



Encouraging The Use Of Pollution Prevention In Enforcement Settlements

A Handbook For EPA Regions



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ENCOURAGING THE USE OF
POLLUTION PREVENTION IN ENFORCEMENT SETTLEMENTS:
A HANDBOOK FOR EPA REGIONS

I PURPOSE AND ORGANIZATION OF THE HANDBOOK

The purpose of this handbook is to motivate interested agency personnel to broaden the use of, pollution prevention as the means of correcting violations (i.e., injunctive relief) and as Supplementary Environmental Projects (SEPs), i.e., pollution prevention in exchange for some degree of penalty reduction.

This handbook follows a study¹ conducted by the authors of the role of, and opportunities for, the use of pollution prevention in the agency's enforcement programs. The primary objective of the study was to evaluate the inclusion of pollution prevention in selected enforcement settlements. Ten specific settlements--negotiated by the EPA regions before or during FY 1992--were analyzed.²

This handbook is organized into five sections. In Section II we review the concepts of pollution prevention, technology innovation, and diffusion. Section III contains a discussion of the role of pollution prevention in the agency's enforcement program. Section IV contains suggested approaches for recognizing and creating the potential for pollution prevention in firms. Section V presents strategies that can facilitate the inclusion of pollution prevention conditions as injunctive relief or as SEPs. Finally, in Appendix A we present a summary of ten case studies of enforcement settlements containing pollution prevention conditions, case study commentary and analysis.

¹ Becker, M.M., and Ashford, N.A., "Recent Experience in Encouraging the Use of Pollution Prevention in Enforcement." Prepared for the Office of Enforcement, U.S. Environmental Protection Agency, February 1994.

² Summaries and analysis of the case studies are presented in Appendix A of this handbook. The full case studies can be found in the full report cited in footnote 1.

II POLLUTION PREVENTION, TECHNOLOGY INNOVATION AND DIFFUSION

A. POLLUTION PREVENTION

Pollution prevention, according to the Pollution Prevention Act of 1990, is:

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.

While pollution can often be prevented by changing operating practices, the focus of this handbook is on pollution prevention through technological change involving one or more of the following activities: materials substitution, product reformulation, and process modification. Based on the above definition, Figure 1 presents the possible locations of technological change for pollution prevention.

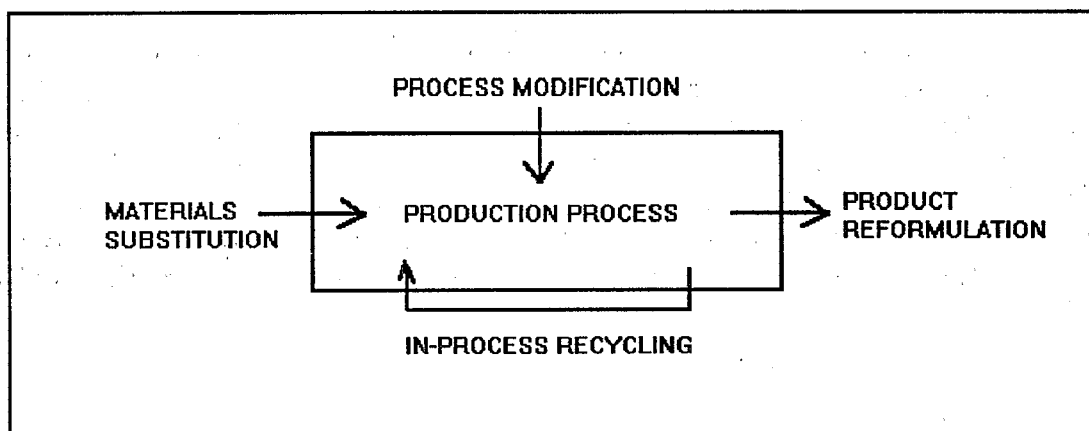


Figure 2-1. Locations of Technological Change for Pollution Prevention.

B. 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 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 accessibility of technical information and assistance (e.g., through consultants and equipment vendors) is a critical factor in diffusing pollution prevention technology, particularly where small and medium-sized firms are concerned. In contrast to technological innovation (described below), as a general rule diffusion of pollution prevention technologies requires little structural or cultural change in the firm.

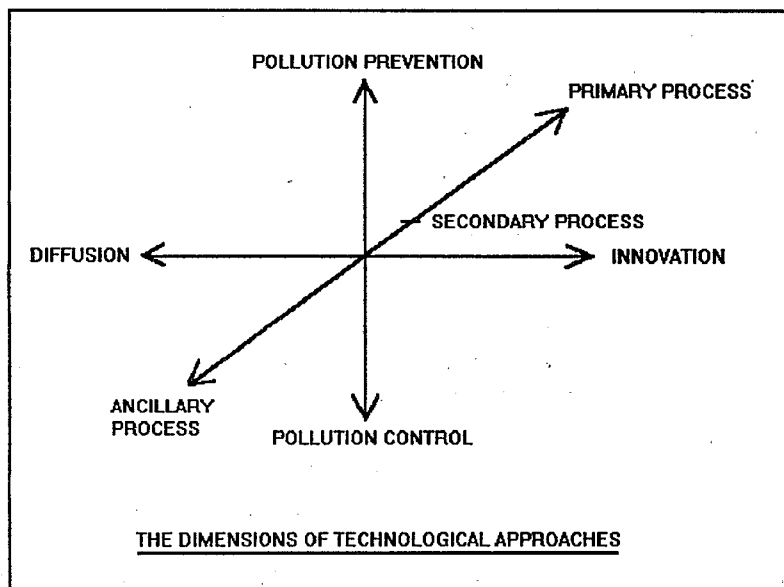
C. TECHNOLOGY INNOVATION

Innovation is the first commercial exploitation of a new invention and can be categorized in various ways.³ *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. Still another dimension--*primary* versus *secondary* versus *ancillary process change*--addresses the locus of the technical change within the manufacturing process. A primary process is one which yields the key functional property(s) of the product (e.g., metal casting in the case of a steel bolt); ancillary processes are, for example, cleaning, degreasing, and defluxing operations. 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.

Technological innovation is considered by many to be an important force in inducing economic growth by increasing productivity, opening up new markets, and helping to create new firms and jobs. 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.

³ For further reading on this subject, see: Ashford, N.A., "Understanding Technological Responses of Industrial Firms to Environmental Problems: Implications for Government Policy," in Environmental Strategies for Industry: International Perspectives on Research Needs and Policy Implications, K. Fischer and J. Schot (eds.), Washington, DC: Island Press, 1993; Ashford, N.A., Ayers, C., and Stone, R.F., "Using Regulation to Change the Market for Innovation," Harvard Environmental Law Review, Vol. 9, No. 2, Summer 1985, pp. 419-466; and Ashford, N.A. and Heaton, G.R., "Regulation and Technological Innovation in the Chemical Industry," Law and Contemporary Problems, Duke University School of Law, Vol. 46, No. 3, Summer 1983, pp. 109-157.

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.⁴ 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 is 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 "environmentally cleaner" substitute products and processes. Examples of these two types of innovative pollution prevention activities are found in the case studies. 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.

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 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.

⁴ Ashford N.A., Heaton, G.A., "Regulation and Technological Innovation in the Chemical Industry," in Law and Contemporary Problems, Vol. 46, No. 3., 1983.

The willingness and capacity of the firm to undertake pollution prevention innovation can be affected by factors internal and external to the firm. Several factors, taken from the innovation literature, are highlighted here.⁵

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, 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.⁶ The "rigidity" of the mature firm's technology can beget a corporate structure and attitude that can act as another barrier to technical change.

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

Factors Internal to the Firm Affecting the Potential for Pollution Prevention Innovation:

- Maturity of the firm and industry
- Size of the firm
- Economic position of the firm and industry
- Markets for new processes and products

⁵ OECD, "Environmental Policy and Technical Change," Paris, 1985.

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.

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 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

4. Markets for new processes and products. Innovation can be stimulated by the prospect of developing new technology or products for the market. The existence of a marketing capacity to exploit these opportunities is critical to the success of the innovation.

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 way⁹, has been found to stimulate innovative and efficient (with regards to energy and raw material costs) technological changes.¹⁰ 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.¹¹ 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 incentives 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

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). (OECD, 1985. op.cit.)

⁹ 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.)

¹⁰ OECD, 1985. op.cit..

¹¹ Karmali, 1990. op.cit..

firm to enter the market with a substitute product. 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.¹² Dow-Silicone replaced PCBs with silicone-based fluid which was developed originally for other purposes but recognized by Dow-Silicone as having suitable dielectric properties. Silicone has since become one of the principal transformer dielectrics on the market today. Figure 2-2 presents this model for regulation-induced technological change in schematic form.

Factors External to the Firm Affecting the Potential for Pollution Prevention Innovation:

- Regulation and liability
- Public and market pressure
- Technical expertise

2 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.

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.¹³

¹² 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.

¹³ OECD, 1985. op.cit..

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.

3. Technical expertise. Technical change for both main business and environmental purposes requires that the "problem space" of the engineer and scientist expand to include environmental concerns along with performance and cost considerations.¹⁴ 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.

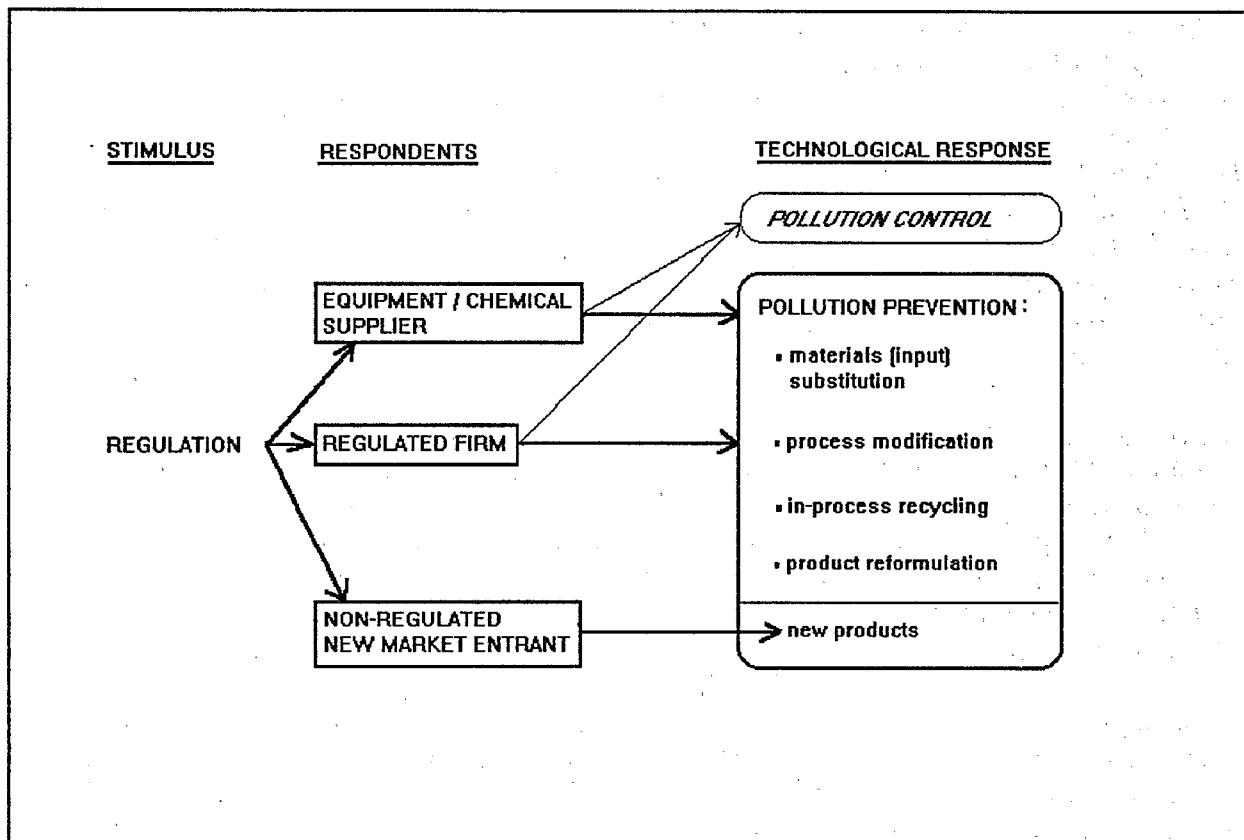


Figure 2-2. A Model of Regulation-Induced Technological Change

¹⁴ In an analogous fashion, managers must be held accountable for environmental performance as well as product quality and production cost.

III THE ROLE OF POLLUTION PREVENTION IN ENFORCEMENT

Pollution prevention is one of the major priorities of the United States Environmental Protection Agency (EPA). In June 1989, the Office of Enforcement issued its Pollution Prevention Strategy. The strategy identified several methods by which enforcement could be used to promote the agency's pollution prevention goals. The primary tool is through the settlement process. While the agency has relatively little statutory or regulatory authority to *require* violators to implement pollution prevention technology, the settlement process provides a mutual opportunity for both the agency's negotiators and the violators to consider pollution prevention as part of the overall settlement process.

By 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 (called the "Pollution Prevention Enforcement Policy" and "SEP Policy", respectively, for short). 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.

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 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--within the context of enforcement. Pollution prevention knowledge and skill--gained by agency negotiators--can help 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.

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 (e.g., 33/50 chemicals) that have been assigned top priority for risk reduction, and/or where no or few cleaner technological alternatives are available. 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.

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.

* * *

Other Reports and Guidance 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. Our study has benefitted greatly from, and builds on, this previous work.

In addition, we refer the reader to a November 1993 memo from the Region I Administrator's office that contains practical guidance on negotiating SEPs.

IV RECOGNIZING AND CREATING THE POTENTIAL FOR POLLUTION PREVENTION IN A FIRM: TECHNICAL AND ORGANIZATIONAL FACTORS

The success of the agency's efforts to include pollution prevention in an enforcement settlement is contingent upon the firm's *willingness* and *capacity* to change its production systems. This section addresses both technical and organizational factors that affect the willingness and capacity of the firm, and ways in which agency negotiators can help to create conditions that are favorable to pollution prevention injunctive relief and SEPs.

The success of the agency's efforts to include pollution prevention in an enforcement settlement is contingent upon the firm's *willingness* and *capacity* to change its production systems.

A. TECHNICAL FACTORS

1. Pollution Prevention Information, Knowledge and Expertise on the Part of the Firm

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, regulatory, and R&D resources and therefore are more likely than smaller companies to have prior knowledge of, and expertise in, pollution prevention. With respect to SEPs, larger companies may have one or more pollution prevention projects "in the wings" at the time of the violation, making the task of proposing an SEP to the agency negotiators somewhat simpler. For companies with little or no prior knowledge and experience in pollution prevention (typically smaller firms), 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 an SEP proposal that is acceptable to the regional negotiators, and instilling confidence in the agency that they are able to execute the project.

The process of encouraging a pollution prevention outcome within the firm could be facilitated by the involving so-called "change agents" and "technical gate-keepers" within the firm in the negotiation process. A change agent may be a technical or non-technical person that sees, and can champion, the

Technical Factors

- Pollution prevention information, knowledge and expertise on the part of the firm
- Consultants
- Potential to transfer technology within the company
- Potential for innovation

benefits of pollution prevention within the firm. A technical gate-keeper is an individual that effectively brings into the firm, and disseminates within the firm, the technical information needed [to change technology or] to fuel the research and development processes that are key to the creation and implementation of new technical ideas.¹⁵ Production line staff are often the source of important information on the sources of waste and ideas on how to reduce it; and union representatives are becoming increasingly aware of the sources of, and remedies for, environmental problems in industrial operations.

If the subject plant is one of several owned by the firm, other plants may be a source of ideas or pollution prevention technologies that can be transferred to the subject facility. Furthermore, if the plant is a subsidiary of a foreign corporation, the foreign owner may be a source of new manufacturing technologies.

2. The Role of the Consultant

Many firms, particularly smaller firms, choose to rely on outside technical consultants to supplement in-house technical capabilities. Outside consultants not only fill a need for additional technical expertise, as we heard in several company interviews, they also help to build confidence for the SEP proposal in the regional negotiators (whether the technical ideas originated from within the firm or the consultant). Therefore, some firms may face a barrier to SEP inclusion if they do not use a technical consultant.

The choice of consultant will, in part, determine the type of project proposed. If the company hires a consultant to assist in correcting a violation, it is likely that the consultant will be retained to develop a pollution prevention SEP proposal.¹⁶ 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.

With respect to injunctive relief, 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 from recommending that firms redesign their production processes or to switch to a new process chemical).¹⁷ 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

¹⁵ 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.

¹⁶ See Metal Filing Furniture Manufacturing (MFFM) and Casted Metal Products Manufacturer (CMPM) cases.

¹⁷ See the Casted Metal Products Manufacturer (CMPM) case.

system rather than cyanide elimination).¹⁸ Consulting departments/divisions of equipment vendors have great incentive to sell their equipment or chemicals and will tend to solve problems accordingly (see for example, the Metal Machining Company (MC) case).^{19 20}

Increasingly, environmental consulting firms are upgrading their services to include recommendations and design services for "off-the-shelf" waste minimization techniques; though the tailor-made changes that would be optimal for a given production situation are unlikely to be suggested from sources outside the firm. These changes are generally too risky for the average environmental consultant to recommend and undertake.

3. Potential to Transfer Technology Within the Company

Firms with more than one production line and/or plant often test a new technology on a single line and, if successful, transfer the technology to their other lines or plants.²¹ This strategy offers great potential to multiply the impact of a single pollution prevention project where the technical change implemented as an SEP or injunctive relief is made to one of several similar processes operated by the firm. While there is theoretical potential to license or sell new technologies to other firms, firms tend to regard their technologies as proprietary--giving them competitive advantage.

4. Potential for Innovation

Section II C contains an enumeration of several factors--internal and external to the firm--that affect its willingness and capacity to innovate. While these factors do not, and cannot, constitute hard-and-fast rules to determine the potential of a particular firm to innovate for pollution prevention, they can serve to illuminate favorable conditions. From the narrative in Section II C, the presence of the following factors may be indicative of a climate conducive to innovation:

¹⁸ Personal conversation with Daryl Beardsly, pollution prevention consultant, August 4, 1993.

¹⁹ 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.

²⁰ 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.

²¹ This was evident in several of the case studies, notably Lid Manufacturer, Medical Device Manufacturer, and Metal Machining Company.

- production units that are relatively small-scale and flexible, as opposed to large-scale, highly automated, mass production systems
- production units that produce a diverse and constantly changing array of products
- firms that have engineering and R&D departments
- firms that have significant positive cash flow
- firms that are expanding, or are part of a growing industry
- firms that have a prospect of developing new technology or products for the market, and marketing capacity to exploit these opportunities
- firms anticipating stringent future environmental and/or occupational safety and health regulation
- firms experiencing public and/or market pressure to reduce the environmental and/or public health impacts of their processes or products

5. Fear of Technical Failure

When considering technology options for injunctive relief, the firm has great incentive to pick a 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.

Fear of technical failure is also a consideration in the context of an SEP; if the SEP fails, the company may have to pay the mitigated portion of the penalty in addition to the administrative costs associated with SEP progress reporting and the project development and implementation costs.

B. ORGANIZATIONAL FACTORS

1. Support from Top-Level Decisionmakers

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. We found that 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. In competition with these two incentives is the 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) as well as the perceived risk of project failure. Therefore, the desire to mitigate the penalty plus the perceived value of the pollution prevention project will have to outweigh the desire for a quick settlement plus perceived risk.

With regard to pollution prevention injunctive relief, the preceding narrative on the firm's fear of technical failure is relevant here as well.

Beyond conferring approval for the project, the commitment and involvement of top-level firm decisionmakers in choosing and implementing a pollution prevention course can improve the prospects of success for the project itself (by ensuring a steady commitment of resources and high priority status), facilitate top-level learning about the merits of pollution prevention, and promote organizational change toward a more environmentally responsible company. Numerous business executives and studies have stressed the importance of top-level commitment to the success of corporate environmental initiatives.²²

Organizational Factors

- Support from top-level decisionmakers
- The firm's legal counsel
- Economic considerations

2. The Role of the Firm's Legal Counsel

Many of the case studies demonstrated the importance of the role of the firm's legal counsel in negotiating pollution prevention SEPs, specifically with regard to helping to establish implementation schedules, milestones, and stipulated penalties. The cases suggest that attorneys with experience in environmental settlements, and, more specifically, with experience in negotiating SEPs may facilitate the inclusion of pollution prevention SEPs, particularly where the nature of the technological change or the firm requires complex settlement terms.

3. Economic Considerations

Pollution prevention investments often carry with them both "hard" economic benefits (e.g., material, energy, water, and waste disposal cost reductions) and "softer" economic benefits (e.g., improved future compliance/liability position, improved rapport with agency, public image, etc.). So-called hard economic benefits are directly linked to investment choices and are quantifiable; whereas softer benefits are less direct, difficult to trace and to quantify (e.g.,

²² See, for example, Schmidheiny, S. with the Business Council for Sustainable Development, "Changing Course: A Global Business Perspective on Development and the Environment." Cambridge: MIT Press, 1992.

longer-term benefits such as avoided future liability). Firms are motivated by both types of economic factors in making investment decisions, to different degrees and in different fashions. For example, harder costs are typically quantified and included in the calculation of profitability indicators (e.g., payback and return-on-investment (ROI)); softer costs are considered qualitatively and not included in profitability calculations. For smaller firms, with shorter planning horizons, hard cost factors tend to drive investment decisions.²³

With respect to SEPs, 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 see little financial incentive to implement a pollution prevention SEP or may have difficulty raising the necessary capital (particularly in the case of small firms). In these cases, it is especially important that the firm be cognizant of the indirect [softer] economic and other benefits that can accrue from undertaking pollution prevention. These benefits may well be more significant than the more direct economic savings.²⁴

²³ For further reading on the subject of financial analysis of pollution prevention investments, see: 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.

²⁴ None of the case study firms faced these barrier as such; however, several 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. The full report suggested that agency negotiators should be less generous with penalty mitigation when economic benefits of the project are direct and quantifiable, and more generous where benefits are indirect and difficult to estimate.

V ELEMENTS OF A SUCCESSFUL NEGOTIATION PROCESS AND SETTLEMENT

This section covers a number of elements that emerged from the case studies (and other research) as important determinants of success, both in realizing opportunities for pollution prevention in SEP and injunctive relief negotiations, as well as in crafting the terms of the settlement. The elements are organized into three sections: elements relevant for both pollution prevention injunctive relief and SEPs; elements particularly relevant to SEPs; and finally, elements particularly relevant to injunctive relief.

A. ELEMENTS RELEVANT TO BOTH INJUNCTIVE RELIEF AND SEPS

1. 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.

Elements Relevant to Both Injunctive Relief and SEPs

- The negotiation process design and structure
- Information
- Timing and time allowed for pollution prevention responses
- Project monitoring

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

and could be encouraged where the new technology addresses a particularly problematic environmental problem and/or where few "cleaner" technology alternatives currently exist.

2. Provision of Information

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 agency policies.

The agency negotiators can also serve a useful role in steering those firms with little pollution prevention knowledge and expertise to sources of technical information. Furthermore, where the firm is seeking a technical consultant, the agency can suggest that the firm look for a consultant that has a proven record in facilitating pollution prevention for their client firms.

Ideally, industry should be provided with a handbook on pollution prevention in general, relevant portions of the agency's enforcement policy, sources of technical information and suggested guidelines for choosing a technical consultant.

3. 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 an 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.

4. Project Monitoring

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 conditions generally have more milestones than the usual settlements. Regions are beginning to implement Local Area Network-based computer tracking systems (e.g., Region 1) to follow compliance milestones--these systems can ease somewhat the additional monitoring burden associated with increased monitoring requirements.

5. Multi-media Approaches and Multi-Media Pay-offs

The adoption of pollution prevention technologies with *multi-media pay-offs* will be facilitated by a shift, wherever possible, from single-medium enforcement strategies to a *multimedia approach*. Through multi-media inspection, the firm may listen with a "number of ears" and be prompted to think of more comprehensive solutions to their pollution problems. 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.²⁵ 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.

B. ELEMENTS PARTICULAR TO SEPs

1. The Need for, and Use of, Pollution Prevention Knowledge and Expertise

There are five major activities within the pollution prevention SEP process where a case 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 an 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 seem 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.

Elements Particular to SEPs

- Pollution prevention knowledge and expertise:
 - a clear understanding of the concept and benefits of pollution prevention
 - a case officer's ability to ask exploratory questions that generate "pollution prevention thinking" on the part of the firm
 - a case officer's knowledge of pollution prevention techniques
- Technically difficult or risky projects
- Adequate incentives to firms without "giving away the store"

²⁵ EPA's "Multi-Media Screening Inspection Program Guidance and National Checklist" (May 1993) is a useful tool for planning, coordinating and conducting multi-media inspections.

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..

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. Using even a limited amount of information on the firm's technology--gathered during the inspection²⁶ 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.²⁷ 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.

Knowledge of specific pollution prevention techniques can be an asset in negotiating pollution prevention SEPs or, more likely, in 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, and closed-loop cooling. 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 should 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

²⁶ 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.

²⁷ 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. Forthcoming, 1994.

(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.

The case studies revealed that some firms are already well versed in pollution prevention, are technologically sophisticated/have retained a skillful pollution prevention technical consultant, and have 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 case study sample, were negotiated by case officers with little or no prior knowledge or experience in pollution prevention.²⁸ 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.

Pollution prevention technical expertise--either general or particularized--is gained primarily "by doing", by verbal information sharing/pooling among technical colleagues,²⁹ and can probably be supplemented by effective training. As more and more case officers have 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.

2. Technically difficult or risky projects

Technically difficult pollution prevention projects, projects that require R&D, and innovative 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. These projects may require longer implementation periods,³⁰ "creative" or somewhat flexible settlement terms,

²⁸ Industrial Coater, Metal Finishing Company, Medical Device Manufacturer and Bleached Kraft Pulp Manufacturer.

²⁹ 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.

³⁰ Implementation periods over a year are generally considered long.

and risk-taking and risk-sharing.³¹

Clearly, not all technically difficult projects should be accepted as SEPs. There are many concerns 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.)

3. Providing Adequate Incentives to Firms Without "Giving Away the Store"

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 willing to accord these benefits to the firm through penalty mitigation.

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).

C. ELEMENTS PARTICULAR TO INJUNCTIVE RELIEF

1. Achieving Compliance

Unlike SEPs, the question of whether pollution prevention is included in a settlement as

³¹ "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. In Section VII we suggest that this strategy requires the agency to take a "portfolio approach" to pollution prevention SEPs by allowing or expecting some technical failures, thereby encouraging some risk-taking as described here. 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.

injunctive relief is typically a question of whether pollution prevention will be used instead of pollution control to bring the company back into compliance. The stakes for the agency negotiators tend to be 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 technological response must have a low risk of failure and must 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 appears to have a higher risk of failure, or will take longer to effectuate, it will be perceived as a less desirable option. The Pollution Prevention in Enforcement Policy seeks to address this issue by "granting" 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.

2. 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. 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.

Elements Particular to Injunctive Relief

- The need to achieve compliance
- Pollution prevention knowledge and expertise: advantages over pollution control

VI CONCLUSION

The benefits of negotiating pollution in enforcement agreements are realized *directly* through changes in firm technology and associated environmental and human health benefits, as well as through many tangible and highly valuable *indirect* environmental, health, and economic benefits from: the transfer of SEP technology to other processes in the subject plant or to other plants owned by the firm; organizational changes that can lead 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, firms tend to see the opportunity to implement pollution prevention--either as an 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.

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 challenging environmental problems. Although the enforcement setting, with its adversarial backdrop and somewhat rigid legalistic framework, is a challenging setting within which to facilitate innovation, the cases demonstrate 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.

QUESTIONS TO GUIDE NEGOTIATION OF POLLUTION PREVENTION IN SEP'S AND INJUNCTIVE RELIEF CASES

There are a number of technical and organizational factors that affect a firm's willingness and capacity to adopt pollution prevention in an enforcement context. To assist agency negotiators in evaluating the potential for pollution prevention during the negotiation process, these factors have been reformulated into a series of questions. The questions are structured so that a positive response indicates potential for pollution prevention.

Evaluating Technical Factors:

- Q. Is pollution prevention likely to decrease the firm's costs of pollution control, save material, energy or water costs, or increase productivity?
- Q. Is the firm, its consultants, suppliers or other technical assistance providers familiar with the concept and techniques of pollution prevention?
- Q. Are the firm's consultants likely to recommend or entertain pollution prevention projects, if they are feasible and attractive?
- Q. Does the firm have one or more appropriate pollution prevention projects that it had considered prior to violation?
- Q. Are important "technical gate-keepers" (including the firm's engineering and R&D departments or consultants) and/or potential "change-agents" participating in the negotiation? If not, and they exist in the firm, can they be brought in?
- Q. Is the subject plant one of several owned by the firm or foreign-owned? Can the plant obtain information or technical assistance from other plants or its owner?
- Q. Is the pollution prevention project proposed likely to be transferred to other production lines or to another plant owned by the firm?
- Q. Is the firm in a good cash flow position, a promising or growing market, or dependent on innovation to prosper?
- Q. Is the firm's technology characterized by relatively small-scale and flexible production units rather than large-scale, highly automated, mass-production systems?

Evaluating Organizational Factors:

Q. Are senior-level officers/managers of the firm supportive of pollution prevention approaches and the opportunity to undertake the project in exchange for penalty mitigation or for other strategic reasons?

Q. Is the firm's legal counsel experienced in environmental matters? in negotiating SEPs?

Q. Is the firm willing to take technical risks?

Q. Are there indirect economic benefits (i.e., reducing current and/or future regulatory costs, potential future liability), as well as direct economic benefits that are highly valued by the firm?

Q. Is the firm concerned about their "environmental image"?

A set of organizational factors, concerning EPA regional offices, can enhance the ability of case officers and attorneys to successfully negotiate pollution prevention conditions. These factors are embodied in the next set of questions.

Evaluating Agency Factors:

Q. Are the case officer and attorney sufficiently knowledgeable about pollution prevention and negotiating pollution prevention settlements?

Q. Is the Regional Office philosophically supportive of these projects?

Q. Are the case officer and the attorney in agreement on the necessary elements for approving or encouraging a pollution prevention SEP or injunctive relief settlement?

Q. Have the case officer and attorney agreed upon their respective roles in encouraging such settlements?

Q. Is there potential for cooperation between the agency and the firm, i.e. is there a proper atmosphere for negotiating pollution prevention agreements?

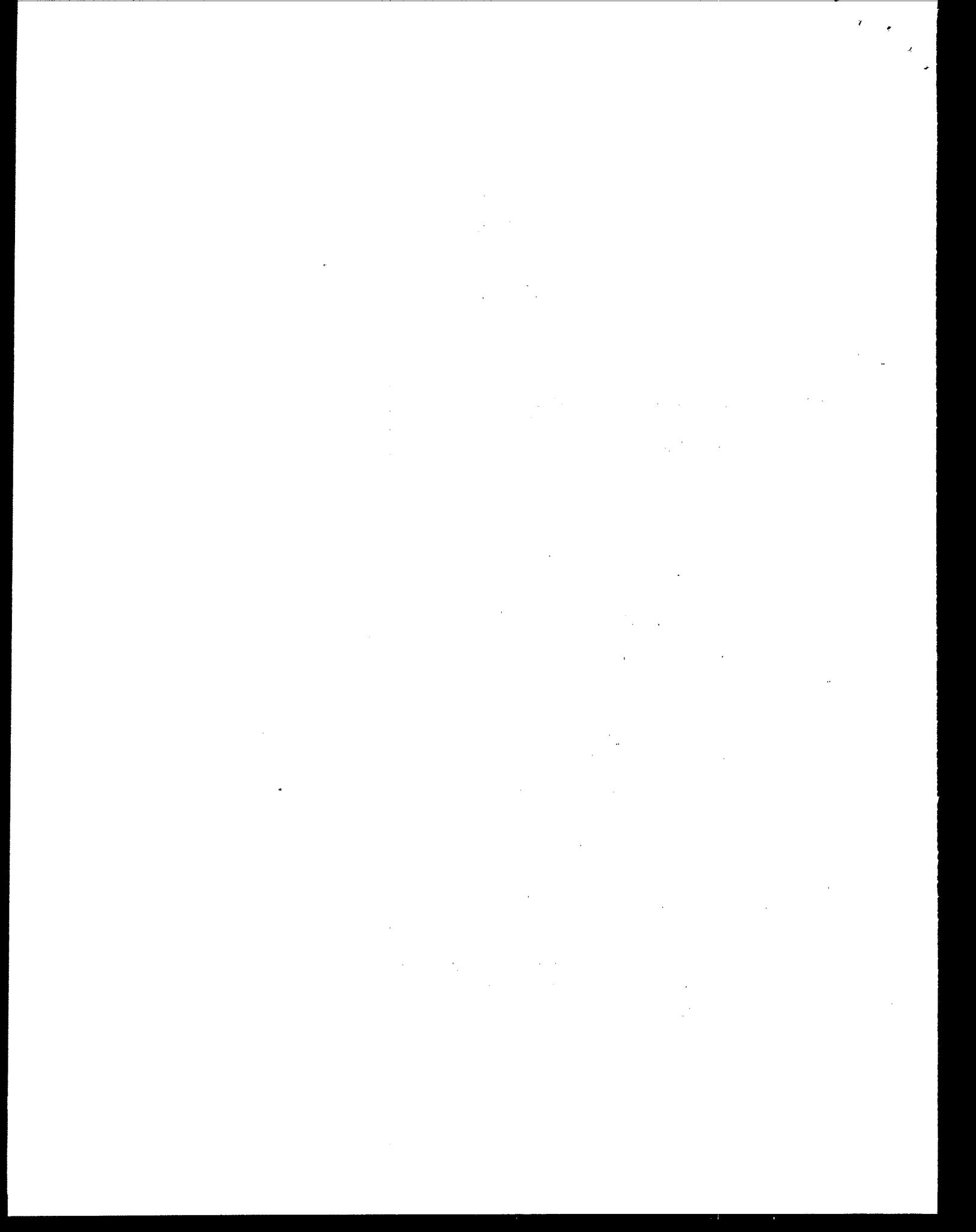
Q. Is the agency willing to dedicate resources to monitoring and shepherding the project?

Q. Has the idea of a pollution prevention project come up relatively early on in the negotiation process?

Q. Is the time allocated for the project to be completed realistic and acceptable to the agency?

Q. Is there appropriate "risk sharing" between the agency and the firm in case of technical failure?

Q. Has the agency provided reasonable incentives to the firm without "giving away the store" or compromising the deterrence effect of inspection?



APPENDIX A

CASE STUDY SUMMARIES AND ANALYSIS*

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)

* Note: Full case studies can be found in the report: Becker, M.M., Ashford, N.A., "Recent Experience in Encouraging the Use of Pollution Prevention in Enforcement." Prepared for the Office of Enforcement, U.S. EPA, May 1994.

APPENDIX A

CASE STUDY SUMMARIES AND ANALYSIS

This Appendix contains descriptions of ten case studies of pollution prevention in enforcement settlements, case study analysis and commentary. Subsections A and B present a tabular and text summary of the full cases, respectively. Subsection C contains case commentary and analysis. Finally, subsections D and E contain commentary on the impact of pollution prevention on the agency's enforcement programs and on the firms, respectively.

A. 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 A-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>	<u>Original Penalty</u>	<u>Final Penalty</u>	<u>Project Cost</u>	<u>Payback</u>
Casted Metal Products Manufacturer (CMPPM)	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	\$95,000	\$30,000	not available	5 to 8 yrs
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.	\$50,000	\$30,000	\$54,000	6 months to 2 years
Lid Manufacturer (LAM)	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.	\$123,947, reduced to \$76,000 for good faith	\$38,000 (\$38,000 reduction for SEP)	\$298,000	not available
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.	\$31,350	\$24,000	\$80,000	none yet (project stopped in original plant)
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.	\$360,000 (reduced to \$330,000 for good faith)	\$93,000	\$218,000	too early, but not promising

<u>Company</u>	<u>Environmental Benefits</u>	<u>Source of Technical Idea</u>	<u>Type of PP</u>	<u>Innovativeness of Change</u>	<u>Technology Transfer Benefit</u>	<u>Organizational Change</u>	<u>Change in Vendor/Consult Relations</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	EPA Regional Case Officer, and consultant and Company	Process modification and chemical substitution	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 prevention goals. They now have a multi-media view of environmental problems.	Company is no longer satisfied with consulting firm that uses traditional approaches to solving 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.	Company	Product reformulation and process modification	Incremental innovation, first commercial application of non/low-solvent technology in particular product niche	Potential to transfer to other product lines	none apparent	Company now uses state pollution prevention technical assistance office for technical advice.
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.	Company and technical consultant	Product reformulation and process modification	Incremental innovation, significant adaptation of existing technology	Potential to transfer to other three production lines	none apparent	Company was very pleased with their consultant who had knowledge of environmental regulations and manufacturing technology.
MDM	Elimination of the use of 16,000 lb/yr of Freon	Company learned about technology from trade journal	Process modification and chemical substitution	Existing technology, not widely diffused	Company will transfer system to another plant	none apparent	none apparent
MFFM	Project designed to reduce paint and solvent use, waste and emissions. Small success to date.	environmental consultant	Process modification	Existing, widely-diffused technology needing relatively minor adaptations	none apparent	SEP includes measures for organizational change, e.g., pollution prevention training.	Company has developed new and strong ties to an environmental consultant.

<u>Company</u>	<u>Sales/No. of Employ.</u>	<u>Violation</u>	<u>Description of PP Project</u>	<u>Original Penalty</u>	<u>Final Penalty</u>	<u>Project Cost</u>	<u>Payback</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	\$159,900	\$23,300	\$170,000	Net positive yearly cash flow of \$4,000 in the first year (see text)
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	\$76,000	\$11,400	\$201,000	Considered good by the Company
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	\$76,000	\$30,550	\$78,300.	5 to 7 years, savings of \$4,000 per month in energy costs
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	\$17,000	\$8,500	\$69,475	8 months, savings to date of \$3-400,000.

<u>Company</u>	<u>Environmental Benefits</u>	<u>Source of Technical Idea</u>	<u>Type of PP</u>	<u>Innovativeness of Change</u>	<u>Technology Transfer Benefit</u>	<u>Organizational Change</u>	<u>Change in Vendor/Consult Relations</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.	Company (nickel tank extension) and Vendor (trivalent chromium)	Nickel tank extension-product redesign, process modification; trichrome- and chemical substitution	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.	Since and now working with state pollution prevention technical assistance program
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.	Company/Equipment and Chemical Vendors	Process modification and chemical substitution	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 their increased capacity to find and evaluate technological alternatives, the Company has become less confident in consultants who are subsidiaries of chemical suppliers.
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.	Company (manufacturing personnel); Pollution prevention audit suggested by EPA Regional Attorney	Process modification and chemical substitution	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.	none apparent
PSSC	Elimination of the use of Freon 113, an ozone depleting chemical, at the subject facility and another facility in another state.	Company and Equipment/Chemical Vendors	Process modification and chemical substitution	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	none apparent

2. Injunctive Relief

<u>Company</u>	<u>Sales/No. of Employ.</u>	<u>Violation</u>	<u>Description of PP Project</u>	<u>Original Penalty</u>	<u>Final Penalty</u>	<u>Project Cost</u>	<u>Payback</u>
Bleached Kraft Pulp Manufacturer (BKPM)		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	\$2.9 million	same	not available	not available

<u>Company</u>	<u>Environmental Benefits</u>	<u>Source of Technical Idea</u>	<u>Type of PP</u>	<u>Innovativeness of Change</u>	<u>Technology Transfer Benefit</u>	<u>Organizational Change</u>	<u>Change in Vendor/Consult Relations</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	Company	Process modification and chemical substitution	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.	none apparent

B. A BRIEF TEXT DESCRIPTION OF INDIVIDUAL CASES

1. Supplemental Environmental Projects

a. *Casted Metal Products Manufacturer (CMPM)*

CMPM 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.

The company was cited with two violations under the Clean Water Act: failure to file a Baseline Monitoring Report (Section 403.12) and exceeding the chromium discharge limits and effluent pH. The company was originally fined \$95,000. In consideration of their willingness to include a SEP in their settlement, EPA reduced the fine to \$30,000.

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

Part I requires the company to:

- 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. Eliminate the use of perchloroethylene, Freon, and nitric acid in those processes discharging wastewater.
- H. Reduce the use of 1-1-1 trichloroethane and isopropyl alcohol to the extent possible.

Part II includes implementation of 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.
- 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.

Through process modifications, the company has reduced wastewater discharges by approximately 100,000 gallons per day (approximately 75% reduction) and 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

*Quantity of chemical 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, e.g., metal casting, acid and caustic cleaning, bluing, and phosphate coating.

The average payback period of all SEP projects implemented is 5 to 8 years. While the company's investment threshold 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.

The company was dissatisfied with their technical 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 ultimately realized was not needed. The consultant 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 for 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 not use them again.

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.

Many 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 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 and compliance officer.

Because the company did not initially have the capacity (i.e., mode of inquiry and knowledge of basic techniques), it was necessary for the EPA 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. 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--one full-time and three part-time.

b. Industrial Coater (IC)

Industrial Coater manufactures coated plastic film. In 1989, IC had projected sales of \$20 million 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.

In August 1989, EPA issued a complaint against the company stating that they had failed to file Form Rs for toluene and methyl ethyl ketone under EPCRA 313.

During the settlement process, the company proposed, and ultimately agreed to, implement a SEP consisting of the reformulation of a toluene-based coating to a low or non-organic solvent-based coating and alteration of the production process used to apply this coating to plastic film. The settlement requires the company to 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 in cleaning to production volume.

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 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 project will include the installation of two banks of high

intensity infrared heat lamps to flow the coating prior to curing, and to stabilize and dry the coating on the plastic web. 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 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 changes will enable them to reduce its use of methyl ethyl ketone in cleaning 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 3.7 million Btus per hour, of which approximately 525,000 Btus come from burning solvent and the balance (3.2 million 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). The CA/FO stipulated that the company shall expend not less than \$25,000 on the project. In consideration of the SEP, the penalty was reduced from \$50,000 to \$30,000.

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.

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; as a result they 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, and the time and

administrative pressures created by the SEP process. 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.

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 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.

Recently, 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 now use the state office for technical advice and a private consultant for compliance audits.

c. Lid Manufacturer (LM)

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.

The company applied coatings containing VOCs in excess of limitations set forth in the federal revisions to the State Implementation Plan under the Clean Air Act, Section 133d, and failed to certify to EPA that its coating lines would either be exempt or in compliance with SIP emissions limitations. The subject plant is located in a non-attainment area for VOCs. The complaint was issued in July 1992.

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 the 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 cost of the SEP, according to the company's October 1992 estimate was \$298,000, 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 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.

The original penalty of \$123,947 was reduced to \$76,000 for good faith and to \$38,000 for the SEP.

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 ensure 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.

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 tended to minimize toxic effects.¹ This may be a concern in the subject facility since the Plastisol gaskets are dried with heat.

Diethyl phthalate (DOP) is one of a number of commonly used organic plasticizers which has 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 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

d. Medical Device Manufacturer (MDM)

MDM 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.

MDM failed to file Form Rs for xylene, trichloroethane and trifluoroethane. They agreed to include a SEP in their settlement with the agency and, as a result, the agency lowered their penalty from \$31,350 to \$24,000.

The medical device manufactured in the subject plant is degreased and sterilized using freon. At the time of the agreement, the company used approximately 16,000 pounds of freon per year. For their SEP, 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 demonstrated 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.

¹ 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, page 551.

² *ibid*, page 547.

³ *Ibid*, page 549.

⁴ *Ibid*, page 438.

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 favorably regarded by the Division Head for its environmental rather than economic benefits.

The SEP stipulates that the company will incur no less than \$10,000 for engineering and testing of deionized water process machinery and not less than \$65,000 to purchase, install and calibrate machinery (unless they choose to discontinue production of products that use freon).

The company required 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 wait for FDA approval. This additional step made it difficult for the company and EPA to structure the agreement, and particularly to develop the implementation schedule. 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 (16 months), and structured in several steps, to allow for the FDA approval process.

The company undertook the second stage evaluation, as outlined in the SEP, and considered the new system to be a technical success. However, for two reasons they have chosen not to purchase the equipment and to pay the stipulated penalty. First, the subject facility is scheduled to close in February of 1994. The company is moving its operations to another plant. Second, the company is in a long and complex FDA product approval process and the submission of a request to modify their process at this time could jeopardize the entire approval.

MDM's engineering group has advanced 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.

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 future technology transfer benefits associated with this project.

e. Metal Filing Manufacturer (MFFM)

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 in October 1991, the company was cited for conducting this activity without a waste treatment permit.

The company agreed to a SEP which required them to investigate, and insofar as practicable implement several identified process changes in an amount not less than \$218,000. The company committed to, and ultimately implemented, the following: installation of an on-site solvent recycling system, installation of a baffle collection system for paint overspray in their electrostatic sprayer, installation of improved paint collection systems in paint bays and electrostatic sprayer to prevent overspray from collecting on floor, installation of paint drum agitators and pumps for nonstandard color paint transfer, improvement of spray efficiency of the electrostatic sprayer and hand held spray guns, and continuous training of painters and operators in efficient painting techniques.

As agreed to in the SEP, the company instituted several administrative measures, including: development of a pollution prevention policy, promotion of plant engineer to vice president for manufacturing and environmental quality to carry out the pollution prevention policy and Program, training of all plant employees on pollution prevention strategies and opportunities for waste reduction, attendance by management personnel at pollution prevention seminars for the industry, development of an inventory control system, improve the spray efficiency of the electrostatic sprayer and hand held spray gun, and continuous training of painters and operators in efficient painting techniques.

The original penalty was reduced from \$360,000 to \$330,000 as a result of a downward recalculation of the willfulness/negligence component of the penalty, and to \$93,130 for the SEP.

All capital projects implemented under the SEP were completed in beginning of June 1993. 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.

f. Metal Finishing Company (MFC)

MFC 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 SEP, 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), and lead contaminated polishing waste and spent chromic acid. The facility is a treatment, storage and disposal facility (TSDF).

The company was found to be out of compliance with several requirements under RCRA, including: failure to properly close hazardous waste storage containers of oil and alkaline solutions from machine shop and chromic acid from plating area; failure to label hazardous waste containers of lead contaminated polishing dust, mixed oil and alkaline solutions, and chromic acid.

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 a SEP to EPA that would eliminate the activities that contributed to the company's violations. The SEP proposed by the company consists of significant modifications to the company's automatic plating line to reduce the generation of lead contaminated polishing dust waste and to convert from hexavalent to trivalent chromium plating solution. At the request of the EPA negotiators, the company agreed to implement a second SEP which was a measure designed to collect lead containing polishing dust waste more effectively.

In order to reduce the generation of lead contaminated 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. Prior to the SEP, the company generated 77 cubic yards of polishing dust waste annually. 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.

To reduce the generation of metal hydroxide sludge, the company proposed to convert the chrome bath from hexavalent chromium to trivalent chromium. The company generated 16,700 gallons of F006 metal hydroxide sludge from its nickel and chromium plating operation prior to the SEP. They projected 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 SEP, the company generated approximately 330 gallons of chromic acid 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 (i.e., the first SEP) would cost \$167,149, take two to four weeks to implement, and would require the company to invest \$70,000 in inventory to supply their customers while the conversion is under way. The company was required to spend not less than \$165,000 (including capital, design and engineering labor costs, and construction labor) on these two components of the SEP, according to the CA/FO. The actual cost, determined after implementation, was \$244,110. The estimated cost for the second SEP (i.e., the dust collection system) was \$5,400; the actual cost was \$5,173. The original penalty was set at \$325,000, was revised to \$150,900 as a result of documentation and affidavits provided by the company. The final penalty was set at \$23,300 in consideration of the two SEPs.

The company projected a net yearly positive operating cash flow of \$4,000 in the first year of full operation.⁵ 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 down in output or increased labor costs.

Finally, at the request EPA, the company agreed to modify their polishing dust collection system by the constructing 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.

The SEP promised a 65 to 85% reduction in the generation of polishing dust waste. The company has cut its waste by 83 - 85%. By reducing the generation of lead contaminated polishing dust and the lead content in the dust, the SEP reduces 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

⁵ This calculation included depreciation. However, the agreement subsequently reached prohibited the company from depreciating its capital costs for the SEP. When recalculated omitting depreciation, the net yearly operating cash flow is reduced to -\$10,000.

than in hexavalent systems (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. 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.

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. The company instituted three major changes in its operating procedures as a result of the enforcement action and SEP. 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) for each, 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.

g. Metal Machining Company (MMC)

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 lapping⁶ equipment.

⁶ A process designed to accurately refine the surface of parts using abrasive, rotating plates.

In April of 1990, a EPA issued a complaint stating that MMC failed to file Form R's in 1988 for phosphoric acid; 1,1,1 trichloroethane; xylene; methyl ethyl ketone under EPCRA 313. In October 1991 the company signed a CA/FO agreeing to implement a SEP. In consideration of the SEP and good faith efforts, the original assessed penalty was reduced from \$76,000 to \$11,400.

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 designed to reduce the amount of 1,1,1 used by 130,000 pounds per year. MMC agreed to spend no less than \$201,000, by September 30, 1991, to retrofit a 1,1,1 degreaser used on non-metal lapped parts to reduce organic solvent use and emissions (estimated reduction in use of 1,1,1 of 3,000 gallons per year); and purchase, install and test equipment to switch from organic solvent to semi-aqueous-based cleaning of ferrous and non-ferrous metal parts.

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 depressant⁷ 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 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.

⁷ Ibid.

The company considers the return on investment (ROI) for the project to be good, particularly given the rising cost of 1,1,1⁸. 1,1,1 use in the plant has been reduced from 30,000 to 17,000 gallons per year.⁹

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 organic solvent manufacturer to help them convert their remaining 1,1,1-based cleaning systems over to non-organic solvent systems. They chose this company because they are a manufacturer of 1,1,1 and other organic solvents used for cleaning and they specialize in cleaning operations. The manufacturing engineer is not satisfied with the consultants because they proposed a very expensive new cleaning system and the engineer does not trust that they are providing complete information. Therefore, the company is conducting their own investigation of the systems that the consultants have suggested as well as other alternatives.

h. Powder Metallurgy Manufacturing Company (PMMC)

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. The company has 50 employees and sales of between \$5 - 6 million per year. The company is a member of the Metal Powder Industrial Federation--a federation of four trade associations. There are about 140 similar companies in this country.

In 1989, the company was cited with failure to file Form R's under EPCRA 313 for the reporting year 1987, for copper, chromium, trichloroethylene, and ammonia.

Prior to the SEP, production of a finished part typically included the following steps: (1) compaction of metal powder in a mold to create "green" parts, (2) sintering of "green" parts in electric ovens in either a disassociated ammonia (hydrogen-nitrogen) or methanol/nitrogen atmosphere to prevent oxidation and corrosion, (3) burnishing of sintered parts to remove excess metal and provide a smooth finish, (4) brightening of brass parts with chromic acid, (5) drying, (6) resin impregnation for corrosion prevention, (7) tapping (thread cutting) of brass parts using

⁸ 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.

⁹ 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.

a water soluble cutting fluid or a heavy black sulfur oil cut with kerosene, (8) water washing to remove the tapping fluid, (9) vapor degreasing with trichloroethylene in a vapor degreaser.

In their settlement with the agency, the company agreed to implement a SEP costing \$78,300. The SEP consisted of five components: an environmental audit (\$4,350), the implementation of a blended hydrogen/nitrogen sintering atmosphere system to eliminate the use and storage of anhydrous ammonia (\$50,598), decontamination and replacement of an existing 10,000 gallon anhydrous ammonia storage tank, with a 1,000 gallon tank (\$2,400), elimination of a trichloroethylene vapor degreaser by switching from an oil-based tapping fluid to a water-based alternative (\$500), and 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).

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. By eliminating the trichloroethylene vapor degreaser, the plant cut approximately 26,860 pounds per year of fugitive trichloroethylene air emissions. Trichloroethylene is an ozone depleting substance, targeted for phase-out under the Montreal Protocol. 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.

According to the company, the projects implemented under the SEP are expected to payback in the "long run"--5 to 7 years.

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. In addition, through a series of energy conservation projects, the company has cut its energy costs by \$4,000 per month.

In consideration of the SEP, the agency reduced the company's fine from \$76,000 to \$30,550. The company was required to implement all components of the SEP within a 360 day time line.

The projects implemented under the SEP policy had been considered by various members of the company prior to the issuance of the complaint. The SEP process was the impetus for their implementation.

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 President believes that a vision of cultural change must come from the top. He is trying to apply TIM principles to productivity, quality, environment and worker health and safety.

i. Pump Service and Sales Company (PSSC)

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. As a result of PSSC's failure to file a Form R for Freon (under EPCRA 313), the company entered into a Consent Agreement and Order with EPA on October 1991.

Prior to the Consent Agreement, the company was using freon for 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. In their settlement, the company agreed to reduce, by not less than 66%, its December 1990 Freon use rate in connection with its pump repair processes both at the subject facility and at a second facility owned by the company.

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 company estimated the cost for the two plants to be \$69,475, including \$56,475 for equipment and \$13,000 for installation. The Original penalty was reduced from \$17,000 to \$8,500.

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 Material Safety Data Sheets (MSDS), the cleaning agent contains: 1-T-Butoxy-2-Propanol, Dipropylene Glycol 1 Monoethyl Ether, and Monocyclic Terpene Hydrocarbons. While animal studies conducted by NIOSH has found that certain glycol ethers¹⁰ are fetotoxicants, such evidence has not been found for Dipropylene Glycol Monoethyl Ether. Monocyclic terpene

¹⁰ 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.

hydrocarbons are a class of plant-based materials which many companies are turning to as an alternative to chlorinated organic solvents. Recent discoveries, however, have linked water effluent containing terpenes with ecotoxicity.

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.

2. Injunctive Relief

a. *Bleached Kraft Pulp Mill (BKPM)*

BKPM 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 CA/FO required the Mill to study a range of potential remedial measures (including fluent treatment systems and in-plant process changes) and propose to EPA a measure(s) to bring the Mill into compliance with chronic toxicity limits under the Clean Water Act. In addition, the mill was required to construct an outfall extension pipe capable of ensuring that the surf zone will be essentially free of mill effluent.

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 AOX¹¹; 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 from digesters and black liquor recovery system¹² 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.

The pollution prevention project consists of the total elimination of chlorine in pulp bleaching. The Mill will eliminate their use of both elemental chlorine and chlorine dioxide and substitute other process steps. In the new process, the pulp will be bleached with hydrogen peroxide and oxygen, rather than chlorine and chlorine dioxide. Anthraquinone will be added to the digester

¹¹ A measure of chlorinated organic compounds.

¹² Condensates contain toxic materials that, in part, end up in discharged effluents. Steam stripping removes most of these materials for wastewater streams.

to increase lignin removal. 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 boiler. 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). The project must be completed in September 1995. The cost of the project is not available.

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 maximum reductions in chlorinated organic compounds, color, odor, foam, and contact irritation for a wide array of Mill constituencies: beach walkers, surfers, kayakers, and anglers. 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). 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 content in the final product is a concern. They are promoting the use of TCF pulp to governmental and institutional purchasing agents.

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.

C. CASE COMMENTARY AND ANALYSIS

1. SEPs versus Injunctive Relief

Of our 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. The case study selection criteria were not inherently biased toward SEPs; rather we sought innovative, somewhat unique pollution prevention projects from among our sample population of both SEPs and injunctive relief cases. One case that we selected, Bleached Kraft Pulp Manufacturer (BKPM), was the only injunctive relief case reported that contained a pollution prevention compliance strategy. We selected it because the pollution prevention project--elimination of chlorine in kraft pulp bleaching--was innovative and had great technology transfer potential.

2. Companies

Since our 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, our selection strategy. Our 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 our 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.

3. Nature of the Violation (Regulatory Program)

Of our 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 our 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 firm¹³ and may save the firm considerable amounts of money.¹⁴ These features are motivations for both the firm and the agency to negotiate SEPs into these cases.¹⁵

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.¹⁶

4. Original and Final Penalties, Project Cost and Payback

Table A-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.

¹³ 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.

¹⁴ 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).

¹⁵ 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.

¹⁶ According to the SEP Policy, only the gravity portion of the penalty can be mitigated by the SEP.

Table A-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.

We obtained payback information from case study firms during our interviews. In one case, MFC, we acquired a copy of the company's profitability analysis which they had submitted to EPA during their SEP negotiations. Our data are a mixture of numerical payback estimates and qualitative impressions of project profitability. In some cases we were unable 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.

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. We address indirect benefits in the section on technology transfer below.

To evaluate environmental benefits of pollution prevention, used as a means to compliance, i.e., injunctive relief, we 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, we 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 A-1 and in more detail in the full case studies--are presented again in summary form in Table A-3 for ease of reference.

The following is an 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.¹⁷ 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.

¹⁷ U.S. Environmental Protection Agency. "Guide to Clean Technology: Alternatives to Chlorinated Solvents for Cleaning and Degreasing." July, 1992.

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

<u>Company</u>	<u>Environmental and Health Benefits</u>
<p><u>SEPs:</u></p> <p>Casted Metal Products Manufacturer (CMPM)</p>	<p>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</p>
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.
<p><u>Injunctive Relief:</u></p> <p>Bleached Kraft Pulp Manufacturer (BKPM)</p>	<p>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.</p>

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.¹⁸ 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 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.

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

¹⁸ Ibid.

equipment in a trade journal. One company, LM, used a technical rather than environmental consultant, to help with equipment design.

In only one case, CMPM, 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 consultant¹⁹ in the CMPM 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 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,

¹⁹ By environmental consultant, we mean consultants engaged primarily in studies, engineering design, and implementation projects for environmental compliance, remediation and pollution prevention.

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.²⁰ 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 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 CMPM, 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 CMPM is the case of PMMC. PMMC 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.

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.

²⁰ 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.

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, PMMC, 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. CMPM 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).

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 we mean 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, we use three general headings: 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, we produce the three-by-three matrix pictured in Table A-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.²¹

When we locate the technological changes made by case study firms within this matrix (Table A-4), we 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, we note that although we selected the most innovative projects for study, our sample was largely made up of diffusion-driven technological changes. In addition, by seeking case studies involving process redesign and product reformulation, our sample contains a significant number of changes to primary or secondary production processes. If we had used a random case study selection process, our 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 14 below, we discuss the length of the project implementation period as a factor in the inclusion of innovative projects in enforcement settlements.

²¹ Abernathy, W.J., 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.

Table A-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

9. Technology Transfer Benefits

In two cases, CMPM 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.

10. Organizational Change

In our interviews with case study firms, we attempted 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.
- MFFM'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, we have only one case upon which to draw insight. In the case of MDM, we interviewed the company's in-house corporate environmental attorney who 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.

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 our interviews.

- MFC 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, CPM, the firm stated that their outside attorney hampered the process because he was unfamiliar with environmental regulations and agencies.

Although we did not have the opportunity to directly interview the outside counsels spoken of by the case study firms and described above, our 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.

We were not able to determine whether the views of outside counselors changed in the course of the settlement process.

12. Change in Vendor/Consultant Relations

Two case provide contrasting experiences in changed relations with consultant/vendor. CPM 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.

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.²²

14. Time to Implement the Pollution Prevention Project

For each case study, Table A-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 complaint²³, 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 as SEPs (see Section 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.

²² 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.

²³ 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.

Table A-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 Implementation Deadline (per CA/FO)</u>
<u>SEPs:</u>			
Casted Metal Products Manufacturer (CMPM)	September 1989	August 1992 (company began studying and implementing pollution prevention 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 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 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 official signing of 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

The unique circumstances of each case, and the limited size of our 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 8 above) to implementation periods. The changes characterized as incremental innovations in Table A-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.

15. An Examination of Whether Pollution Prevention Projects 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 our interviews, we 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.

D. IMPACT ON THE FIRM

There are many impacts on the firm stemming from the inclusion of pollution prevention in enforcement. In this section we present our observations and analysis, organized into two parts: impact during the enforcement process and impact beyond enforcement. We note the same limitation of our study here as is given in Section D above, namely that the majority of our observations came about in the context of studying SEPs; however, we believe that most of the conclusions reached in this section apply both to SEPs and injunctive relief.

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 our 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 our 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 our 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 current²⁴ 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.

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 C 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.

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,

²⁴ 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.

MFC, MMC--there is great potential for further pollution prevention. At this early stage, we cannot conclude that the type of project implemented--classified by the framework presented in Table A-4--is a strong determinant of the company's pollution prevention activities beyond the enforcement settlement.

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

Based on our interviews, we learned that none of the case study firms knew of the SEP policy prior to EPA's inspection.²⁵ This is not surprising since the policy is relatively new and many of the inspections were conducted between 1988-91. We can be reasonably sure, that within our 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, our research tells us that these incentives for non-compliance should be weighed against incentives for compliance, such as:

- 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.

²⁵ One firm, MFC, learned about SEPs after the EPA inspection and before the first settlement conference.

The collective experience of our 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.

