluster in Headquarters was the key aspect of the negotiation process that led to the Region's acceptance of the TCF project. One Region representative views this as the least important factor; in fact, this was seen as a settlement delay. It appears that the ability to reach an agreement involving both the TCF conversion and the outfall pipe and steam stripping system gave the region negotiators sufficient confidence that the benefits of the TCF project could be realized with greater assurance of meeting the objectives of the enforcement action (i.e., achieving the chronic toxicity limits and improving water quality for recreational use).

According to one Regional negotiator, neither the EPA Regional negotiating staff, DOJ staff, nor the EPA staff and managers in Headquarters who negotiated or approved the BKPM settlement made any reference to the Pollution Prevention in Enforcement Policy during briefings and deliberations concerning the settlement. From the Region's perspective, the Policy at that time was not widely publicized nor routinely considered in enforcement settlements (at least one regional negotiator was unaware of the existence of the Policy).

The Region sought technical assistance from the Agency's pulp and paper expert in Region 10. The Company did not think the Region had sufficient understanding of pulping technology; this appears to be part of the reason why the Company proposed the TCF project to Headquarters rather than the Region. A Regional representative disagreed with this assertion.