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Redesign of the Pollution Abatement Costs and Expenditures (PACE) Survey: Findings and Recommendations from the Pretest and Follow-up Visits

Final Report

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*RTI International is a trade name of Research Triangle Institute.

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SECTION 1. INTRODUCTION

The Pollution Abatement Costs and Expenditures (PACE) survey is the only comprehensive source of pollution abatement costs and expenditures related to environmental protection in the United States. The PACE survey collects facility-level data on pollution abatement capital expenditures and operating costs in the manufacturing industry.[1] The survey captures pollution abatement costs associated with compliance with local, state, and federal regulations and voluntary or market-driven pollution abatement activities.[2] The Environmental Protection Agency (EPA) uses these data to calculate the costs of their regulations (e.g., 1990 Cost of Clean Environment, Annual Office of Management and Budget Reports to Congress on Costs and Benefits of Federal Regulation (Thompson Report), Section 812 Clean Air Retrospective Cost Analysis). Trade associations, manufacturers, marketing and research companies, university researchers, financial and environmental institutions, other federal agencies, state and local governments, and environmental reporters also use PACE data. For example, trade associations use the PACE data to track the cost of complying with environmental regulations to their members while university researchers use the data to examine the impact of regulations on international competitiveness, productivity, and job growth in the manufacturing sector.

The PACE survey captures expenditures whose primary purpose is environmental protection. Investments or activities that increase profits or efficiency in the absence of environmental considerations are not included, even if pollution abatement occurs as a side benefit. In addition, only incremental costs of pollution abatement are included. These incremental costs are the additional costs associated with the *environmental portion* of an investment or of annual operating and maintenance costs. For example, pollution abatement equipment may be integrated into larger investment projects, pollution abatement technologies may be integrated into production equipment, or pollution abatement operating costs may be combined with other costs in a larger cost center.

Pollution abatement costs and expenditures include installation or retrofit of capital equipment, annual operating costs, and certain other environmental-related expenses. The PACE

[1]Mining and electric utility establishments were included in the 1999 PACE survey and they were included in the 2004 PACE pilot and pretest. However, they are not included in the 2005 PACE survey because costs related to electric utilities are being collected by EIA-767 and costs related to mining establishments are less than 4% of total pollution abatement operating costs.

[2]Because cost data are collected at the facility level, costs incurred at the corporate level (such as research and development) are not included in the survey unless they are billed directly to the facility.

survey disaggregates pollution abatement capital expenditures and operating costs into four activity categories:

- **Treatment/capture activities** are any method, technique, or process designed to remove pollutants, **after** their generation in the production process, from air emissions, water discharges, or solid waste.
- **Recycling activities** are the postproduction on-site or off-site processing of waste for an alternative use. Recycling activities include the recovery of liquid, solid, or gaseous wastes and their reuse in the same or another production process.
- **Disposal activities** involve the final placement, destruction, or disposition of waste after pollution treatment/capture and/or recycling has occurred. Disposal in an environmentally-sound manner can include landfill disposal or the use of injection wells.
- **Pollution prevention activities** are any method, technique, or process that reduces the amount of pollution generated during the production process. Pollution prevention activities include raw materials substitution or modifications, leak and spill prevention, and process and equipment modifications.

Total pollution abatement capital expenditures and operating costs are also disaggregated by three types of media: air emissions, water discharges, and solid waste. Total pollution abatement operating cost are separated into five cost categories: 1) salaries, wages, and benefits, 2) energy costs, 3) materials and supplies, 4) contract work, leasing and other purchased services; and 5) depreciation. The survey also collects information on gross book value of pollution abatement capital assets, permits and fees, site cleanup, product redesign or reformulation, and cost offsets.

1.1 History of PACE Data Collection

The PACE survey was conducted annually between 1973 and 1994, with the exception of 1987, when no survey was conducted.[3] After a 5-year lapse due to budgetary reasons, the PACE survey was reinstituted in 2000 to collect data for reference year 1999. The survey has not been administered since 2000 in order to evaluate the accuracy of the survey responses.

Over its history, the PACE sample selection methodology has changed, although it generally targets medium and large facilities and typically draws a sample of approximately 20,000 facilities. The 1999 survey was the first since the late 1970's to include facilities with fewer than 20 employees in the sample.[4] Prior to 1994, the PACE survey was a subsample of the concurrent Annual Survey of Manufactures (ASM), which is a proper subsample of the Census

[3]The microdata for 1973 to 1978 and 1983 are missing. However, the aggregate data for these years are available in PACE publications.

[4]Establishments with fewer than 20 employees are not being included in the 2005 survey.

of Manufacturers (CM). The 1994 sample was drawn from the 1992 CM, rather than the 1994 ASM. The sample for the 1999 survey, which was based on North American Industry Classification System (NAICS) industry classifications instead of the Standard Industrial Classification (SIC) system, was drawn from the 1997 CM, the Census of Mining, and the universe of electric utilities. The sample frame for the 2005 PACE survey is the 2002 CM. Because PACE respondents are familiar with the ASM, the 2005 PACE survey is designed to be consistent with the ASM in terms of structure and definitions (e.g., capital, depreciation). The consistency in structure between the ASM and PACE should lower respondent burden, lower administrative burden for the Census Bureau, and increase response rates. Given that the PACE sample frame is the 2002 CM, the 2005 PACE survey asks some ASM questions (e.g. value of shipments and employment) of the non-ASM plants to facilitate editing and imputation of the data.

Although the basic design of the PACE survey remained relatively unchanged from 1973 to 1994, some alterations did occur, generally with the intention of collecting more detailed information (e.g., pollution prevention, hazardous waste management, and recycling). However, the 1999 PACE survey was significantly different in terms of both content and structure from previous PACE surveys. The fact that the 1999 PACE data is longitudinally inconsistent with past PACE data makes historical comparisons very difficult, if not impossible (see Becker and Shadbegian (2004) for details). Additional detail on the history of the PACE survey, the type of cost and expenditure data collected, and its use in published research can be found in Ross et al. (2004).

1.2 Motivation for Redesigning the PACE Survey

Data from the PACE survey have been used to analyze a wide variety of policy questions, ranging from the overall costs of government environmental regulations to how these costs influence economic activities such as international competitiveness, facility location decisions, investment and labor demand, and economic efficiency. Previous use of the PACE data by government agencies and academic researchers has led to a number of concerns with respect to the PACE data and the survey instrument. Some of these issues include:

- varying interpretations of the terminology used to distinguish between pollution abatement, pollution treatment, and pollution prevention;
- longitudinal inconsistency of the data on pollution abatement capital and operating costs over time;
- lack of a validation capability or method for checking the accuracy of reported abatement costs;

- ability to distinguish between a blank data field (missing) and zero costs; and
- concern over double counting some costs.

The next sections discuss these issues in more detail.

1.2.1 PACE Survey and the Academic Literature

Users of PACE data in the research community have raised a number of concerns about the reliability of the reported values. A brief listing of these issues includes the following:

- For a variety of reasons, the PACE survey may not capture all pollution-related costs such as hidden costs hidden due to the facility's cost accounting structure and unmeasured changes in productivity due to switching to a less polluting raw material (Jorgenson and Wilcoxen, 1990; Levinson, 1996; Boyd and McClelland, 1999; Becker and Henderson, 2001; Joshi, Krishnan, and Lave, 2001; Gray and Shadbegian, 1998, 2002, 2003; Shadbegian and Gray, 2005).
- Facilities may have a difficult time estimating the appropriate baseline against which to compare costs (Jaffe et al., 1995; Levinson, 1996; Berman and Bui, 2001).
- There is no information on benefits of environmental investments (Jaffe et al., 1995; Berman and Bui, 2001; Morgenstern, Pizer, and Shih, 2001).
- It may be hard to determine if an expenditure should be classified as "environmental" (Jaffe et al., 1995).

Specific comments and concerns about the PACE survey are occasionally included in research literature. For example, Becker and Henderson (2001) note that the survey may not accurately measure some pollution abatement costs, such as costs associated with pollution prevention. They attribute this inaccuracy in part due to the lack of documentation of certain costs, inability of facilities to estimate some costs, and the lack of an obvious baseline. As a methodological issue, oversampling of larger facilities also implies oversampling of older facilities. Becker and Henderson findings suggest survey data underestimate costs, especially the costs of environmental regulations for younger facilities. Other studies such as Boyd and McClelland (1999), Joshi, Krishnan, and Lave (2001), and Gray and Shadbegian (2002,2003) find that $1 dollar of pollution abatement spending leads to more than $1 of actual environmental cost, which could be because abatement spending reduces the productivity of nonabatement inputs (real negative productivity effect) or because plants underreport PACE expenditures.[5] In a production function framework, Shadbegian and Gray (2005) distinguish between these two

[5] More specifically, Gray and Shadbegian (2002) find that at paper mills, oil refineries, and steel mills $1.00 of pollution abatement operating costs translated into the equivalent of $1.80, $1.40, $3.30 in lower productivity respectively.

effects and find evidence in favor of underreporting. This finding is consistent with Becker and Henderson (2001).

Berman and Bui (2001) analyze the effects of air quality regulations on oil refinery productivity in the Los Angeles Air Basin finding that investments in abatement capital enhanced productivity. Unlike Boyd and McClelland (1999), Becker and Henderson (2001), Joshi, Krishnan, and Lave (2001), and Gray and Shadbegian (2002, 2003), Berman and Bui's results suggest that abatement cost measures may overestimate the economic cost of environmental regulations, because these expenditures can increase productivity. These contradictory findings on whether the survey data under- or overestimate pollution abatement costs can be found throughout the literature. One of the main reasons for this debate lies in the difficulty of accurately estimating pollution prevention costs. Some argue that these costs are underestimated because of the exclusion of activities that include some aspect of pollution abatement but are not conducted with the primary purpose of protecting the environment. This issue is more prominent in pollution prevention activities than in treatment activities; pollution prevention activities tend to be part of a larger project, while pollution treatment activities tend to occur at the end of the production process and are therefore more likely to be captured by the PACE survey. Others suggest that even those activities that meet the above criteria and are included still result in some increase in profitability because of more efficient process techniques—implying that costs are overestimated. This argument underscores the need for more detailed and accurate data on pollution prevention.

Other studies also highlight concerns with using the PACE survey data to analyze costs and benefits of pollution-related expenditures. Levinson (1996) states that it is difficult for respondents to assess the true economic cost (such as inefficiencies due to input substitution or altered production processes) of regulation, which can cause abatement operating costs to be either overstated or understated. Morgenstern, Pizer, and Shih (2001) and Gray and Shadbegian (1998) note that changes in production processes in general, and specific costs associated with installing and maintaining the equipment used in these changes, make it hard to determine the true costs of environmental compliance.

1.2.2 PACE Survey and the Center for Economic Studies

The Center for Economic Studies (CES) at the U.S. Census Bureau has raised a number of issues, related to survey design, with the PACE data (Streitwieser, 1995). First, the 1973 to 1978 and 1983 micro- (facility-) level data files have been lost, hampering efforts at time-series

analysis.[6] Second, comparing responses over time can be problematic because of changes in survey design (see Section 2.2). Third, state and industry classifications from the PACE data are not identical to CM and ASM data. Location conflicts at the state level generally average less than 1 percent of the database population. However, differences in industrial classifications tend to be higher, though usually less than 10 percent.

Some PACE data are also imputed by Census, similar to procedures used for the CM/ASM data, and hence are typically deleted from micro analyses.[7] Prior to 1989, little is known about how these imputed data points were estimated. There are also a substantial number of blank data fields. For example, between 1984 and 1986 approximately 30% of the data fields were left blank; this rate nearly doubled between 1988 and 1992 to 57.2 percent (when blank fields were no longer filled with imputed data). These blank data are treated as zeros when calculating published total expenditure figures. Handling blank fields this way can cause substantial underestimates of pollution abatement costs and, as many researchers will attest, needs to be remedied. General measurement errors are possible, as well, in cases where responses are not accurate, although proper survey design (which is also consistent across years) will help limit this effect. Indications of these errors include facilities reporting more environmental capital expenditures than total capital expenditures (for the period 1979-1988, six percent of facilities that reported investment in capital for pollution abatement), and facilities reporting more depreciation of environmental capital than total depreciation (5 to 10 percent of facilities from 1979-1988).

Streitwieser (1995) makes a number of recommendations regarding the PACE survey: draw the PACE sample from the concurrent ASM, have facilities report total employment and shipment values on PACE to assist matching to other sources, maintain all methods of identifying facilities, and have consistency between PACE and the ASM/CM surveys. Streitwieser also makes several general recommendations about flagging missing and imputed data and reviewing the survey instrument and maintaining consistency among government branches conducting the various data collection efforts.

1.2.3 RFF Workshop on the PACE Survey

RFF convened a workshop of experts in March 2000 to discuss the PACE survey. The purpose of this workshop, funded by EPA, was to identify problems with the previous PACE survey and to propose potential solutions to these problems. The gap in data collection from

[6]The published aggregate data are available for the years missing micro data (1973 to 1978 and 1983).
[7] This paragraph draws heavily from Streitwieser (1995).

1994 to 1999 was seen as an opportunity for visiting some of the issues that were raised in the literature, many of which are mentioned above. This workshop (Burtraw et al., 2001) discussed in detail a number of issues concerning the existing design of the PACE survey and suggested potential changes (which could be made with varying levels of effort and probabilities of success). The experts' suggestions on survey design can be roughly separated into two categories: 1) eliciting additional information on expenditures not currently covered by the survey, and 2) redesigning the survey to obtain more accurate and more disaggregated data. Other general recommendations, such as creating an advisory panel to review the survey, along with ideas for extending survey coverage to additional industries, were also discussed. Some of these suggestions, such as including electric utilities and mining, were instituted in the 1999 survey (conducted in 2000).

A summary of the broad RFF recommendations taken from Burtraw et al. (2001) includes the following:

- Focus additional attention on capital expenditures.
- Focus additional attention on cost recovery (also referred to as cost offsets).
- Link the PACE cost data to EPA emissions data and other types of information.
- Assess the validity and accuracy of the survey and examine outlying responses.
- Maintain a consistent structure from year to year.
- Consider using both short and long forms for particular industries of interest and possibly use industry-specific questions.

More-specific recommendations include the following:

- Ask binary yes/no questions.
- Distinguish between zeros and blanks.
- Ask for more disaggregation of costs by pollutant and possibly the regulation prompting the expenditures.
- Provide additional examples of costs.
- Include measures of cost savings experienced by facilities.

The numerous RFF recommendations and additional recommendations suggested by other sources accentuate the need for redesigning the PACE survey. Given that the survey has not been administered since 1999 and the issues surrounding the longitudinal integrity of the 1999 data makes now an opportune time to redesign the survey. Section 4 discusses possible ways to address the most important concerns previously described while ensuring longitudinal consistency with the 1994 and prior survey data.

1.3 Overview of the PACE Survey Redesign Process

The following sections discuss the process undertaken to redesign the PACE survey and the findings and recommendations resulting from these changes. The redesign process had two major phases.

- Phase 1: Several activities occurred within phase 1. First, an expert panel and EPA workgroup provided comments and feedback on a preliminary draft of the PACE survey instrument. Four on-site interviews were also conducted with facilities to gain insights into the type of environmental cost information that facilities track and have available for calculating costs associated with pollution abatement. This was followed by a total of nine one-on-one interviews with facilities and industry trade associations to obtain comments on a draft survey instrument.
- Phase 2: Each comment from phase 1 was evaluated by the expert panel and EPA staff, and when considered appropriate, integrated into the 2004 PACE pretest and pilot survey. This report focuses on the 2004 PACE survey pretest, which included eighteen on-site follow-up visits conducted to discuss the survey instrument and guidance document and to collect information to develop independent engineering cost estimates. The pilot test of the 2004 PACE survey was conducted by the U.S. Census Bureau and is only briefly discussed in this report.

In Section 2 we discuss these two phases in more detail. In section 3 we discuss the results of the pretest of 2004 PACE survey. Section 4 discusses the general comments provided by respondents on the survey instrument and guidance document. The comparison of the reported costs to the independent engineering cost estimates are presented in Section 5, followed by a summary of findings in Section 6. Section 7 discusses the modifications to the 2005 PACE survey and guidance document.

The 2004 PACE pretest survey and *Guidelines and Definitions* document is provided in Appendix A while Appendix B contains the specific recommendations facilities provided during the on-site visits. Appendix C contains the 2005 PACE Survey and *Guidelines and Definitions* document. Appendix D provides facility-level cost comparisons.

SECTION 2. SURVEY REDESIGN PROCESS

Considerable effort was taken to consult with experts and stakeholders outside the EPA on a regular basis throughout the design and testing of the 2004 PACE survey instrument and guidance document. The first phase in redesigning the survey included three key activities: 1) consultation with an expert panel, 2) on-site visits with four facilities; and 3) one-on-one interviews with a total of nine facilities and trade associations. Each activity is described in more detail below. In addition, an EPA Workgroup consisting of representatives from program offices within EPA provided input at various points in the project. Using feedback from the participants in phase 1, the 2004 PACE survey form and guidance document were developed. The second phase included a pretest and pilot of the 2004 PACE survey form and guidance document. Eighteen facilities participated in the pretest conducted by RTI and approximately 2,000 facilities received the pilot survey conducted by the U.S. Bureau of Census. The pretest and pilot targeted facilities in a range of industries to evaluate the survey's ability to accurately collect information on pollution abatement operating costs and capital expenditures.

2.1 Phase 1: Review Past PACE Instruments and Develop 2004 Pretest Survey Instrument

The initial draft PACE survey instrument and guidance document was developed with input from an expert panel, an EPA workgroup and industry representatives. The next sections describe each group in more detail.

2.1.1 Expert Panel

A panel of four experts was convened at the beginning of the project to provide reviews and advice on all aspects of survey instrument and guidance document development, including data collection and analysis of the pretest and pilot data. The expert panel consisted of the following people:

- Dr. V. Kerry Smith, an environmental economist, is the University Distinguished Professor of Agricultural and Resources Economics at North Carolina State University. He also serves as the Director of the Center for Environmental and Resource Economics Policy (CENREP).
- Dr. Wayne Gray, an environmental economist, is a Professor in the Department of Economics at Clark University. He is also a Research Associate with the National Bureau of Economic Research and Coordinator of the Boston Research Data Center of the U.S. Census Bureau.
- Dr. Brenda Cox, a survey design expert, is a Survey Research Leader in the Centers for Public Health Research and Evaluation at Battelle Memorial Institute.

- Mr. William Vatavuk, P.E., an environmental engineer, is the President of Vatavuk Engineering, an engineering consultant firm that provides air pollution control technology and cost analysis services.

Others participating in the panel meetings included an RTI consultant (Arik Levinson, Georgetown University), EPA staff (Kelly Maguire, Cynthia Morgan, Ron Shadbegian, and Shannon Price), a representative from the U.S. Census Bureau (Randy Becker), and RTI staff (Michael Gallaher, Brian Murray, Rebecca Nicholson, and Martin Ross).

2.1.2 EPA Workgroup

Representatives from seven program offices (i.e., offices that use the PACE data in regulatory analyses or other capacities) throughout EPA participated in a workgroup to provide input on the PACE project. The EPA offices represented were the Office of Air and Radiation (OAR); Office of Environmental Information (OEI); Office of Policy, Economics and Innovation (OPEI); Office of Prevention, Pesticides, and Toxic Substances (OPPTS); Office of Research and Development (ORD); Office of Solid Waste and Emergency Response (OSWER), and Office of Water (OW). The group met twice in 2004 and provided formal comments on the draft PACE survey instrument and guidance document. Members provided many suggestions for items that they would like to see on the survey (e.g., more examples of pollution prevention activities), as well as categories of examples to be considered for inclusion in the instructions.

2.1.3 Preliminary On-Site Visits With Industry Representatives

The purpose of the four on-site visits was threefold: (1) to collect firsthand information regarding how facility representatives track capital and operating costs associated with compliance with environmental regulations; (2) to determine the availability and usefulness of these data for responding to the PACE survey; and (3) to solicit comments regarding the format, content, and clarity of the 1994 and 1999 versions of the PACE survey instruments. Four preliminary on-site visits were completed during March and April 2004. One facility from the pulp and paper, iron and steel, petroleum, and electric utility industries was visited by an engineer and economist from RTI. Facilities in these industries were targeted because historically, they represent four of the top five industries in terms of aggregate pollution abatement expenditures.[8] Participants from the facilities included environmental managers, directors of environmental affairs, environmental committee/department staff, process and project engineers, accounting or finance analysts, and others who help calculate the costs associated with pollution abatement at the facility or corporate level. The participants discussed

[8]The chemical industry has the largest pollution abatement expenditures. However, this industry was viewed as too diverse to be included as a targeted industry for a site visit.

the process by which they collect, record, and track pollution abatement operating costs and capital expenditures data that are used to complete the PACE survey. The feedback provided during the on-site interviews was used to develop a preliminary version of the PACE survey and guidelines document.

2.1.4 One-on-One Interviews

A total of nine one-on-one interviews were conducted with trade associations and facilities in four focus industries:[9]

- pulp and paper (National Council for Air and Stream Improvement [NCASI] and one facility),
- iron and steel (American Iron and Steel Institute and two facilities),
- petroleum (American Petroleum Institute [API] and one facility), and
- electric utilities (Edison Electric Institute [EEI] and one facility).

During the interviews industry experts familiar with how facilities measure and track pollution abatement capital expenditures and operating costs provided feedback on a draft version of the survey form and guidance document. Prior to each meeting, the PACE survey instrument and guidance document, with examples of pollution abatement specific to the industry, were sent to the meeting participants. The meetings were conducted by an engineer and an economist from RTI, and in some instances a representative from EPA also attended the meeting. The departments represented by the trade association and facility participants included compliance and testing, air and water quality, accounting, engineering, statistics, economics, and environmental management.

2.1.5 Summary of Phase 1: Issues and Recommendations

Based on this information garnered during the on-site visits, RTI developed a lengthy list of issues that were discussed during a series of EPA and expert panel meetings. Some of the recommendations were incorporated into the 2004 version of the survey and guidance document and some were not. The next sections discuss some of the key issues and the expert panel response and recommendations to these issues.

[9]Seven individual interviews were conducted. For the iron and steel industry, representatives from the trade association and two separate facilities attended the same meeting. Other associations solicited input from member companies prior to the meeting, though representatives from these companies did not attend the meetings.

General Structure

The process of redesigning the survey instrument and instructions began with a review of the 1994 and 1999 survey instruments by the expert panel. The facilities were also asked during the preliminary on-site visits about which components of the 1994 and 1999 survey they preferred and which they found most difficult to complete. The expert panel agreed that the 1994 survey instrument was the preferred version, and this version should be the starting point for revisions. However, much of the terminology used in the 1999 version was carried over to the 2004 PACE survey because the language in the 1999 survey was consistent with terminology used by industry. Consequently, the 2004 PACE survey form was redeveloped taking into consideration the best aspects of both the 1994 and 1999 PACE survey forms.

In the 1994 PACE survey the instructions were integrated into the survey form whereas in 1999, the survey form and guidelines document were separate documents. The panel preferred separating the form from the guidelines document because it streamlined the survey instrument and made it simpler for facilities to visualize how different cost categories were being disaggregated. And during on-site visits, facilities agreed that they preferred to complete the survey without embedded instructions.

However, the panel noted that some facilities do not read the instructions in detail and instead use the instructions as a reference when needed. With this in mind, abbreviated instructions, as well page references to the guidance document for complete instructions and examples of items to include and exclude were incorporated on the survey form for most questions.

The option of having short and long forms was discussed by the expert panel. A long form would potentially ask more detailed information (greater disaggregation such as labor costs by pollution medium) and be distributed to a subsample of the industries. A short form, on the other hand, would collect only the basic items (e.g., total pollution abatement operating costs and capital expenditures). Most of the expert panel agreed that having long forms would be a good way to collect more detailed information. However, based on the sample of facilities visited as part of the on-site visits, it is unclear if more detailed/disaggregated information on pollution abatement expenditures exists, and some reviewers questioned if the benefits would exceed the additional burden placed on respondents. As a result, the option of short versus long forms was not pursued at this time. However, this option may be reconsidered in the future.

The expert panel emphasized the importance of consistency over time to support longitudinal analysis with the PACE data. Thus, any modifications of questions needed to be

weighed against the costs of weakening the longitudinal consistency of the survey. Even if certain questions do not capture all the desired costs and expenditures, there are still benefits in having a consistent "proxy." The 1999 survey did not preserve the longitudinal integrity of the survey (see Becker and Shadbegian (2004) for a detailed discussion of what adjustments need to be made to the data to compare the results of the 1999 survey with the results of earlier PACE surveys). Efforts were made to insure that the 2005 PACE survey is longitudinal consistent with prior surveys (i.e, 1973 through 1994).

Several facilities raised the question during the on-site visits of the potential availability of an internet-based or electronic version of the survey instrument and guidance document. However, most facilities interviewed indicated that they would likely print the survey to make calculations and assemble the information. Also, paper versions have the appearance of maintaining confidentiality, whereas electronic versions are viewed as being too easy to share and less secure. Therefore, the expert panel decided to mail paper copies of the survey form and guidance document to facilities.

Response/Nonresponse Issues

In the 1999 survey instrument, "don't know" response options were included for the first time mainly to reduce the burden on respondents. Facilities participating in the one-on-one interviews reported that they liked having the "don't know" option, although several facilities indicated that they tend not to use the "don't know" option. They feared it may reflect poorly on their management capabilities and furthermore, they do not want to appear imprecise on a government survey.

The panel was opposed to including the "don't know" option because it provides facilities with an easy way out and makes them less likely to estimate pollution abatement operating costs and capital expenditures when accounting data are not readily available. It was noted by the panel that it is better for the facility to approximate costs as opposed to the Census Bureau imputing values. The panel also speculated that lower costs reported in the 1999 survey could have resulted from having "don't know" as an option.[10]

To clarify the distinction between nonresponse and zero costs, the 2004 pretest PACE survey form explicitly states that if no expenditures were incurred at the facility that year, then the facility should enter "zero" to distinguish between missing values. Previous versions of the survey did not explicitly have a "zero" check box and the panel was concerned that some

[10] After making the appropriate adjustments to the 1994 and 1999 data to make them comparable, pollution abatement operating costs and end-of-line capital expenditures are found to be much lower in 1999 than in 1994.

facilities simply left the item blank if they had no costs, leading to confusion between zero costs and nonresponse. To emphasize this point, a checkbox for "zero" was added to all cost questions on the 2004 pretest PACE survey.

The expert panel discussed whether "000" should be provided on the pretest survey instrument (to indicate costs are to be rounded to the nearest thousand). The panel decided that "000" should be included in the box with a comma to explicitly indicate that the respondent was to report in thousands of dollars.

In the event that facilities were not able to provide cost data, the panel discussed the potential of asking respondents to provide a brief one-sentence description that might provide insightful information on what abatement activities were being conducted at the facility. However, the panel concluded that questions asking for text responses (as opposed to check boxes or numerical responses) are difficult and costly to tabulate and analyze. For this reason, these types of questions were kept to a minimum.

Pollution Abatement Activities

Pollution abatement is divided into four activities: treatment/capture, disposal, recycling, and pollution prevention. The definition of treatment was maintained from previous versions of the PACE survey, and, in general, facilities were familiar with the concept of treatment. However, the term was expanded to "treatment/capture" because some facilities indicated that treatment implies some type of chemical or physical process whereas there are some processes that prevent pollution from entering air or water. For example, baghouses capture dust but do not alter its physical properties. Thus, to insure that processes that capture but do not alter are part of treatment in the PACE survey, the term "capture" was added.

In the 1999 and 2004 PACE survey, disposal and recycling are reported in separate categories, whereas in previous versions of the PACE survey they were combined. During the on-site visits, facilities all said they have increased their recycling activities over time and try to track this information separately. However, the difference between recycling and disposal was not always clear to facilities. For example, facilities frequently pay disposal fees to contractors that remove waste of which part is then recycled. Thus, examples such as the following were added to the *Guidelines and Definition* document to help make the distinction between recycling and disposal.

> A facility hires an outside contractor to periodically pick up spent process catalyst for disposal. Contract fees for this disposal should be included in ***pollution abatement operating costs (contract work)*** for disposal.

The ability of facilities to identify pollution prevention activities was investigated during the preliminary on-site visits. The 1999 PACE survey asked for a single aggregate expenditure for pollution prevention activities (combining both capital and operating costs) and had yes/no questions that investigated specific activities. As part of the preliminary on-site visits, we explored whether facilities understood the definition of pollution prevention and if they track the operating costs and capital expenditures associated with pollution prevention activities separately.

Discussion of the pollution prevention section with facilities revealed some confusion about what should be included in the costs of pollution prevention. For example, many routine equipment upgrades lead to greater energy efficiency and hence less pollution. As a result, the instructions were modified and examples included that explicitly state that only incremental costs related to the pollution prevention activity should be reported and not, for example, the total costs of the overall project. To help clarify this point, the following example of what to include in pollution prevention for capital expenditures was incorporated into the guidance document:

> [Include only] The pollution abatement ***portion of*** production process enhancements, such as increased energy efficiency or lean manufacturing, intended for environmental protection.

In addition, from the information garnered during the site visits, the panel determined that facilities were capable of distinguishing between pollution prevention *capital* expenditures and pollution prevention *operating costs* because they are tracked separately; thus, the combined 1999 category was disaggregated into capital and operating cost categories.

Capital Expenditures and Operating Costs

In the 2004 pretest PACE survey, capital expenditures and operating costs were partitioned into two distinct items (as opposed to being integrated into a single matrix as in the 1999 survey). The pollution abatement capital expenditures section is separated into the four activity categories (treatment/capture, recycling, disposal, and pollution prevention). During the preliminary on-site visits, facilities indicated that they could separate capital expenditures by these categories, and these categories are helpful in thinking through the types of expenditures

that are related to pollution abatement. These four activity categories are summed to obtain total pollution abatement capital expenditures. The survey also asks for facilities to disaggregate total pollution abatement capital expenditures by media type (air emissions, water discharges, and solid waste) and by hazardous versus nonhazardous waste. Total pollution abatement capital expenditures are disaggregated by percentages across these categories because these responses are more likely to be "good faith" estimates as opposed to engineering calculations.

Total pollution abatement operating costs are divided into four categories: 1) salaries and wages, 2) fuels, electricity and other utilities and energy costs, 3) materials and supplies; and 4) contract work, leasing and other purchased services. During the preliminary on-site visits, facilities indicated that they were most likely to track operating costs by these categories. Total pollution abatement operating costs are the sum of these four cost categories. Total pollution abatement operating costs are disaggregated by percentage by activity category, medium, and hazardous/nonhazardous.

The expert panel recommended against using a matrix form similar to the 1994 survey where operating cost categories (depreciation, salary/wages, fuel/electricity, contract work/services, materials/leasing) were asked by pollution medium. Facilities indicated that they do not track operating costs by pollution media. As a result, it was decided to build total pollution abatement operating costs first and then disaggregate the *total* by medium (as opposed to completing the entire matrix, which could potentially result in missing information).

Depreciation was included as part of operating costs all previous PACE surveys but not the 1999 version of the PACE survey. In the past, it has been included as an operating cost category similar to labor, energy, and materials. However, there were differing opinions across the panel in terms of the value of the depreciation information. In the end, the expert panel agreed that it was desirable to continue collecting this information but to keep it as a separate line item (separate from the operating cost categories).

Leasing was treated differently in earlier versions of the PACE survey. In the 1994 version, it was included as part of materials and as part of pollution abatement capital expenditures if the expenditure met Financial Accounting Standards Board standards. However, facilities indicated that they consider leasing an annual expenditure; hence, instructions were added stating that leasing should be included as part of operating costs in the contract work, leasing, and other purchased services category.

All of the facilities visited expressed some difficulty in calculating pollution abatement operating costs, especially those associated with air emissions, because many of the pollution prevention systems, such as air handling, are integrated with normal operating activities. Several facilities suggested we ask about environmental controls (number and/or capacity) because this information helped facilities identify and calculate operating costs associated with air emissions. To address their concerns, we expanded the list (which became Item 2A, see Appendix A) that asked about the type and number of air pollution control devices operating and newly installed at the facility during 2005. During the preliminary site visits, facilities indicated that they had little trouble completing this section.

Hazardous

Based on the facility visits, distinguishing between costs for hazardous and nonhazardous pollution abatement was not always clear. For instance, there is often one piece of equipment used to abate both hazardous and nonhazardous pollution at a facility. Thus, it is unclear what portion of capital or operating costs for this piece of equipment should be attributed to hazardous and what portion should be attributed to nonhazardous. In both the 1994 and 1999 surveys, costs were disaggregated by hazardous versus nonhazardous abatement so the expert panel recommended that this question be included in the pretest (primarily to maintain longitudinal consistency). However, pretest responses varied greatly across facilities within the focus industries indicating facilities may have trouble identifying this item.

Voluntary Expenditures

The issue of asking for the share of pollution abatement expenditures that is voluntary was discussed by the expert panel. However, it was decided not to include a question related to voluntary expenditures. Nowhere else on the survey are there questions about the motivation of expenditures. In addition, many voluntary pollution abatement expenditures are made to gain a competitive position or in anticipation of future regulations, and it would be difficult to distinguish voluntary pollution abatement expenditures from profit-motivated voluntary activities.

Costs Not Included in Previous Items

A section was added to capture all costs not included in the estimates of pollution abatement capital expenditure and pollution abatement operating cost. This section includes questions on permits and fee, site cleanup, product redesign or reformulation, and tradable permits.

During the site visits, facilities raised questions about where they should report labor expenditures used to fill out permits. Labor costs or contract work associated with permits should not be included in the estimate of payments for permits and fees. The expert panel decided that the instructions should be explicit that *all* labor and administrative costs related to permits should be included as part of salaries and wages in pollution abatement operating costs. The instructions also indicate that permit costs (one time or annual) should not be included as part of pollution abatement capital expenditures. Annual or one-time permit charges and fees should be reported as part of total payments to government entities for permits and fees related to pollution abatement.

Product redesign includes capital expenditures and operating costs of product reformulation intended to reduce the pollution generated by consumers or users of products manufactured at the facility (downstream pollutants). Although these costs are not related to pollution generated at the facility, they can represent a large part of the cost of regulatory compliance for certain industries. Some of the participants in the one-on-one interviews, particularly those in the petroleum industry, requested the inclusion of this question. Refineries cited large capital expenditures for desulferization equipment to support regulations that are phasing in low-sulfur gasoline requirements.

The expert panel agreed that a question related to the total cost of tradable permits bought and sold should also be included as part of the pretest and pilot. In addition, the item on tradable permits requested the number of permits exercised this year by type (SO_2, NO_x, and other). However, the response rate for these questions was low and the panel decided to drop questions regarding tradable permits from the 2005 PACE survey. The panel noted that this information was available from other sources.

Cost Offsets

Cost offsets are related to pollution abatement operating costs but are included as a separate item on the form. Even though a question on cost offsets was historically included on the PACE survey, they were not asked about in the 1999 survey. The expert panel thought this was an important issue and included it on the 2004 PACE pretest and pilot survey. During the on-site visits, we asked facilities about cost offsets and found that they understood this category and could easily provide revenue from recycling activities.

Guidelines and Definitions Document

The *Guidelines and Definitions* document provides survey definitions, general instructions on how to complete the survey, examples of costs and expenditures to be included and/or excluded, and examples related to each item on the form. The document defines the types of media (air emissions, water discharges, and solid waste), pollution abatement activities (treatment/capture, recycling, disposal, and pollution prevention), and pollution prevention activities (raw materials substitution or modifications, leak and spill prevention, and process/equipment modification/redesign). Two figures were included to illustrate the relationship between pollution abatement activities (see Figure 1 in the pretest *Guidelines and Definitions* document in Appendix A) and the overall structure of the survey (see Figure 2 in the pretest *Guidelines and Definitions* document in Appendix A). Facilities indicated that these figures were helpful because it allowed them to visualize all the categories together and determine in which category a specific cost should be included.

The *Guidelines and Definitions* document also includes a new, separate section of additional examples of pollution abatement activities along with examples on permits and fees, site cleanup, product redesign, and cost offsets. In addition, customized examples were developed for four industries (iron and steel, pulp and paper, electric utility, and petroleum) to be included as part of the pretest.

During the initial one-on-one interviews, we learned that it was common for support for some areas related to pollution abatement (e.g., filling out permits, R&D) to be provided partially or completely at the corporate level. The instructions clearly state in several places that only corporate expenditures directly billed to the facility should be included in the cost estimates.

Based on the information garnered during these one-on-one interviews, many modifications were made to the *Guidelines and Definitions* document prior to the pretest. Some of the changes include:

- The list of statutes under Additional Information was dropped.
- The instructions on how to estimate incremental costs were moved from the back of the guidelines to the front of the guidelines so they would be read earlier in the process of completing the survey.
- The definition of disposal was modified to indicate that discharge of pollutants into the environment is included in this activity category.
- The concept of “primary purpose is pollution abatement” (as opposed to profit motivated) was emphasized.
- Examples were provided to illustrate the different types of product redesign.

- Instructions were added to explain that the number of employees recorded in the survey is conceptually the total number of labor hours at the facility in 2004 divided by 2,000 hours.
- The instructions explained that permit preparation should be included as part of labor costs in pollution abatement operating cost, not permits and fees.
- The *Guidelines and Definitions* document was modified to underscore that tradable permits should include SO_2, NO_x, and other regional regulatory permits (or credits) and that tradable permits that have been exercised versus purchased and banked should not be included. An example for this item was also included.

2.2 Phase 2: Pretest of the 2004 PACE Survey

The comments from the one-on-one interviews, the expert panel, and the EPA workgroup gathered during phase 1 were used to draft the 2004 pretest PACE survey form and guidance document. An information collection request (ICR) was submitted to the Office of Management and Budget (OMB) to conduct a pretest of the 2004 PACE. The pretest targeted facilities from the largest polluting industries but also included facilities from lesser polluting industries (see Chapter 4 for a complete list of industries), based on previous PACE expenditures. Facilities recruited to participate in the pretest were sent a copy of the survey form and the *Guidelines and Definitions* document and instructed to complete and return the survey form within 4 weeks. Facilities in the pulp and paper, iron and steel, petroleum, and electric utility industries received instructions with industry-specific examples. A common set of instructions with general examples was sent to facilities in all other industries. Appendix A contains a copy of the pretest survey instrument and the *Guidelines and Definitions* document.

As part of the pretest, an RTI economist and engineer visited each facility to evaluate the results provided on the survey instrument and obtain feedback on the guidance document. The visit also included a walk-through of the facility with facility representatives to identify pollution abatement techniques in operation that could be used later to develop independent cost estimates. The objective of testing the survey form and guidance document coupled with the on-site visit was to assess the survey instrument and obtain input for modifications to the survey form and guidance document. The goal of the pretest and pilot survey was to increase the accuracy and reliability of the estimates of pollution abatement capital expenditures and operating costs in any future, full-scale implementation of the survey instrument. A summary of the pretest data collected from participating facilities is presented in Section 3. Findings from the on-site visits are presented in Section 4.

2.2.1. Pilot Survey

In addition to the pretest of the draft survey instrument and *Guidelines and Definitions* document, the process of finalizing the 2005 PACE survey also included a pilot survey. The pilot survey was a mandatory survey administered by the U.S. Census Bureau to a sample of approximately 2000 manufacturing facilities.

To increase the efficiency of both the sample for the pilot and the full 2005 PACE survey, approximately 30,000 screener cards were mailed to facilities to ascertain their level of pollution abatement operating costs and capital expenditures. Based on the information obtained from the screener survey a sample of approximately 2000 facilities was selected to receive the pilot PACE survey. The goal of the pilot survey was to determine if there were any systematic problems with the survey content and any issues with the ability of facilities to respond to the survey. Given this objective, the pilot sample targeted facilities that were deemed to have significant levels of pollution abatement activity. Hard copies of the survey were mailed to facilities and asked to be returned within 30 days. The response rate from the pilot survey was approximately 65%. Findings from the pilot test were discussed at the expert panel meetings, and recommendations were incorporated into the 2005 PACE survey and guidance document.

SECTION 3. RESULTS FROM THE PRETEST OF THE PACE SURVEY

The pretest of the PACE survey was conducted during the summer of 2005 collecting information on pollution abatement operating costs and capital expenditures incurred in 2004. Eighteen facilities participated in the pretest of the PACE survey. The industry sectors represented by these facilities include chemical, computer and electrical equipment, electricity generation, fabrication metal, iron and steel, pulp and paper, furniture, plastics and petroleum. The petroleum sector is included under the "other" category because of confidentiality issues. Table 3-1 lists the industry sectors, along with average employment and value of shipments at the facilities in each industry sector. The industry sectors were selected to be representative of high and medium emission sources, and both large and medium-size facilities were included. Facilities ranged in size from 115 to 2,700 employees, with value of shipments ranging from approximately $20 million to $6.2 billion.

Table 3-1. Average Facility Size by Industry Sector

Sector	Average Employment	Average Value of Shipments
Chemical	492	$414,934,000
Computer and electrical equipment	1,646	NP
Electric utility	221	$494,146,500
Fab metal	267	$91,385,500
Iron and steel	407	$407,293,667
Paper	774	$471,155,750
Other[a]	1,537	$2,159,449,333

[a]Other includes furniture, petroleum, and plastics facilities.

NP: Facility viewed this information as confidential and did not provide it.

The survey asked for capital expenditures (Item 3) by pollution abatement categories: treatment, recycling, disposal, and pollution prevention. As shown in Table 3-2, not all facilities reported capital expenditures for pollution abatement in 2004. Because capital expenditures are generally episodic, this pattern is not unexpected. Fourteen of the facilities reported capital expenditures of less than $1 million, with six of the facilities reporting no capital expenditures in 2004. Average capital expenditures were greatest for the electric utilities. These facilities reported capital expenditures of approximately $50 million for the installation of new selective catalytic reduction (SCR) systems. These were classified as "treatment" and hence dominated all other pollution abatement activity categories.

Table 3-2. Average Pollution Abatement Capital Expenditure: Items 3A and 3B

Sector	Treatment	Recycling	Disposal	Pollution Prevention	Total Capital Expenditures	Cost per Value of Shipments
Chemical	$4,500	—	$524,500	$23,000	$552,000	$0.0010
Computer and electrical equipment	$5,500	—	$12,500	$205,500	$223,500	$0.0001
Electric utility	$58,672,000	—	$830,500	$96,000	$59,598,500	$0.1397
Fab metal	—	—	—	—	—	—
Iron and steel	$21,000	—	—	$264,333	$285,333	$0.0010
Paper	$1,547,750	$6,500	$131,500	$274,750	$1,960,500	$0.0047
Other[a]	$11,778,667	—	—	$158,333	$11,936,667	$0.0019
Total Average	$8,830,778	$1,444	$181,167	$167,556	$9,180,889	$0.0172

[a]Other includes furniture, petroleum, and plastics facilities.

NP: Facility did not report value of shipments.

Table 3-3 shows that the share of capital expenditures and operating costs related to hazardous pollutants varies from zero to greater than 90 percent, with the chemical computer and electrical equipment industries having the largest share of expenditures and costs related to hazardous pollutants.

The survey partitioned operating costs (Item 4) into four cost categories: 1) salaries/wages, 2) fuels, electricity, and other utilities and energy costs, 3) materials and supplies, and 4) contract work, leasing, and other purchased services. Operating costs were relatively evenly distributed across the four cost categories (see Table 3-4). Salaries and wages account for the largest share at 31 percent. The iron and steel sector reported the largest operating costs, followed by the electric utility and paper sectors.

Table 3-5 shows that most operating costs were associated with treatment activities followed by disposal and recycling activities. Ten percent of operating costs were reported to be associated with pollution prevention activities. However, as described in Section 4, many of these costs were misclassified and should have been reported as treatment. Table 3-6 shows that operating costs were generally distributed evenly across air emissions, water discharges, and solid s. Multimedia pollutants account for only 2 percent of operating costs.

Table 3-3. Percentage of Capital Expenditures and Operating Costs for Hazardous Pollutants: Items 3C and 4E

Sector	Hazardous Capital Expenditures	Hazardous Operating Costs
Chemical	92%	85%
Computer and electrical equipment	47%	46%
Electric utility	0%	0%
Fab metal	NA	27%
Iron and steel	27%	16%
Paper	32%	22%
Other[a]	33%	46%

[a]Other includes furniture, petroleum, and plastics facilities.

NA: Industry respondents reported no capital expenditures.

Table 3-4. Average Operating Costs per Facility: Item 4A

Sector	Salaries/ Wages	Fuels	Materials	Contract Work	Total Operating Costs	Cost per Value of Shipments
Chemical	$1,449,000	$560,500	$852,500	$1,019,500	$3,881,500	$0.010
Computer and electrical equipment	$983,500	$1,027,000	$438,000	$239,500	$2,688,000	NP
Electric utility	$1,661,500	$50,000	$3,888,500	$1,065,000	$6,665,000	$0.015
Fab metal	$189,500	$67,500	$151,000	$146,000	$554,000	$0.008
Iron and steel	$919,333	$6,181,000	$1,181,333	$2,355,667	$10,637,000	$0.030
Paper	$1,666,250	$1,658,750	$1,234,000	$1,797,500	$6,356,500	$0.027
Other[a]	$1,715,667	$42,667	$10,333	$1,561,667	$3,330,333	$0.003
Percentage	31%	22%	22%	25%	100%	$0.015

[a]Other includes furniture, petroleum, and plastics facilities.

NP: Facility did not report value of shipments.

Table 3-5. Share of Operating Costs by Activity Category: Item 4C

Sector	Treatment	Recycling	Disposal	Pollution Prevention
Chemical	45%	17%	35%	3%
Computer and electrical equipment	40%	38%	15%	8%
Electric utility	44%	7%	48%	1%
Fab metal	84%	4%	12%	1%
Iron and steel	57%	6%	2%	35%
Paper	70%	5%	24%	1%
Other[a]	49%	12%	26%	13%
Average for all facilities	57%	11%	22%	10%

[a]Other includes furniture, petroleum, and plastics facilities.

Note: Sectors may not sum to 100 percent due to rounding.

Table 3-6. Distribution of Operating Costs by Media: Items 4D and 4E

Sector	Air Emissions	Water Discharges	Solid s	Multimedia Pollutants
Chemical	15%	40%	43%	3%
Computer and electrical equipment	43%	44%	13%	2%
Electric utility	42%	3%	55%	0%
Fab metal	22%	55%	24%	0%
Iron and steel	41%	32%	25%	2%
Paper	42%	32%	25%	1%
Other[a]	44%	20%	29%	7%
Average for all facilities	37%	31%	29%	2%

[a]Other includes furniture, petroleum, and plastics facilities.

Note: Sectors may not sum to 100 percent due to rounding.

Table 3-7 provides average reported values by industry for other key items. Permit and fee costs varied by sector with the iron and steel, paper, and other industry sectors reporting the largest costs. The largest cost offsets were reported by the computer and electrical equipment and iron and steel industries. The iron and steel industries reported the largest book value of pollution abatement capital.

Table 3-7. Average Per-Facility Expenditures

Sector	Permits and Fees (Item 5A)	Cost Offsets (Item 6A)	Book Value of Pollution Capital (Item 7C)
Chemical	$9,500	$978,000	$17,244,500
Computer and electrical equipment	$10,000	$2,321,500	$10,937,500
Electric utility	$153,000	$564,000	$75,000,000
Fab metal	$85,000	$15,500	$879,000
Iron and steel	$415,667	$2,077,000	$177,274,667
Paper	$297,000	$100,500	$71,447,250
Other[a]	$226,000	$11,667	$70,110,000

[a]Other includes furniture, petroleum, and plastics facilities.

SECTION 4. FINDINGS FROM FOLLOW-UP VISITS

After each facility returned their completed pretest PACE survey form, RTI staff conducted an on-site visit to discuss their responses and tour the facility. The objectives of the follow-up visits were a) to assess the ability of respondents to provide accurate data on pollution abatement capital expenditures and operating costs, b) to obtain information on abatement equipment and activities that RTI could use to develop independent costs estimates to compare with facility estimates, and c) to use this information to improve the survey instrument and *Guidelines and Definitions* document.

To assess the facility's ability to provide accurate data, RTI asked about the tracking and accounting systems the facility used to obtain cost data and the processes used to distinguish between environmental and non-environmental costs. Of specific interest were

- what share (if any) of their environmental accounting process was automated or formalized,
- what staff were involved in completing the survey, and
- how the facility interpreted key definitions such as recycling and pollution prevention.

As part of these discussions, RTI asked about the types of abatement equipment and activities used to develop the cost estimates reported in the survey. RTI used this information to develop their own pollution abatement operating cost and capital expenditure estimates. RTI estimates were then compared to the costs reported by the facility on the PACE survey (these comparisons are presented in section 5). Although the limited sample size does not allow for drawing statistical inferences, the comparisons do provide insights into the reasonableness and consistency of pollution abatement costs reported by facilities. In this section we discuss the feedback provided by facilities on the survey form and guidance document. In section 5 we present our independent cost estimates and then discuss how these estimates compare to the values reported by facilities.

4.1 Approach to Completing the Survey

Researchers have expressed concerns that facilities may have an incentive to overstate pollution abatement costs and expenditures. However, based on our interviews with facilities we found no evidence of such behavior. In many instances, respondents had questions about what should and should not be included in certain items, such as air handling units or nonhazardous

waste disposal. However, there was no evidence that respondents were trying to bias the results (high or low). In several instances, facilities appeared to be conservative by not including some items, such as air permit costs where no pollution abatement was involved.

Whereas the environmental managers typically make a good-faith effort to accurately complete the instrument, there was a cap on the level of effort they were willing to devote to completing the survey. Several facilities said they took the "recommended burden" of about 10 hours reported in the OMB statement on page 7 of the survey as the estimate of time they should take to complete the survey form. Consequently, as discussed below, respondents did not always attempt to provide detailed cost estimates, such as electricity usage associated with pollution abatement equipment, which could potentially lead to underreporting of costs.

4.2 Procedures for Completing the Survey

Most facilities obtained cost information directly from the company's main accounting system (such as SAP Enterprise Software or Oracle-based systems) and this information, coupled with the professional judgment of the environmental manager, was used to complete the survey. However, from the site visits we learned that many industries are already collecting some form of pollution abatement cost data. Even though no facility visited had a dedicated environmental cost tracking system, several flagged capital projects and/or operating costs as environmental expenses. Being able to identify environmental costs was often motivated by other industry surveys administered by trade associations. For example, some facilities in the pulp and paper industry had developed an internal tracking process to estimate environmental costs in response to periodic cost surveys distributed by the American Forest and Paper Association (AF&PA). In addition, the accounting processes used by electric utilities were based on Federal Energy Regulatory Commission (FERC) categories, some of which target environmental costs.

Capital expenditures, as opposed to operating costs, were more likely to be tracked in existing accounting systems as environmental expenses. Capital projects for environmental purposes are simpler to identify. Capital expenditures are tracked against well-defined budgets and each entry is frequently coded to identify the purpose of the expenditure (e.g., environmental, process maintenance, quality improvement). However, during the process downtime needed to perform a capital environmental project, facilities may perform other types of maintenance, and these additional non-environmental costs can be difficult to isolate.

Accounting systems typically track all purchases, labor costs, utility costs, and contracting costs. In most cases, there is no separate account of environmental costs; however, all environmental managers stated that they could identify environmental expenditures from the

details in the accounting system. For example, associated pollution abatement operating costs were determined using equipment utility requirements, solvent recovery data and costs, and estimated labor hours for all environmental staff (including technicians and operators running the solvent recovery center). In many instances, the environmental manager used a series of spreadsheets developed to provide estimates of annual environmental costs for industry trade associations and others.

Finally, most facilities indicated that if the PACE survey is conducted annually they would institute a more formal cost-tracking system. Furthermore, some of the environmental managers at the facilities had previous experience completing earlier versions of the PACE survey and in these instances had a much better understanding of the concepts and definitions related to pollution abatement. This implies that as environmental managers become more familiar with the PACE survey, the quality of the data (both accuracy and consistency) may increase over time.

4.2.1 Cost Centers

Cost centers are typically based on individual production departments allowing the central online database to be used to generate cost reports for a well-defined set of operations. For example, many wastewater treatment systems were set up as separate cost centers because, if large enough, they are tracked as a separate department with staff and an operating budget. One large integrated iron and steel facility's accounting system had multiple environmental cost centers, including a blast furnace, wastewater, BOF wastewater, caster wastewater, baghouses, and road dust control. These covered most, but not all, of their environmental costs.

Whether a facility has environmental cost centers as part of their accounting system affects how inclusive cost estimates may be and the environmental engineers' knowledge of what is included in the cost estimates. Environmental cost centers were most common at large facilities with multiple/large pollution abatement systems. They seemed to significantly reduce the time required to complete the survey and are probably more likely to capture electricity costs because these centers have their own electricity meters.

However, at large facilities the environmental managers had limited knowledge about which line items were included in the cost centers and did not have much incentive to find out more detail. Thus, it is difficult to assess whether all the costs are actually related to pollution abatement. In contrast, at smaller facilities with no environmental tracking systems, the environmental manager had to flag individual items in the accounting system by hand to estimate costs. In most cases, the environmental manager had a complete understanding of all the

pollution abatement activities at the facility, potentially providing a more accurate determination of what should and should not be included. The downside of this more hands-on approach is that, because costs were being estimated from scratch, some items might have been too difficult or time consuming to calculate and hence were omitted. Because the site visits found that environmental cost centers are important in the burden and potential accuracy of the PACE surveys, it may be useful as part of the survey to ask if the facility's accounting system has cost centers set up to track environmental expenditures.

4.3 Assessment of *Guidelines and Definitions* Document

Item 9 of the pretest survey included three questions related to the *Guidelines and Definitions* document that accompanied the survey. These questions were designed to determine if respondents used the *Guidelines and Definitions* document and if they found the document and examples adequate. The item also included four "quiz" questions designed to test a respondents understanding of pollution prevention versus pollution treatment. These questions presented example projects and respondents were asked to classify the project as either pollution treatment, pollution prevention, or not to be included because the primary motivation was not pollution abatement.

All of the facilities indicated that they read/used the *Guidelines and Definitions* document while completing the survey (Item 9A). Eight-two percent reported that the document and the instructions embedded in the survey were sufficient to complete the survey (Item 9B) and 88 percent responded that the illustrative examples on pages 13 through 15 were useful (Item 9C). Overall facilities answered 88 percent of the "quiz" questions correctly, indicating a basic understanding of the key underlying definitions. The three "quiz" questions ask if the respondents could correctly classify costs as treatment, pollution prevention, or profit motivated (not to be included). Ninety-two percent answered Item 9D (treatment) correctly, 82 percent answered Item 9E (not included) correctly, and 88 percent answered Item 9E (pollution prevention) correctly.

Although all respondents had suggestions for improvements to the *Guidelines and Definitions* document, most of them thought the instructions were straightforward. They were generally in favor of adding additional examples to help clarify the definitions. They also indicated that examples that were related to unique activities conducted at their facility would be useful.

Many facilities had questions about which costs should be included as pollution prevention and how to interpret definitions of pollution abatement activities (such as recycling versus disposal). In general, individuals who had been involved in completing the survey in prior years had much less trouble understanding the definitions (about one third of respondents had completed a previous PACE survey).

Environmentally-Motivated Investments

The concept of an investment or activity being motivated by profit rather than pollution abatement was straightforward for most facilities. However, frequently an investment generated co-benefits (increased efficiency and decreased emissions), and because investment decisions were typically made at corporate headquarters, respondents sometimes had difficulty assessing the motive of the investment.

We encountered many unique situations that affected reporting. For example, several facilities operate trash compactors because their disposal costs are calculated by volume and not weight. The trash compactors are profitable to purchase and operate because they significantly reduce disposal costs. However, they would not be operating in the absence of environmental requirements for safe disposal. Hence, they should be included as pollution abatement costs, but this was unclear to the facility.

A few facilities needed the concept of pollution prevention explained several times. For example, the site visit team would state “In the absence of all environmental concerns, if your company would have undertaken the investment or activities anyway, then it should not be counted as pollution prevention.” Eventually everyone was able to fully understand the intent of the survey, even if they did not have the information available to make the distinction between abatement and other expenditures.

Incremental Costs

Facilities were comfortable with the concept of incremental costs associated with pollution abatement. Several facilities indicated that they purchased low-sulfur fuels, and in these instances they used the price difference between the high-sulfur and low-sulfur fuels to calculate costs reported on the survey. Difficulties in identifying incremental costs typically came not from a lack of understanding of the concept, but because, in many instances, equipment or fuel upgrades also resulted in increases in production efficiency. For example, a manufacturing facility indicated that it had recently upgraded its coating spray guns, but it was not sure if the motivation for the investment was to lower material coating costs because of the improved accuracy of the guns or to reduce VOC emissions by using less coating. Therefore, this facility

was unsure whether to include the costs of upgrading its coating spray guns as pollution abatement expense.

Recycling Versus Disposal

The distinction between recycling and disposal was an area of confusion. Much of what solid waste facilities dispose of is recycled downstream prior to being landfilled. For example, metals are recovered from baghouse dust and slag in the iron and steel industry after they leave the facility. The facility pays a reduced disposal fee but typically does not receive revenues (offsets) in return. Some facilities wanted to classify the transportation costs associated with baghouse dust as recycling costs because recycling activities were being conducted downstream and because of the negative connotation of classifying it as disposal. Several facilities said that they used to dispose of these materials, but now they recycle them.

4.3.1 Errors of Omission and Commission

One of the more significant problems with facilities' estimates of expenditures and costs are errors of omission and commission. Large items that are mistakenly included or omitted are likely to account for significant variation in reported costs across facilities. For example, one company incorrectly omitted all disposal costs because they were not hazardous. Inclusion of these disposal costs would have more than doubled their total reported operating costs. Another facility mistakenly included all costs associated with their annual sewer bill, which was mostly clean water. This inflated their annual costs by approximately 40 percent. As discussed in Section 7, more specific examples were added to the *Guidelines and Definitions* document to help minimize this reporting problem. In contrast, cost estimates that were taken from an accounting system (capital expenditures, materials and suppliers, contract work) or calculated using simple spreadsheets (salaries and electricity cost) appear to be more accurate.

Errors of commission can probably be identified by analyzing outliers. For example, an entry such as $145,000 in permits and fees (inclusion of water bill) for a medium-size facility may be questionable because based on facilities of similar type and size, permits are more likely to be in the range of $10,000 to $20,000. However, errors of omission will be more difficult to identify using data analysis tools. It is more difficult to assess whether a facility left out a share of their costs.

4.4 Assessment of Item Survey Responses

This section discusses comments and issues facilities had with specific items on the survey. An engineering assessment of the reported expenditures and costs is presented in Section 4.5.

4.4.1 Item 1: Facility Information

Employment (Item 1Da)

In most cases, the number of full-time equivalent (FTE) employees was obtained directly from the company's human resource records. In a few cases, the facility was unsure how to determine "production" workers versus "all other employees" and guessed at the division between the two categories. It was suggested that a question be added to ask how many FTEs are classified as environmental managers. We learned that facilities tend to focus primarily on environmental managers' labor hours in the salaries calculations (Item 4Aa) because it was difficult and time consuming to calculate the time spent by employees on operation and maintenance (O&M) activities related to environmental activities. The number of FTEs used for environmental managers would provide some information on the extent to which the O&M labor effort is included in the reported value for salaries and wages.

Production Capacity (Item 1Db)

Respondents found it difficult to indicate the production capacity "units" in Part 1D. Many facilities did not know what units to use, and the units provided by the facility in the "other" category varied greatly. Thus, comparisons of production across manufacturing industries and even within industries may be difficult. For example, one chemical company reported the amount of dry pharmacologically active ingredients produced. However, they also mix the active ingredients with various other substances to create the final dosage forms of the drugs (i.e., tablets). In another example, a facility used multiple processes to manufacture many different products, and as a result, reported the total number of machine (major equipment) production shifts.

In industries, such as pulp and paper, where "actual production" was an easy number for them to come up with, "production capacity" was quite difficult because they are capable of making a variety of grades of paper (with different thicknesses), each of which would result in a different overall "capacity" for the facility. One suggestion was to revise the question to use check boxes with ranges for capacity relative to actual production (e.g., 0 to 5 percent above actual; 5 to 10 percent above actual; 10 to 20 percent) rather than asking for a single capacity figure. Other comments on units that were industry specific included the following:

- All facilities visited in the iron and steel industry indicated that the production value should be in terms of melting capacity (rather than capacity from the rolling mill or the tons of steel shapes shipped) because most of the environmental expenditures are associated with the furnace. This is referred to as "raw steel" production, and the facilities said that this is a better parameter for normalizing expenditures than tons of

steel shipped because some plants purchase semifinished steel shapes from other plants to use excess rolling mill capacity.

- The electric utility facilities visited indicated that kWh (not kW) was the appropriate measure of production and would be a better indicator of annual costs compared to kW.

In contrast, the dollar value of production was simple to provide and is already reported by these facilities for the Economic Census. Most facilities thought that this would be the most reliable figure for normalizing costs for comparison across facilities. Although there is always the exception—one facility shipped all its output to a second facility within the same company; thus, it had difficulty determining the value of shipments. Because of the difficulty facilities had in identifying consistent "units," the capacity question was dropped from the survey. In its place the expert panel recommended that facilities who do not receive the ASM survey be asked to report their value of shipments on the 2005 PACE survey.

4.4.2 Item 2: Pollution Abatement Activities

Facilities generally had no trouble indicating the number of air pollution control devices (APCDs) operating or newly installed (Item 2A). Most facilities indicated they liked the question and thought that it should remain in the final survey. However, suggestions were offered on modifying or expanding the list of control devices provided in the pretest instrument, because in several instances, facilities had difficulty determining the appropriate category. The most common suggestions were the following:

- baghouses and fabric filters should be listed as separate line items,
- wet scrubbers should be added as a separate line item, and
- spray booths should be added as a separate line item.

In Item 2B, there was some confusion about whether the annual quantity of waste water treated and discharged water should be additive. Some facilities said that all treated wastewater is discharged (hence the values are the same). Other facilities treat and reuse wastewater, recirculating it many times a day in closed loop systems and have no discharge. In addition, many facilities discharge clean water directly into rivers at no cost. In most instances, the facilities interpreted and answered the question correctly. Because there was initial confusion and uncertainty, more examples were added to the instructions to help clear up the confusion. In the 2005 PACE survey, Item 2B was revised to ask about "treated on-site" and "treated off-site" because these activities are better correlated with pollution abatement costs (see Section 7.1 for more details).

The annual quantity of solid waste treated or disposed of was the most difficult question in Item 2 to answer (Item 2Cd). One issue cited by several facilities is that there is no place to enter disposal, treatment, or recycling of solvents or sludge. This caused problems for several facilities because waste solvents and sludge are classified as solid waste under the Toxic Release Inventory (TRI). Some other questions or areas of confusion related to solid waste that were raised during the site visits include the following:

- Some solid waste is burned as fuel and thus never disposed of. For example, sawdust collected by baghouses is burned to generate electricity, and it was unclear if this should this be included as treated solid waste, or if the saw dust is a valuable by-product (baghouse operations are always counted as pollution abatement).
- Should wet or dry sludge weight be reported (85 percent of the wet weight is water)? Wet sludge is sometimes disposed of through land spreading. Also, should the amount of wet sludge dewatered be included in "treated" and the dried sludge weight be included in "disposed of"?
- Steel mills ship electric arc furnace (EAF) dust to a zinc smelter for recovery of the zinc and slag, which is then processed for resale. The plant representatives thought the survey was unclear on how to classify this type of waste. The plant would have liked to have "recycling" listed as an option in Item 2Cd. However, the only choices were "treated" or "disposed of." Steel mills were emphatic that they did not consider the shipment of slag off-site as disposal, stating that "the slag is not being disposed of, it is being sent offsite for recycling" (even though they received no revenue back—only lower disposal costs).
- An electric utility explained that their state laws classify coal ash as a "special waste"; consequently, they did not include the facility's coal ash tonnage in the annual quantity of solid waste sent to municipal landfills.

4.4.3 *Item 3: Capital Expenditures*

As indicated above, pollution abatement capital expenditures are readily tracked by facilities' accounting systems and are likely to be accurate. Facilities track actual capital cost expenditures against their capital budgets, and most said they could easily identify which investment projects included an environmental component. However, a few had trouble isolating the environmental cost portion of projects when expenditures also include costs for non-environmental equipment. Environmental projects may include other work that needs to be done in the same process area as part of the environmental project. Facilities said they lose money when they are not running, so if equipment is taken off-line for environmental reasons, it makes sense for facilities to make any needed non-environmental modifications or upgrades at the same time, and these may be rolled into the project budget.

RTI determined during a site visit that one response was not correct. During discussions the respondent indicated that they had installed no new pollution abatement equipment in 2004, yet they had reported over $300,000 in capital expenditures for 2004. The environmental manager indicated that he was not sure where this number came from and implied that they had made an error.

Total Capital Expenditures by Pollution Abatement Activity. The large majority of the reported capital expenditures were associated with relatively few treatment projects. These included installation of new selective catalytic reduction (SCR) systems on boiler units. Many of these larger capital intensive projects were multiyear projects, and expenditures were partitioned over several years.

Recycling, disposal, and pollution prevention represented significantly less capital expenditures but a larger number of (smaller) projects. Disposal projects included holding ponds (such as ash retention) and storm water retention ponds along with associated pumping stations. Pollution prevention typically included capital projects for spill prevention and containment. In one instance, an underground storage tank was not leaking but was removed as a preventative measure and replaced with an above-ground storage tank.

Total Capital Expenditures by Pollution Media. Allocating capital expenditures by pollution media was relatively simple for all of the facilities. Capital projects are typically associated with a single media (air, water, or solid waste) and are easily partitioned. Most projects were related to air emissions.

It is unclear if facilities fully understood the category “multimedia pollutants.” Only three facilities reported a percentage for this category: one facility reported that 100 percent of their total capital expenditures were spent for multimedia pollutants while two facilities reported less than one percent was spent on multimedia pollutants. As discussed in Section 7, the multimedia pollutants category as a percentage of both total capital expenditures and total operating costs was not included on the 2005 PACE survey form.

Total Capital Expenditures by Hazardous Pollutants. The percentage of total capital expenditures spent for hazardous pollutants was difficult for most facilities to estimate. In several instances, the facility decided to count 100 percent of the cost of the project to bring the facility into compliance with EPA regulations as “hazardous” because the goal of most regulations is to achieve reductions in hazardous pollutants (even though both hazardous and non-hazardous are emitted from the facility). Other facilities said that their estimate of the percentage of total capital

expenditures spent on hazardous pollutants was a rough estimate, and some openly stated that it was simply a guess. Therefore, as discussed in Section 7.1, this item was dropped from the 2005 PACE survey.

4.4.4 Item 4: Operating Costs

The operating costs of pollution abatement were the most difficult items for facilities to estimate. Frequently, pollution abatement operating costs are not tracked separately - they are included as part of the overall business expenses.

Total Operating Costs by Cost Categories

Salaries and Wages: Salaries and wages appear to be generally reliable but potentially low. The reported value for salaries and wages was typically based on the number of environmental managers, and hourly labor associated with operation and maintenance (O&M) of pollution abatement equipment was added to this value. Spreadsheets were commonly used to tabulate the number of FTEs and apply the appropriate wages (and loading factors if needed).

However, sporadic O&M activities were frequently not captured. We often heard the comment that a certain activity only takes "5 minutes per day" or "15 minutes per week" or "we only recharge with chemicals twice a year," and many of these activities were not captured in the hourly labor estimates. For example, one facility did not include activities associated with wastewater treatment system operation or cumulative hourly labor for work orders issued for environmental equipment maintenance. Other facilities did not include lab technicians who perform some sampling for environmental compliance or labor hours for equipment operators to monitor smaller APCDs.

The salaries and hourly wages used in the cost calculations were generally pulled directly from the facilities' accounting or human resources systems. In most cases, as instructed in the *Guidelines and Definitions* document, they represented fully compensated wages (loaded with benefits). However, in some cases, the environmental manager filling out the survey was not sure if loadings had been applied (they did not always know what underlay the accounting numbers). As a result, reported salaries and wages are likely to be slightly understated due to not including labor for small or infrequent environmental activities and some wage rates not being loaded with benefits to account for full compensation. In an effort to mitigate this reporting problem, several examples were added to the *Guidelines and Definitions* document to provide guidance to facilities on how to estimate environmentally-related salary and wages.

As mentioned earlier, one potential modification to the salaries and wages category is to have respondents report separately the number of full-time staff classified as spending 100 percent of their time on environmental work. Most facilities had one or more full-time environmental manager or engineer. This portion of the salaries and wages estimate is fairly reliable. Then the less-reliable portion (salaries for occasional support from lab technicians, maintenance workers, and equipment operators) could be assessed separately since salaries and wages associated with these supporting activities were typically underestimated.

Fuels, Electricity, and Other Utilities and Energy Costs: For fuels, electricity, and other utilities and energy costs, several facilities stated upfront that they were not able to include all electricity costs associated with pollution abatement activities because they are spread across many different electricity meters. They indicated that it would be difficult (overly time-consuming) to determine all estimates of energy usage for pollution abatement, especially for large facilities. In these cases, facilities omitted some costs completely (leading to an underestimate) as opposed to trying to provide a rough estimate that could be included in their survey response. For example, one facility indicated that they omitted a) the cost of electricity to operate fans and blowers in exhaust streams and b) the cost of electricity to operate centralized refrigeration units that provide coolant for condensers, water for packed-bed and venturi scrubbers, and air used in the cleaning cycles for the pulse-jet baghouses because they were too difficult to estimate. In an attempt to mitigate this reporting problem several examples were added to the *Guidelines and Definitions* document to illustrate how fuel and electricity costs for pollution abatement could be estimated.

Electric utilities accounted for the largest share of omitted electricity costs. Neither of the two electric utilities that participated in the pretest reported any electricity cost associated with pollution abatement (one facility reported $100,000 for fuel oil, which was determined should not have been included in PACE). The utilities indicated that even though 1 to 5 percent of total electricity generation at the facility is used to power pollution abatement equipment (primarily for flue gas desulphurization), they have no way of measuring this energy usage. RTI estimated that annual energy costs at these facilities ranged from $5 to $20 million.

When facilities did provide an estimate for energy costs, they typically determined this estimate using a spreadsheet that listed all motors, horsepower (hp) size, etc., and then summed up the electricity requirements' total megawatt hours. Getting the electricity requirement information for pollution abatement equipment is not difficult, but it does take some time and effort.

One way to improve the quality of the energy cost data is to collect information on gas and oil use separately from electricity use. Facilities all track the costs of different fuels separately, and gas and oil costs for environmental use are sometimes more reliable because they are monitored separately. In one facility, where gas used for a regenerative thermal oxidizer (RTO) was not monitored separately, the cost estimate was based on averaging spring and fall monthly invoices because other heating loads were minimal during the spring and fall months of the year.

Determining the share of the energy costs associated with air-handling systems used for pollution abatement was confusing for many facilities. Some facilities said that they remove fumes and dust particles primarily for worker safety issues so they would be using their air-handling systems even if they did not have a baghouse. However, some facilities included all the horsepower required to pull the air into and through the baghouse in their estimate of energy costs. For facilities with large baghouses positioned hundreds of feet from the facility, the issue is clearer—motors that move air out of the facility are not related to pollution abatement - but the motors that pull the air to and through the baghouse are associated with pollution abatement.

However, for smaller manufacturing operations where the baghouses are attached or adjacent to the building, a single power source moves the air out of the facility and through the baghouse. Some of these smaller facilities included all energy costs associated with their air-handling systems, while others did not include any of the energy costs of their air-handling system. Based on the on-site interviews, facilities are more likely to exclude energy costs since, as discussed above, these units are not metered separately.

Materials and Supplies: Materials and supplies are generally tracked by accounting systems because they represent payments made to vendors. Most materials and supplies costs used for pollution abatement are easy to identify (e.g., chemicals used to treat wastewater are usually only associated with wastewater treatment). However, several facilities indicated that they may have missed smaller additional costs for materials and supplies. But they felt that these costs are minimal and not worth the effort of tracking down. For example, during one site visit RTI determined that materials for recharging a filtration system were not included. After talking with engineers and accountants, RTI determined that the facility used twenty bags per year at a cost per bag of $8. A total of $160 was omitted from material and supplies used for pollution abatement. Thus the reported material and supply costs could be slightly lower than true costs.

Contract Work, Leasing, and Other Purchased Services: Contract costs are readily tracked and tend to be dominated by costs associated with solid waste management (e.g., sludge

handling, operation of on-site landfill, and dredging of ash ponds). However, determining which contract maintenance costs to include or exclude from contract work is difficult and the decision was typically a judgment call made by the environmental manager. If contract maintenance work is included as a lump sum without extracting all the non-environmental costs, then data could be biased slightly high. For example, for some smaller facilities, all waste was typically combined (e.g., manufacturing, cafeteria, office) and disposed of under a single contract.

Total Operating Costs by Pollution Abatement Activity

Most facilities were able to determine the percentage of total operating costs for each pollution abatement activity category. However, there were some issues related to distinguishing between pollution treatment and pollution prevention and between recycling and disposal and these are discussed below.

Treatment: Two facilities indicated that "treatment" typically included some type of a chemical process. This narrower definition of treatment led to confusion and the inappropriate classification of some operating costs as pollution prevention by these facilities. Specifically, they did not think the baghouses fit the definition of treatment because they are simply capturing and removing particles from the air. After discussion, it was agreed that expanding the activity from"treatment" to "treatment and capture" would clarify the issue (see Section 7.1).

Recycling: The survey's intent is to capture on-site and off-site recycling costs incurred by the facility. Thus, if a facility has operating costs associated with on-site recycling or pays a third party for recycling services, these costs should be reported in Item 4Cb. However, many facilities had trouble distinguishing between off-site recycling and disposal costs. As previously discussed, one facility was adamant that they did not dispose of their waste; they sent it off-site to be recycled (even though they received no cost offset, just conceptually a lower disposal cost). However, these are disposal costs, even though some recycling is taking place prior to being landfilled. As a result, the share of recycling costs is likely to be overstated in these instances. Examples were added to the *Guidelines and Definitions* document to help clarify the distinction between recycling and disposal.

A related issue is that if the waste transportation cost exceeds the recycled material value, the facility is charged a disposal fee. In contrast, if the recycled material value exceeds the waste transportation cost, the facility receives a recycling offset. This may lead to an underestimation of recycling activity.

Disposal: From the site visits, RTI garnered that some facilities did not include disposal of manufacturing by-products because they were not hazardous. Those interviewed said that disposal of simple scrap materials did not seem environmentally motivated. We explained that the counterfactual would be to dump the scrap instead of paying to have it transported to an environmentally-sound landfill because in most cases the value of the product does not exceed disposal costs.

Pollution prevention: We encountered very few pollution prevention activities at the facilities we visited. For some facilities, the majority of operating costs reported were classified as pollution prevention, but in most instances, these were incorrect. For example, baghouses were classified as pollution prevention and not as treatment because the baghouse was not treating the dust; it was preventing it from entering the atmosphere. As discussed above, using the term "treatment and capture" will help to clarify that these activities are not pollution prevention.

Total Operating Costs by Pollution Media

Allocating total operating costs across the four types of pollution media (air emissions, water discharges, solid waste, and multimedia pollutants) was relatively straightforward for the facilities. Either cost centers or large components of systems costs were assigned to specific pollution media, or expert judgment was used to determine the percentages.

Total Operating Costs by Hazardous Pollutants

As with capital expenditures, determining the percentage of total operating costs spent for hazardous pollutants was difficult for many facilities. The typical method used to estimate the percentage spent on hazardous waste was to link it to the media percentages (air emissions, water discharges, and solid waste). For example, if all solid waste was hazardous, then Item 4E would be equal to Item 4Dc (if air emissions and water discharges were not hazardous). If a facility was unable to make this link, then they provided a rough estimate. No facility used spreadsheets or calculations to estimate the percentage of costs associated with hazardous waste. As noted above this item is no longer part of the survey.

4.4.5 Item 5: Costs Not Included in Previous Items

Permits and fees: The total payment to government entities for permits and fees are readily available in the facilities' accounting systems, and most facilities had no trouble reporting

these costs. However, there were a few instances where the facility incorrectly included or omitted the cost of facility permits. For example, one facility did not include the cost of their air permits because they said they were not abating pollution—they were simply venting to the atmosphere; thus, they thought the cost associated with the permits was not a pollution abatement cost. A second facility included all ($200,000) water discharge fees even though the water was clean and the discharge was required as part of normal manufacturing operations. In an effort to clarify the types of permits and fees that should be included in this category, examples were added to the *Guidelines and Definitions* document.

Site cleanup: Facilities were very aware of any site cleanup activities they were conducting. Site cleanup was typically contracted out so facilities' were able to obtain the capital expenditures or operating costs for site cleanup from their accounting system.

Product redesign: Only one facility (a petroleum refinery) listed costs (over $100 million) for product redesign in 2004. These costs were not associated with reducing pollutants at the facility, but the redesign resulted in cleaner-burning fuel. As discussed in Section 7.1, this item was included in the final version of the survey (even though it is *not* a PACE expenditure) because respondents want a place to report these costs.

Tradable permits: No facilities participating in the pretest indicated they traded permits in 2004. However, one facility said they did not like the phrase "tradable permits" because they think in terms of "credits" and were somewhat confused as to what costs should be reported. They suggested at least adding the phrase "tradable permits and/or credits" to the text.

4.4.6 Item 6: Cost Offsets

Facilities seemed to understand the difference between recycling for profit and offsets from pollution abatement related to recycling. And in most instances their accounting systems captured the recycling revenue related to pollution abatement. For large recovery operations such as recovery and regeneration of expensive metals (cobalt, platinum), the dollar value is sufficiently high that firms have special accounting systems in place to track the revenue returned. However, some smaller offsets may not be captured. For example, proper accounting of relatively small waste reduction/recycling efforts (such as cardboard and fiber drum compacting, can and drum crushing), or where revenue is returned to the plant as reclaimed product (solvents), seems to be difficult to track.

Several facilities indicated that the main cost savings from recycling are associated with filling up their landfill site more slowly. For example, one facility said that selling sludge

extended the site's landfill life from 25 to 50 years, so they only have to set aside roughly $200,000 each year for landfill closure costs, instead of $800,000 per year. However, they were unsure if this should be included as an offset (and did not report it).

4.4.7 Item 7: Depreciation

Deprecation expense: Depreciation expense for pollution abatement structures and equipment was obtained from the facilities' accounting system. Depreciation expenses for large equipment, such as wastewater treatment systems, were relatively straightforward to determine because wastewater treatment is commonly a separate business unit. Depreciation for other pollution abatement equipment was more difficult to identify because the equipment could be part of several different business units.

Gross book value of capital: Determining the gross book value of pollution abatement capital was a time consuming task for many facilities and the accuracy and completeness of the underlying information used in the calculation varied. The intent of this item is to obtain information on the total pollution abatement equipment in place and to potentially use the information as a "reasonableness" check for plant-level pollution abatement operating costs. However, the reliability of the reported value is questionable. If the equipment was fully depreciated, it was not always included. In other instances, facilities noted that they did not have records that specified if the capital investment projects were for environmental versus non-environmental purposes prior to about 1990.

4.4.8 Item 8: Burden

The reported burden ranged from 4 to 55 hours, with an average burden of 17 hours. Facilities indicated that many factors influence their level of effort, such as established automated environmental cost centers. If the survey was to be reinstated annually, most facilities said they would probably automate other categories and this could reduce their future reporting burden by approximately 50%.

4.4.9 Item 9: Review

Ninety percent of participants responded that the examples were useful and the instructions clear. Approximately 80 percent of the facilities were able to correctly answer the quiz questions, indicating that they either read the instructions and/or had previous knowledge of the terms and definitions.

SECTION 5. ASSESSMENT OF THE 2004 PRETEST PACE SURVEY ESTIMATES

RTI developed independent cost estimates for 74 percent of costs reported from the pretest of the PACE survey. For the remaining 26 percent of costs, primarily associated with materials and contract services, for which facilities obtained their cost estimates directly from their accounting systems, there was insufficient information available for RTI to develop independent cost estimates.

The on-site visits were used to collect the information needed to develop independent engineering cost estimates for pollution abatement capital expenditures and operating costs reported by the facilities. However, in many instances, the information necessary for detailed engineering calculations was not available. For example, to estimate electricity costs, we ideally would have had information on the horsepower rating of every one of the dozens of pumps and fans used for pollution abatement in the facilities.

In general, RTI is more likely to underestimate costs when information is incomplete. For example, many plants tend to overdesign systems, either to accommodate future expansion, handle surges, or ensure that they remain in compliance by performing well below their allowable limits for air and water discharges. RTI would not have knowledge of systems that are overdesigned and that are using more labor, energy, or materials than standard engineering cost manuals would predict. In these instances, because RTI estimates are frequently based on engineering cost manuals, RTI would underestimate the capacity of the units and hence underestimate associated capital and operating costs. Similarly, plants incur site-specific expenses because of plant configurations, space limitations, piping distances, etc., that we cannot accurately account for in our estimates. As a result, one would expect the independent engineering cost analysis to underestimate, rather than overestimate, the facility-reported costs.

In general, when EPA estimates the cost of a proposed regulation, the Agency does not make any claim for a greater accuracy than a nominal level of +/– 30 percent.[11] In addition, the lack of site-specific information can increase the uncertainty to +/– 50 percent. Uncertainty is greater for operating costs estimates (as compared to capital expenditures) because in many instances these estimates involve work practices where the level of effort is unknown or difficult to quantify and because costs are frequently based on incremental activities that build on existing practices.

[11]EPA Air Pollution Control Cost Manual, Chapter 1, pp. 1-4, EPA/452/B-02-001, January 2002.

5.1 Methodology for Generating Independent Cost Estimates

RTI generated independent engineering cost estimates to assess the accuracy of the reported costs (e.g., do they adequately capture the actual costs incurred by the facility, are the reported costs within the expected range). As noted in Section 4 of this report, accounting records served as the primary source of the cost estimates for most facilities' reported costs, particularly for capital costs, materials and supplies, and contract work, leasing, and other purchased services. Even when estimates rather than actual costs were provided, the estimates were often tied to actual costs (e.g., calculating electricity costs by determining total electricity requirements for pollution abatement and then multiplying the requirements by an actual electricity rate.)

RTI's independent cost estimates were developed using various cost references and available information on the cost items as provided by the facility. In most cases, follow-up phone calls and e-mails were made after the site visit to collect more detailed information on specific cost items. RTI's development of their independent cost estimates are discussed below.

5.1.1 Independent Estimates for Pollution Abatement Capital Expenditures

For capital expenditures, RTI relied on a variety of secondary sources to develop cost estimates. These sources included

- EPA publications,
- industry-specific publications (e.g., American Forest and Paper Association cost documents),
- federal agencies (e.g., Energy Information Administration),
- other facilities with similar equipment/operations,
- general industrial cost references (e.g., Means Building Construction Cost Data, 2005, Ed. 63), and
- equipment vendor websites to identify costs for similar items.

Costs were frequently adjusted depending on the site-specific conditions and, if needed, further adjusted to a base year of 2004 using cost indices from sources such as the *Chemical Engineering Journal* (www.che.com). In cases where multiple cost estimates were available, the most representative and most recent information was selected for the independent cost estimate. For example, estimates of the cost of new electrostatic precipitators (ESPs) installed at pulp and paper mills were available from both EPA and industry sources. The industry estimates were used because they were more recent (base year of 2003, versus 1991 for the EPA estimates) and more representative of the ESPs installed at the pulp and paper mills included in the PACE

pretest (industry cost estimates were for oversized ESPs that can be operated with at least one field out of service to allow for online maintenance, whereas EPA estimates were for standard high-efficiency ESPs sized to match actual flow rates).

In some cases, the estimate of pollution abatement capital cost included obscure equipment or small components whose costs are not traditionally found in the available literature on costs. Where possible, RTI assessed the order of magnitude of these costs relative to larger capital projects to determine if they seemed reasonable.

One issue that frequently needed to be addressed involved situations where large capital projects spanned several years (e.g., a $100 million dollar, 3-year project), and thus, the reported 2004 costs represented only a portion of these costs and did not correspond to "whole" items. In these cases, cost estimates were develop for the entire project and the facility was asked what percentage of the multi-year costs should be attributed to 2004 and we then compared the total facility reported costs in the survey to RTI's estimates.

5.1.2 Independent Estimates for Pollution Abatement Operating Costs

In general, the facility respondents found that quantifying operating costs required more effort than quantifying capital costs because, unlike most capital costs, environmental operating costs were closely intertwined with process operating costs, particularly for items such as electricity and materials and supplies. In most cases, it was difficult for the facility to provide specific information from which RTI could generate independent cost estimates. The methods and data sources used to generate the independent cost estimates for each operating cost category are discussed below.

Salaries and Wages

In many instances, the facility was able to provide the number of FTEs, and their labor category, that were used to generate the salaries and wages reported on the survey. Generally the total figure included all of the staff in the environmental department (including administrative staff), wastewater treatment system operators (if applicable), a portion of the maintenance labor tracked by the facility's accounting system, and a portion of the time spent by laboratory technicians to collect and analyze wastewater and solid waste. In some cases, facilities included corporate staff salaries if these salaries were charged directly to the facility. Given this information, RTI generated independent cost estimates based on the total FTEs involved in environmental activities and average salary data for environmental engineers, operators, and laboratory technicians, as reported by the Bureau of Labor Statistics (BLS) (http://www.acinet.org/acinet). These salaries were also loaded to account for benefits using an

average overhead rate of 34 percent of wages obtained from the U.S. Department of Commerce, Bureau of Economic Analysis (BEA) (http://www.bea.doc.gov/bea/regional/sqpi/default.cfm).

In addition to the FTEs the facilities used to calculate their costs, RTI assessed whether certain activities (and associated labor) were omitted or included inappropriately, and we estimated the costs of that labor to determine what the total salaries and wages value would have been had these costs been included. If a facility did not report operating and maintenance costs to run pollution abatement equipment, EPA sources were referenced when available. For example, based on EPA methodology, the amount of labor required to run and maintain APCDs is about 0.5 hours per device per shift. For example, a facility that operates 10 APCDs, runs 3 shifts per day, and operates 351 days per year, the total labor hours for APCD operation would be 5,625 hours per year as follows:

(10 devices) x (0.5 hr/shift) x (3 shifts/day) x (351 days/year) = 5,625 hrs/yr

To arrive at a labor cost estimate, we then multiplied this figure by the average labor rates from the BLS, with the 34 percent overhead applied. If we assumed the operator labor rate was $30 per hour, then the total cost estimate for operator labor to operate and maintain the APCDs would be $226,125 per year, as follows:

(5,625 hrs/yr) x ($30/hr) x (1.34) = $226,125

The *Guidelines and Definitions* document was revised to include an example of how to quantify total salaries and wages to make it clear that the salaries should be loaded (overhead applied) and that facilities should include all environmentally related labor, including operator labor for maintaining APCDs, lab technician labor, etc.

Fuels and Electricity

Fuel costs, such as natural gas for incinerators dedicated to air pollution abatement, were estimated by RTI based on equipment specifications provided by the facility. For example, to estimate the amount of fuel expected to be consumed by an incinerator, design information supplied by the facility was combined with procedures in EPA's *Control Cost Manual* to estimate annual consumption. This was then multiplied by the cost of natural gas (dollars per 1,000 cubic foot) for 2004, which was obtained from the Energy Information Administration's *Natural Gas Monthly*. In other instances, expected steam usage rates were estimated based on facility information, and an average per-unit cost of steam was available from EPA documents.

As noted previously, facilities often could isolate electricity costs for on-site wastewater treatment units because the wastewater treatment system is typically treated as a separate business unit. In these instances, RTI estimates for electricity costs were developed based on facility-provided total electricity requirements for the pollution abatement equipment (megawatt-hours) and the cost of electricity ($/megawatt-hour) in that facility's location. Industrial electricity rates for each state were obtained from the Energy Information Administration (http://www.eia.doe.gov/cneaf/electricity/epm/epm.pdf). Facilities often quoted lower rates, which is not unusual since industrial facilities are often able to negotiate lower rates. However, we had no way to verify this; thus, RTI used the EIA published rates in its cost estimates.

Energy consumption for running some devices, such as APCDs, was more difficult for facilities to isolate; as a result, associated energy costs were sometimes omitted. In those cases where the electricity requirements for the APCDs were omitted, we estimated the electricity requirements for the reported collection of APCDs at the facility based on industry and EPA reference documents; converted the units to megawatt hours (MW-hr) using standard conversions (e.g., 1MW = 1,341 horsepower) and the known or assumed operating hours per year, and we then multiplied that number by the electricity rates. An example is provided below:

> Based on information from Facility A, the total horsepower (hp) requirement for the facility's wastewater treatment system pumps is 760 hp. The facility's on-site wastewater treatment facility includes 25 aerators, each rated at 75 hp, for a total of 1,875 hp. The APCD and associated fans and pumps have a total hp requirement of 1,475 hp. The facility operates 365 days per year, 24 hours per day, and pays an industrial electricity rate of $38.77 per megawatt-hr (MW-hr).
>
> Total electricity usage for pollution abatement = 760 + 1,875 + 1,475 = 4,110 hp
>
> Total electricity usage in units of MW-hr/yr =
> (4,110 hp) x (365 day/yr) x (24 hr/day)/ (1 MW/1,341hp) = 26,848 MW-hr/yr
>
> Total electricity cost = (26,848 MW-hr/yr) x ($38.77/MW-hr) = $1,041,000/yr

The *Guidelines and Definitions* document was revised to include an example similar to the one above to help encourage facilities to develop estimates of electricity usage in those cases where it is difficult for them to isolate these costs from the facility's total annual electricity bill.

Materials and Supplies

For a number of facilities, the wastewater treatment system represented the bulk of the materials and supplies costs. Facilities could easily extract this information from the accounting system since these materials (e.g., flocculants, nutrients, caustic) were often used only for wastewater treatment, and because in many cases the wastewater treatment system costs were tracked separately. However, in many instances it was difficult for RTI to replicate facility material cost estimates because no details were available in the facilities' accounting systems on quantities and types of materials.

When facility personnel were able to provide information on the amount of chemicals purchased, the costs could be checked by comparing the unit costs paid by the facility to costs reported in publications such as the *Chemical Market Reporter*. The EPA *Control Cost Manual* also was a source of information for costs of certain items such as replacement bags for baghouses. Because some facilities omitted material and supply costs for APCDs, for example, we generated estimates of these costs using assumptions in the EPA *Control Cost Manual*. For most APCDs, the EPA *Control Cost Manual* assumes that that materials and supplies are equal to the maintenance labor cost. As noted in the previous section on salaries and wages, the APCD maintenance labor requirements are assumed to be 0.5 labor hours per device per shift.

Contract Work, Leasing, and Other Purchased Services

Facilities generally had no trouble obtaining costs for this category of operating costs because they represented actual payments to outside entities and were typically isolated from costs incurred for the manufacturing operations. However, similar to material costs, it was difficult for RTI to generate independent estimates for contract work because facilities were not able to provide many details about the operations.

Solid waste management represented a significant portion of the contract work, leasing, and other purchased costs for a number of facilities. In some cases, we were able to compare these costs to costs borne by similar facilities. For those facilities that did not operate on-site landfills, we obtained information on landfill tipping fees from local government websites. Information on the cost of incineration of industrial wastes was obtained from the Environmental Technology Council (ETC) (http://www.etc.org/costsurvey8.cfm). EPA documents published by the Office of Solid Waste also contained useful cost data.

5.2 Cost Comparison by Pollution Abatement Category

Table 5-1 presents RTI's cost estimates and facilities' survey-reported costs by pollution abatement category. The first column in Table 5-1 lists the total costs reported on the survey. The second column presents the share of facility-reported costs (74 percent) for the components for which RTI was able to develop independent cost estimates. The third column presents RTI's cost estimates. The fourth column shows the facility costs as a percentage of RTI's cost estimate. A percentage less than (greater than) 100% indicates that RTI's cost estimate is higher (lower) than the facility reported cost estimate.

Table 5-1. Comparison of Costs Reported on the Survey and Independent Engineering Estimates

Cost Type	Survey ($1,000s)	Cost Checks		Facility as % of RTI
		Facility Component[a]	RTI Component	
Capital Expenditure	**$165,256**	**$156,927**	**$160,997**	**97.5%**
Treatment	$158,954	$156,493	$160,667	97.4%
Recycling	$26	—	—	—
Disposal	$3,261	$274	$194	141.2%
Pollution prevention	$3,016	$151	$120	125.8%
Operating Costs	**$94,905**	**$45,848**	**$60,529**	**75.7%**
Salaries/wages	$23,137	$17,681	$12,785	138.3%
Fuels	$28,716	$16,698	$41,689	40.1%[b]
Materials and supplies	$19,171	$6,712	$2,945	227.9%
Contract work	$23,882	$4,757	$3,110	153.0%
Costs Not Included Previously	**$14,091**	**$32**	**$32**	**100.0%**
Permits and fees	$3,628	$32	$32	100.0%
Site cleanup	$10,463	—	—	—
Cost Offsets[c]	**–$14,426**	**–$1,965**	**–$124**	**1,584.7%**
Total Costs	**$274,252**	**$202,806**	**$221,558**	**91.5%**

[a]This column represents the subset of reported survey costs that correspond to the pollution abatement activities for which RTI was able to develop independent engineering cost estimating.

[b]The large difference is caused by two facilities that did not report $26 million in electricity costs for pollution abatement equipment because internal electricity consumption is not metered.

[c]Cost offsets are not included in calculation of the total cost row of this table.

In total, the costs provided by the facility on the survey were 92 percent of RTI's cost estimates. Fuels accounted for the majority of difference between survey-reported costs and RTI estimates. Reported costs for annual fuel usage were 40 percent of RTI's cost estimate for fuels, primarily because two electric utilities did not report any electricity usage associated with pollution abatement equipment. Facilities that generate on-site the majority of their electricity they consume typically do not meter usage. During the on-site visits, facilities indicated that metering systems are expensive and the cost cannot be justified because the systems would have minimal to no impact on productivity.

RTI's cost estimates slightly exceed the survey responses for capital expenditures (primarily because of the evaluation of one large project). Operating costs provided on the survey were 76 percent of RTI's estimates. However, this difference is again due primarily to just two facilities where sizable electricity costs for pollution abatement equipment were not included. If these two facilities are removed, operating costs reported on the survey are 34 percent greater than RTI estimates, with 9 of 16 facilities reporting operating costs greater than RTI's estimates.

Whereas in the aggregate costs reported on the survey were relatively close to RTI's cost estimate, i.e., within the +/– 30 percent threshold, there was more variance in the individual components. As seen in the last column of Table 5-1, reported expenditures for disposal and pollution prevention capital expenditures and salaries/wages, materials, and contract work operating costs were larger than RTI's estimates.

RTI was only able to develop estimates for about a quarter of reported materials and contract work costs. In general, materials/supplies and contract work were the most difficult categories for RTI to verify because of the limited information available explaining what was included in the facilities' reported costs. In many instances, environmental managers did not know the details of what was included in their cost centers and said it would be too time consuming to review individual components.

5.3 Cost Comparison by Facility

There was also variance across individual facilities when comparing survey costs with RTI's cost estimates. Table 5-2 provides capital expenditure and operating cost estimates for each of the 18 facilities. As shown in Table 5-2, RTI was able to develop independent cost estimates for over 85% of the reported capital expenditures. Total capital expenditures reported by the facilities and RTI's estimates were relatively close and in all instances were within the

range of +/– 30 percent. Survey estimates ranged from 89 percent to 114 percent of costs estimated by RTI.

Table 5-2. Capital Expenditures and Operating Cost Comparison by Facility

Sector Facility Number	Capital Expenditures		Operating Costs	
	% of Total Expenditure Estimated by RTI[a]	Facility Estimate as % of RTI's Estimate[b]	% of Total Expenditure Estimated by RTI[a]	Facility Estimate as % of RTI's Estimate[b]
Chemical facility 1	100.0%	88.7%	96.3%	97.7%
Chemical facility 2	0.0%[c]	—	50.4%	101.9%
Computer facility 1	0.0%	—	36.9%	141.2%
Electronic equipment facility 1	0.0%	—	99.4%	200.8%
Electric utility facility 1	98.5%	92.9%	0.0%	0.0%[e]
Electric utility facility 2	98.6%	94.7%	1.8%	1.8%[e]
Fabrication metal facility 1	—[d]	—	98.0%	55.8%
Fabrication metal facility 2	—	—	33.3%	100.1%
Furniture facility 1	—	—	44.6%	90.5%
Iron and steel facility 1	0.0%	—	36.9%	154.2%
Iron and steel facility 2	—	—	18.3%	136.2%
Iron and steel facility 3	0.0%	—	54.4%	162.8%
Paper facility 1 (Pulp)	81.1%	100.0%	100.0%	294.5%
Paper facility 2 (Integrated)	58.0%	113.6%	49.4%	72.0%
Paper facility 3 (Integrated)	96.5%	100.0%	61.5%	86.2%
Paper facility 4 (Integrated)	78.5%	101.7%	71.5%	80.0%
Plastics facility 1	92.9%	113.0%	52.4%	129.2%
Petroleum facility 1	—	—	3.5%	19.3%
Total Costs	**95.0%**	**97.5%**	**48.3%**	**75.7%**
Total Costs (Less Electric Utility Facilities 1 and 2)	**85.7%**	**111.1%**	**56.1%**	**134.0%**

[a]These columns represent the % of facility reported capital costs and operating costs, respectively, for which RTI was able to develop independent engineering cost estimates

[b] (Facility Cost Estimate/RTI Cost Estimate) *100

[c]RTI was not able to develop independent cost estimates for any of the facilities capital expenditures.

[d]The facility reported no capital expenditures.

[e]These facilities reported no electricity operating costs. However, RTI estimated electricity costs in the millions of dollars. As a result, the facility operating costs as a percentage of RTI estimates are approximately zero.

For operating costs, RTI was able to generate independent cost estimates for slightly over half of the reported costs and there was greater variance between costs reported on the survey

and RTI estimates. For 8 of the 18 facilities, survey operating costs estimates were within +/– 30 percent of RTI operating cost estimates. The largest differences were for Electric Utility Facilities 1 and 2, where the facilities that did not report any electricity costs for pollution abatement equipment because internal electricity consumption is not metered. As shown in Table 5-2, when these two facilities are removed from the total, survey cost estimates are 134 percent of RTI's cost estimates.

5.4 Facility-Level Cost Comparisons

The following discussions present additional details for a facility for which survey estimates were greater than RTI's estimate (Facility 10 – Iron and Steel Facility), a facility for which the survey estimates were less than RTI's estimates (Facility 5 – Electric Utility), and a facility where survey cost estimates were close to RTI's cost estimates (Facility 16 – Paper Facility). Appendix D contains facility-level cost comparisons for all 18 facilities.

5.4.1 Iron and Steel Facility 1

The majority of this facility's reported costs were from fuels and contract work (see Table 5-3). RTI's electricity estimates for pollution abatement equipment (mainly baghouse operations) closely matched survey costs. However, RTI's electricity estimate for wastewater processes at the facility was less than half of that reported on the survey. RTI estimated annual salaries of $302,000, which is approximately half of the costs provided on the survey ($589,000). The difference is likely due to differences between actual and estimated labor rates and the number of hours attributed to production and other personnel RTI was unable to account for in their estimate. RTI contacted the facility again, but they were unable to provide additional information on these labor estimates. RTI did not have enough information to calculate independent waste disposal contract work.

Table 5-3. Facility-Level Cost Comparisons: Iron and Steel Facility 1

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	0.0%	—
Treatment	0.0%	—
Recycling	—	—
Disposal	—	—
Pollution prevention	0.0%	—
Operating Costs	36.9%	154.2%
Salaries/wages	100.0%	195.0%
Fuels	38.5%	133.8%
Materials and supplies	85.1%	229.9%
Contract work	0.0%	—
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	—	—
Cost Offsets	45.7%	100.0%
Total Costs	34.5%	154.2%

5.4.2 Electric Utility Facility 1

As shown in Table 5-4, the dominant cost category reported by electric utility facility 1 was capital expenditure, mainly treatment for installing a new end-of-pipe treatment system. The facility reported spending $71 million in 2004 (with an additional $16 million in 2003 when the project was started) for the system. RTI estimated a total cost for the system of $92 million. Subtracting the $16 million from 2003 yields a cost estimate of $76 million.

Table 5-4. Facility-Level Cost Comparisons: Electric Utility Facility 1

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	98.5%	92.9%
Treatment	100.0%	92.8%
Recycling	—	—
Disposal	—	—
Pollution prevention	100.0%	141.9%
Operating Costs	0.0%	0.0%
Salaries/wages	0.0%	—
Fuels	—	0.0%
Materials and supplies	0.0%	—
Contract work	0.0%	—
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	—	—
Cost Offsets	0.0%	—
Total Costs	88.8%	72.9%

The major discrepancy between the reported survey costs and RTI's cost estimates was the operating cost expenditures for electricity. The facility included no electricity costs for operating pollution abatement equipment, because the facility generates its own electricity and does not meter any electricity consumption throughout the plant. However, during the visit, the facility indicated its plant consumed about 5 percent of generated power to operate pollution abatement equipment. Based on the 5 percent consumption value and total generation in 2004, RTI estimated a pollution abatement electricity cost of approximately $21 million.

5.4.3 Paper Facility 4

Total facility-level costs from the survey and RTI's cost estimates matched closely for the paper facility 4 (see Table 5-5). However, there was some variance in the individual cost categories. For the largest cost component, pollution abatement capital expenditures (treatment) for a coating system, the cost reported on the survey and RTI's independent cost estimates were nearly identically (approximately $10 million). Areas of discrepancies for capital expenditures included disposal cost, where RTI's cost estimate for an excavator ($185,000) was less than the reported survey cost ($265,000).

Table 5-5. Facility-Level Cost Comparisons: Paper Facility 4

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	78.5%	101.7%
Treatment	100.0%	100.0%
Recycling	—	—
Disposal	—	—
Pollution prevention	0.0%	—
Operating Costs	71.5%	80.0%
Salaries/wages	100.0%	79.5%
Fuels	100.0%	86.6%
Materials and supplies	100.0%	15.8%
Contract work	0.0%	—
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	—	—
Cost Offsets	0.0%	—
Total Costs	72.6%	92.3%

The reported survey costs for operating costs were less than RTI's operate costs estimate. RTI estimated a larger number of FTEs involved in pollution abatement activities and hence estimated greater salary and wage costs. RTI contacted the facility, but the facility was not able to provide additional information on the components of its labor costs. For fuels costs, RTI matched natural gas cost estimates by the facility but identified additional electricity usage associated with recovery boiler electrostatic precipitators not reported by the facility. Therefore, RTI's estimate for fuel costs was greater than the costs reported by the facility.

SECTION 6. SUMMARY OF FINDINGS FROM THE PRETEST

This section presents a summary of findings based on the pretest of the survey with 18 manufacturing facilities, subsequent follow-up visits, and the comparison of survey responses with independent engineering cost estimates developed by RTI.

6.1 Implications for Data Quality

The concept of an investment or activity being profit motivated was straightforward for most facilities. However, frequently investments generated co-benefits (increased efficiency and decreased emissions), and because investment decisions were typically made at corporate headquarters, facilities sometimes had difficulty assessing whether an expenditure or annual operating cost was motivated by profit or pollution abatement. Only the latter should be included in PACE.

Facilities were comfortable with the concept of incremental costs associated with pollution abatement. Several facilities indicated that they purchased low-sulfur fuels, and in these instances, they used the price difference between the high-sulfur and low-sulfur fuels to calculate costs reported on the survey. Difficulties in identifying incremental costs typically came not from misunderstanding the concept, but because in many instances equipment or fuel upgrades also resulted in increases in production efficiency. As mentioned previously, it is not always clear which is the driving factor in the investment decision or how much of the investment should be attributed to pollution control.

Cost estimates for specific items appeared to be fairly accurate. In most instances, they were obtained from an accounting system (capital expenditures, materials and supplies, contract work) or calculated using simple spreadsheets (salaries and electricity cost). However, facilities do in some cases mistakenly include or exclude large items for a significant portion of the variance in reported costs across facilities. On the other hand, based on our limited sample, these errors tend to offset each other, and we found little evidence that facilities are more likely to include or omit costs inappropriately in the aggregate.

Many facilities indicated that implementing the survey annually would lower the burden and increase the quality of the data because tracking systems would likely be put in place in anticipation of filling out the survey each year. The development of formal systems for tracking pollution abatement costs implies that response rates, accuracy, and consistency should improve over time.

6.2 Limitations of Particular Data Components

Facilities indicated that capital expenditures and many operating costs were relatively straightforward to identify and quantify. However, there were some data items that facilities indicated were difficult to estimate and these are described below.

6.2.1 Operating Costs for Fuels and Electricity

Electricity costs for operating pollution abatement equipment were typically underestimated in all sectors. However, the issue is most significant for electric utilities because their pollution abatement energy usage can consume 1 to 5 percent of their generating capacity, and the facilities participating in the pretest indicated they cannot directly measure this usage.

Facilities in several other sectors indicated that they did not include all electricity costs because pollution abatement energy use is not metered separately. In addition, there were conceptual issues regarding the share of air-handing energy costs that were worker safety (health) related rather than pollution abatement related.

6.2.2 Recycling

Many facilities had trouble distinguishing between off-site recycling and disposal costs. At issue is the relationship between waste transportation costs and the value of the recycled material. If the waste transportation cost exceeds the recycled material value, the facility is charged a disposal fee. In contrast, if the value of recycled material exceeds the waste transportation cost, the facility receives a recycling offset. Facilities were not comfortable with this accounting-based definition of recycling, which led to inconsistencies in how facilities reported recycling costs.

6.2.3 Pollution Prevention

Changes have been made to the survey to correct for several misinterpretations, such as adding “capture” to the definition of treatment. However, the impacts on operating costs associated with years of product and process redesign targeted at preventing pollutants are difficult to capture. Incremental price data and counterfactuals of what the facility would have done in the absence of environmental concerns are typically not available and difficult to estimate.

6.2.4 Multimedia Pollutants

From the on-site visits, it was not clear if facilities fully understood the term “multimedia” or if it was useful. Facilities typically think of investments and activities in terms of the traditional media of air, water, and solid waste. One intent of including multimedia was to

provide facilities with an option to simplify the completion of the survey. However, we believe this category may have generated more confusion than information.

6.2.5 Percent Hazardous

Determining the percentage of operating costs associated with hazardous pollutants was difficult for most facilities. No facility developed separate spreadsheets or calculations to estimate the percentage of costs associated with hazardous waste. Rough estimates were generally provided; as a result, the information may not be reliable.

6.2.6 Total Book Value of Pollution Abatement Capital

The underlying information used by facilities to report their total book value of pollution abatement capital varied greatly in accuracy and completeness. In many instances, if the equipment was fully depreciated, it was not included. In other instances, facilities noted that they did not have records that specified if the capital investment projects were for environmental versus non-environmental purposes prior to about 1990.

6.3 Implications for National Estimates of Pollution Abatement Expenditures

Based on the pretest and follow-up on-site visits, the facilities' responses to the pretest PACE survey appear to be reasonably accurate in reflecting pollution abatement expenditures and costs in the aggregate. When comparing survey responses with independent estimates generated by RTI, individual facility costs and costs associated with specific survey items showed different levels of consistency. This includes over- and underestimation of specific engineering cost items, errors of omission and commission, and misclassification of costs across activity categories. However, in general, discrepancies appear to be largely offsetting and do not represent a significant source of bias in the national estimate levels of pollution abatement expenditures, although the discrepancies do have implications for facility-level cost analysis.

In several industries, trade associations are currently collecting different levels of pollution abatement cost and expenditure data. This lowers the burden of the PACE survey but does represent some duplication of effort. However, an important role of PACE is to potentially coordinate across industries to develop consistent, nationally representative cost data for policy analysis.

6.4 Implications for Research and Analysis

When conducting research based on PACE data, it will be important to consider how variations in survey responses may influence the results of statistical analyses. At an aggregate level across all locations and/or industries, such as is reported in publicly available PACE

findings, the data appear to provide a good representation of costs experienced by industries in a particular year. More disaggregated analyses will need to consider additional issues. For instance, comparing findings across industries introduces the potential for differing levels of completeness in industries' accounting systems which could affect the results. A qualitative examination of reporting accuracy across the industries visited during this project does not indicate any systematic bias in errors for small versus large firms or for particular industries with lower versus higher abatement costs. However, since accounting systems play a significant role in how facilities complete the survey, it is essential to consider how differences in accounting capabilities may impact responses across industries.

Standard methodologies used by facilities to track capital costs will also have important implications for those reported costs. Accounting systems provide accurate data on such expenditures; however, they only track and report the portion of capital costs experienced in a particular year, which can represent an unknown fraction of total costs for a pollution control device. Consequently, if a researcher were interested in estimating costs associated with a specific regulation, examination of multiple years would be necessary to capture all costs, especially as the timing of firms' responses to regulations will vary.

Time-series analyses of PACE data conducted in the future will need to consider additional factors. For example, if (or as) accounting systems' abilities to track environmental expenditures improve over time, possibly in response to reinstituting the PACE survey, the variance of reported costs could decrease without necessarily reflecting any changes in firm behavior. This may also affect the feasibility of comparing future PACE data to those collected in the past.

Aside from these types of concerns, results from time-series analyses at a relatively aggregated level appear less likely to be affected by reporting inaccuracies than cross-sectional, or especially facility-level, analyses. Across the sample of 18 facilities participating in the pretest of the draft survey, the over- and underestimates of costs were relatively balanced in aggregate. Variations in accuracy among facilities and across types of costs might tend to indicate, however, that detailed analyses would be best conducted using relatively large sample sizes to offset the effects of any outlier observations. To the extent that reported information on facility size, production, and/or employment, in conjunction with installed pollution control equipment, could be used to evaluate and remove outliers, cross-sectional and facility-level analyses will be more successful.

SECTION 7. MODIFICATIONS TO THE PACE SURVEY AND *GUIDELINES AND DEFINITIONS* DOCUMENT

As the final part of phase 2 of this study, recommended changes based on the pretest, follow-up site visits, and pilot test were identified and incorporated into the PACE survey instrument and *Guidelines and Definitions* document. Each recommended change and modification were reviewed by the project team, which included the expert panel (only Wayne Gray and Kerry Smith, the two economists) and staff from RTI, EPA, and Census, prior to being incorporated. As expected, not all of the suggestions were incorporated into the 2005 PACE survey instrument and *Guidelines and Definitions* document. This section identifies the major changes that were made (and not made) to the survey instrument and *Guidelines and Definitions* document as a result of the pretest, follow-up site visit, and pilot test, followed by a discussion of the motivation and rational for these changes. In general, the majority of the changes during this process were made to the *Guidelines and Definitions* document. Appendix A contains the 2004 pretest PACE survey instrument and *Guidelines and Definitions* document that was sent to the 18 facilities. Appendix B contains a list of all comments provided by respondents during the pretest and follow-up visits. Appendix C contains the revised survey instrument and *Guidelines and Definitions* document, where the changes outlined in this section have been incorporated.

7.1 Changes to the PACE Survey Instrument

Item 1—Facility Information

- The pretest Item 1D (employment, production capacity, actual production, and value of shipments) was replaced with a question that asked facilities to report total employment, total value of shipments, and total capital expenditures. This question is based on wording from the ASM and will only be asked of facilities that are not in the ASM sampling frame – however, all facilities will be asked to report total capital expenditures. The information will be used primarily for data editing and imputation.
- The questions regarding total employment, total value of shipments and total capital expenditures will now be asked before any pollution abatement questions are asked, so that this information can be collected even if the facility is not required to complete the survey.

Item 2—Pollution Abatement Activities

- Item 2 on the pretest was originally intended to provide information to help RTI engineers develop their independent cost estimates. However, facilities thought the question was useful and should remain in the final version of the PACE survey. Facilities indicated that Item 2 helped them conceptualize some of the issues and provided examples of control devices and techniques that should be included as pollution abatement. The facilities found it convenient to be able to answer the

questions regarding number of devices and techniques by simple recall, without research. The modifications made to Item 2 are discussed in the next bullets.

- In Item 2A, several new devices were added to the list based on comments by facilities, such as continuous emission monitoring systems and nonventuri wet scrubbers.
- In Item 2Be the annual quantity of wastewater was changed from "treated" and "discharged" to "treated on-site" and "treated off-site." On the pretest, it was unclear to several facilities if treated was to be inclusive of discharged wastewater (i.e., all treated wastewater is typically discharged) or if these were exclusive categories (wastewater is either treated or discharged).
- Item 2Cd the annual quantity of solid waste was changed from "treated" and "disposed of" to "treated on-site," "on-site disposal," and "off-site disposal." Again, the distinction between "treated" and "disposed of" on the pretest survey instrument was not clear to facilities.

Item 3—Capital Expenditures

- In Item 3Aa, the term "treatment" was changed to "treatment/capture." This change should help clarify that certain expenditures, such as baghouses, are not to be included as pollution prevention activities (also applies to Item 4C). Several facilities indicated that according to their definition, treatment required a chemical process and baghouses were simply preventing pollution from entering the atmosphere.
- Multimedia pollutants were dropped as a media option from Item 3C. Facilities had trouble understanding the concept of multimedia pollutants.
- The question about the percentage of total capital expenditures spent on hazardous pollutants was dropped from the survey (pretest Item 3D). The majority of facilities responded that their percentage of capital expenditures spent on hazardous pollutants was either close to 0 or 100 percent. During the site visits, facilities indicated that they simply made an educated guess about this number; they had no actual way to estimate this amount.
- The question on gross book value of capital was moved from Item 7C (Depreciation) on the pretest to part of Item 3D on the 2005 PACE survey. The expert panel decided that this question fit better in the section on capital expenditures.

Item 4—Operating Costs

- The questions related to estimating depreciation expense (Item 7) were moved to operating costs (Item 4A). This layout is the same one used in the 1994 PACE survey, thus making total operating costs longitudinally consistent. The move was also considered beneficial because in the future researchers could easily subtract depreciation expense if they wished to use an alternative definition of operating costs without depreciation.
- The multimedia pollutants category under operating costs, Item 4Dd on the pretest, was dropped for reasons similar to those cited above under capital expenditures.

- The percentage hazardous was dropped from Item 4 on the pretest for reasons similar to those cited above under capital expenditures.

Item 5—Costs Not Included in Previous Items

- No changes were made to Items 5A, 5B, and 5C. Respondents thought these questions were clear, although there was confusion over what should be included in Item 5A under permits and fees. The examples in the *Guidelines and Definitions* document were expanded to help clear up this confusion.
- As part of the expert panel meetings, there was signification discussion as to whether the survey should ask about the cost of product redesign. There was consensus that product redesign costs should not be part of the PACE survey as it is designed to capture the costs of abating pollution at the facility and not costs to reduce the pollution generated by their products. However, during the site visits, several facilities indicated that they want to report this cost. Although these facilities understood the distinction between a cost to reduce pollution at the facility and a cost to reduce the pollution generated by their products, they still thought both should be reported. Thus the panel decided that product redesign questions would be included in the survey but not tabulated or included as part of PACE reports. It was noted by the U.S. Census Bureau that there was precedent in other surveys to include questions where the primary purpose was to improve the data quality of other items.
- The question on tradable permits, Item 5D on the pretest, was dropped. The response rate on the pilot test was very low. The information is primarily relevant for the electric utility industry and the data is available from alternative information sources. In the instructions we included a note that tradable permits should NOT be included in permits and fees.

Item 6—Cost Offsets

- No changes.

Item 7—Depreciation

- Item 7. Moved questions on gross book value of capital to Item 3 and moved depreciation up to Item 4. Delete remainder of Item 7 on the pretest.

Item 8—Burden

- No changes were recommended for this item.

Item 9—Review

- This item was dropped because it was only intended to assess the use and quality of the instructions as part of the PACE redesign process.

Item 10—Certification

- No changes were recommended for this item.

7.2 Potential Changes Discussed But Not Made to the Survey Instrument

Not all changes proposed for consideration were incorporate into the survey form or guidance document. The following is a list of issues or recommendations that were reviewed by the project team but were not integrated into the survey instrument.

- The project team discussed adding a question in Item 1D that would ask the facilities if they have environmental cost centers for tracking pollution abatement costs, because we learned during the site visits that the existence of these cost centers influenced the information facilities had available for completing the survey. However, it was decided that asking about accounting and tracking procedures strayed too far from the intent of the survey.
- The project team discussed adding a fifth category, Monitoring & Testing, to capital expenditures, Item 3Ae, because monitoring and testing do not fall neatly into one of the four existing categories. However, based on the facility visits, it appears that monitoring and testing costs are correctly included as part of larger (typically treatment) systems.
- The project team discussed breaking electricity costs out from other fuel costs (oil, natural gas, coal) in Item 4Ab because, based on the site visits, electricity costs have a higher degree of uncertainty (i.e., they are harder to estimate because they are generally not metered separately). However, it was determined that this disaggregation would be an unnecessary burden on facilities because the publications report total energy costs.
- The project team considered moving Item 4 (operating costs) before Item 3 (capital expenditures) because operating costs are typically the larger of the two types of expenditures and have a higher incident rate (non-zero response). However, it was decided that because questions about capital expenditures are easier to answer, these should appear first on the survey.

7.3 Changes to the *Guidelines and Definitions* Document

The main comments received during the on-site visits about the *Guidelines and Definitions* document was that it was difficult and time-consuming to find specific definitions and examples and that more examples were needed. As a result, a significant number of changes and additions were made to the *Guidelines and Definitions* document to make the guidance document more useful. Some of the more significant changes include a complete cross-index between the PACE survey instrument and instructions, refined definitions based on comments from the on-site visits, and an expanded list of examples of the types of capital expenditures and operating costs to be included and excluded. The major changes are discussed below.

7.3.1 Linking the Survey and Guidelines Document

Page numbers were added to the survey form that cross-index the *Guidelines and Definitions* document; page numbers were also added to the flow diagram in Figure 1 of the *Guidelines and Definitions* document. Respondents indicated that they were more likely to use the *Guidelines and Definitions* document as a resource guide, rather than reading it prior to the completing the survey. A thorough cross-index between the survey instrument and *Guidelines and Definitions* document should make the guidance document more useful as a reference and reduce the time needed to complete the survey form.

7.3.2 Additional Examples

The examples added as a result of comments received during the on-site visits can be separated into two general categories: lists of specific activities and capital expenditures and operating costs (by cost category) to be included and excluded, and examples to illustrate the concept of incremental costs and methods for calculating or estimating incremental costs. We emphasize in the guidance document that the examples are hypothetical and to be used as guidance only. Some project members were concerned that facilities may use the numbers in the examples in their calculations as opposed to determining estimates for their facility.

To improve facilities' ability to find specific definitions and examples, a section was included that provides guidance on how to complete each item on the survey, along with definitions and examples related to each item. Facilities indicated that item-by-item instructions would help them locate information faster. Tables listing examples of expenditures/costs to be included and excluded were also expanded based on insights gained during the site visits and are now located under the relevant item headings. These lists were moved to Section 4, "Completing the Survey," so that they could be easily associated with specific survey items. We emphasize in the document that these lists are only intended to be used as examples and are not exhaustive.

The key issues addressed

- emphasize that all industrial solid waste disposal costs are to be included, not just disposal costs associated with hazardous or toxic substances;
- provide recycling examples, such as the inclusion of systems to capture and use waste gas with energy value;
- clarify that labor cost associated with environmental audits, ISO 14000 certification, and environmental permit preparations are to be included;
- provide examples of permits and fees to indicate that facilities should include fees such as initial fees related to environmental permits as well as annual fees related to Title V permits;

- emphasize that contract work should include industrial sewage and solid waste disposal costs paid to federal, state, or local governments (not just to private contractors); and
- clarify that corporate staff and corporate R&D activities should NOT be included unless billed directly to the facility.

Almost all facilities participating in the site visits indicated that additional and more specific examples would be helpful. In the pretest version of the *Guidelines and Definitions* document, all examples were located in a separate section. These examples focused on the distinction between treatment, recycling, disposal, and pollution prevention. Facilities thought these examples were helpful, but many still wanted more examples. In response to these comments, additional examples were integrated throughout the document, the majority of them are in Section 4.

One set of examples highlights that salaries and wages should include benefits. This topic received considerable discussion during the expert panel meetings because benefits were not included in the 1994 PACE survey. However, the project team all agreed that the appropriate metric was the fully compensated salary/wage and that reported costs should include benefits. The instructions and examples reflect this change. Longitudinal consistency is somewhat compromised. but it was noted that historical labor cost data could be adjusted using average industry benefits data from the BLS.

Examples to help facilities distinguish between recycling and disposal activities were also integrated into Section 4. During the site visits facilities indicated that on-site recycling activities were relatively straightforward to identify. However, the difference between off-site recycling and disposal is frequently only an accounting distinction. For example, in some instances a fee is paid to a recycling company and then revenue (offsets) is received in return. In other instances the facility simply pays a lower disposal fee because of the potential recycling value of its waste. Examples were provided to help clarify the issue. (Note: both cases above yield the correct pollution abatement costs, only the disaggregation is affected.)

Examples also emphasized the distinction between co- or by-products sold for recycling (not part of PACE) and off-site recycling, which lowers disposal costs (where remaining disposal costs should be reported as part of PACE).

Examples were added to 1) illustrate the concept of incremental costs and 2) provide methods or approaches for estimating costs when accounting cost data is unavailable. These examples emphasized the following information:

- Incremental costs of pollution abatement are the costs associated with the environmental portion of an investment project or the environmental portion of annual operating and maintenance costs. The guidelines included one example on incremental capital costs and one example on incremental operating costs. Examples also indicated that pollution abatement equipment may be integrated into larger investment projects, or pollution abatement operating costs may be combined with other costs in a larger cost center. In these instances, only the share of costs associated with pollution abatement should be included.
- If actual costs are not available, the facility should use all available relevant information to make informed estimate of the costs. Examples of operating cost labor calculations were provided to make facilities aware that they should include partial FTEs and periodic activities. In addition, examples of estimating electricity costs were provided, indicating that estimates could be based on the number of motors, total horsepower, or a best judgment on the shared total electricity usage associated with pollution abatement.

As mentioned above, one concern raised by the project team was how the numbers in the examples would be interpreted by survey respondents. In the labor cost examples, typical hourly wage rates are used in the calculations. Similarly, typical electric rates ($/kWh) are used in the energy costs examples. The concern is that respondents might simply use the typical wage rates and electric rates when developing their own costs estimates (even though the instructions tell them to use their own rates). One option suggested by the panel was to use hypothetical numbers, such as a wage rate of $1/hour. However, the project team engineers thought the examples should be as realistic as possible. In discussions with RTI's cognitive survey design experts it was recommended that all wage and electricity rates be rounded to multiples of tens (e.g., $50/hour) to make it obvious that these are only example rates.

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APPENDIX A. 2004 PACE PRETEST SURVEY AND *GUIDELINES AND DEFINITIONS* DOCUMENT

Form

2004 POLLUTION ABATEMENT COSTS AND EXPENDITURES (PACE) - PRETEST

NOTICE – All information provided on this pretest of the PACE survey will remain confidential.

IMPORTANT

Please read guidelines, definitions, and examples before completing this survey form.

Report for the facility located at the address below.

Please correct errors in name, address, and ZIP code. ENTER street and number if not shown.

Item 1 **FACILITY INFORMATION**

A. Check ONE box that best describes the status as of December 31, 2004, of the facility identified in the address box above.

- ☐ In operation as of December 31, 2004.
- ☐ Temporarily idle (intend to resume operations)
  → How long as of December 31, 2004? | Months |
- ☐ Sold or leased to another company
  → **SOLD OR LEASED TO**

Name		
Street		
City	State	ZIP Code

- ☐ Permanently ceased operations
  → Date closed? | Month | Year |

B. Report data for the calendar or fiscal year 2004. If your fiscal year ends between October 31 and February 28, fiscal-year figures are acceptable; otherwise report calendar year data. If you are reporting for a fiscal year, provide the period covered by the fiscal year.

- ☐ Calendar year 2004 data reported
- ☐ Fiscal year 2004 data reported →

Period covered?	Month	Year		Month	Year
From			To		

C. Check ONE box that best describes this facility's pollution abatement and other environmental protection expenditures for 2004.

- ☐ These expenditures were $0 (zero) in 2004. (There were NO pollution abatement expenditures for 2004.)
- ☐ These expenditures were included in rent, taxes, or lease agreements.
- ☐ These expenditures were between $1 and $999.

You do not need to report any expenditures. ***Please complete Item 10*** *of the form and return it.*

- ☐ These expenditures were more than $999. → ***Continue with Item 1D.***

D. Report the following information for this facility in 2004.

a. Average number of full-time equivalent (FTE) employees (include leased employees) .....

Provide this estimate by the following two categories for 2004. Lines i and ii should sum to equal line 1Da.

i. Production workers directly involved in production or manufacturing of facility output .....

ii. All other employees at your facility.....

b. Production capacity at your facility

c. Actual production in 2004

Indicate units. *(Check only one box.)*

- ☐ Short tons of product (per year)
- ☐ Barrels (per day)
- ☐ Megawatts (per hour)
- ☐ Tons of pulp (per year)
- ☐ Tons of paper (per year)
- ☐ Other *Describe:*_____

d. Report the dollar value of production in 2004, based on estimated sales price(s) of what was produced at this facility during 2004. Do not report annual sales. Report in thousands of dollars. *(Value of production = value of shipments + value of ending inventory – value of beginning inventory)*

Value of production in 2004 ..... $,000

Item 2 POLLUTION ABATEMENT ACTIVITIES

The questions in this section refer to different types of pollution abatement activities that may have occurred at your facility in 2004.

A. How many air pollution treatment control devices were operating at the beginning of 2004? How many were newly installed by the end of 2004? If no control devices were installed or operating in 2004, check the box in the "Zero" column.

Control Device	Total Number of Devices Operating Facility-Wide (beginning of 2004)	Zero	Number of Devices Newly Installed (end of 2004)	Zero
a. Electrostatic precipitator (ESP)		☐		☐
b. Baghouses/fabric filters		☐		☐
c. Venturi scrubbers		☐		☐
d. Acid-gas scrubbers		☐		☐
e. Carbon adsorbers		☐		☐
f. Incinerators/thermal oxidizers/catalytic oxidizers		☐		☐
g. Flares		☐		☐
h. Refrigerated condensers		☐		☐
i. Biofilter/bioreactor		☐		☐
j. Selective non-catalytic reduction (SNCR)		☐		☐
k. Selective catalytic reduction (SCR)		☐		☐
l. Other *Describe:*_____		☐		☐

Questions B and C ask about water/liquid and solid waste pollution abatement techniques.

B. What water/liquid pollution abatement techniques were used at this facility in 2004?	Yes	No
a. Physical (containing, screening, filtration, UV disinfection, underground injection, etc.).....	☐	☐
b. Biological (activated sludge, aeration lagoon, biological filter, etc.)	☐	☐
c. Chemical (oxidation, reduction, neutralization, etc.).....	☐	☐
d. Thermal (incineration, pyrolysis, etc.).....	☐	☐

e. Annual quantity of wastewater

Treated

Discharged

Indicate units. *(Check only one box.)*

- ☐ Gallons per day
- ☐ Other *Describe:*_____

C. What solid waste pollution abatement techniques were used at this facility in 2004?

	Yes	No
a. Physical (containment, dewatering, landfilling, underground injection, etc.)	☐	☐
b. Biological (composting, landfarming, phytoremediation, etc.)	☐	☐
c. Thermal (incineration, pyrolysis, etc.)	☐	☐

d. Annual quantity of solid waste

Treated ☐

Disposed of ☐

Indicate units. *(Check only one box.)*

☐ Short tons per day

☐ Other *Describe:* _____

Item 3 **CAPITAL EXPENDITURES**

The questions in this section ask about capital costs of pollution abatement in 2004. First, report your capital cost expenditures by type of pollution abatement activity. Add these values together to determine TOTAL CAPITAL EXPENDITURES of pollution abatement. **Provide an estimate of TOTAL CAPITAL EXPENDITURES even if you are unable to provide separate estimates for each component of capital expenditures.**

- Report only capital expenditures for abatement activities whose primary purpose is pollution abatement.
- Do NOT report capital expenditures from a previous year. (Depreciation expense is recorded in Item 7.)
- Include all installation and start-up costs for pollution abatement expenditures. Include labor only when contracted specifically for installation.
- Include capital expenditures related to monitoring and testing.
- Exclude capital expenditures related to site clean up. (This information is recorded in Item 5.)
- Exclude capital expenditures related to product redesign or reformulation intended to reduce the pollution generated by consumers or uses from products manufactured at this facility. (This information is recorded in Item 5.)
- Report in thousands of dollars. If your facility had no capital expenditures or capital expenditures less than $500 for pollution abatement in 2004 in a specific category, check the box in the "Zero" column.

A. Provide estimates of capital expenditures by the following four pollution abatement activity categories for this facility in 2004. (See pages 4–5 in the guidelines for definitions.)

		Zero
a. Treatment	$,000	☐
b. Recycling	$,000	☐
c. Disposal	$,000	☐
d. Pollution prevention	$,000	☐

Indicate which of the components to the right are included in the POLLUTION PREVENTION estimate you reported in Item 3Ad above. *(Check all that apply.)*

☐ Raw materials modifications

☐ Leak and spill prevention

☐ Process/equipment modification/redesign

B. Add Items 3Aa–d to calculate TOTAL CAPITAL EXPENDITURES for pollution abatement in 2004. Provide an estimate of TOTAL CAPITAL EXPENDITURES even if you are unable to provide separate estimates for 3Aa–d.

		Zero
TOTAL CAPITAL EXPENDITURES	**$,000**	☐

C. What percentage of pollution abatement TOTAL CAPITAL EXPENDITURES in Item 3B was spent for each of the four types of media for this facility in 2004? (See page 7 in the guidelines for definitions.)

		Zero
a. Air emissions	%	☐
b. Water discharges	%	☐
c. Solid wastes	%	☐
d. Multimedia pollutants (not included in other media categories above)	%	☐

a + b + c + d = 100 %

D. What percentage of pollution abatement TOTAL CAPITAL EXPENDITURES in Item 3B was spent for hazardous pollutants for this facility in 2004? (See pages 7–8 in the guidelines for definition.)

	Zero
%	☐

Item 4 OPERATING COSTS

The questions in this section ask about operating costs of pollution abatement. First, report your operating cost expenditures by type of pollution abatement activity. Add these values together to determine TOTAL OPERATING COSTS of pollution abatement. **Provide an estimate of TOTAL OPERATING COSTS even if you are unable to provide separate estimates for each component of operating costs.**

- Report only operating costs for abatement activities whose primary purpose is pollution abatement.
- Exclude depreciation expense. (This information is recorded in Item 7.)
- Include operating costs related to monitoring, testing, and on-site administration costs associated with regulatory compliance.
- Exclude operating costs related to site cleanup. (This information is recorded in Item 5.)
- Exclude operating costs related to product redesign or reformulation intended to reduce the pollution generated by consumers or uses from products manufactured at this facility. (This information is recorded in Item 5.)
- Cost offsets, such as revenue from recycling, should NOT be deducted. (This information is recorded in Item 6.)
- Report in thousands of dollars. If your facility had no operating costs or operating costs less than $500 for pollution abatement in 2004 in a specific category, check the box in the "Zero" column.

A. Provide estimates of operating costs of pollution abatement by the following four cost categories for this facility in 2004.

		Zero
a. Salaries/wages (for all time spent by professional, administrative, operating, and maintenance employees on pollution abatement activities)	$,000	☐
b. Fuels, electricity, and other utilities and energy costs	$,000	☐
c. Materials and supplies	$,000	☐
d. Contract work, leasing, and other purchased services	$,000	☐

B. Add Items 4Aa–d to calculate TOTAL OPERATING COSTS for pollution abatement in 2004. Provide an estimate of TOTAL OPERATING COSTS even if you are unable to provide separate estimates for Items 4Aa–d.

		Zero
TOTAL OPERATING COSTS	**$,000**	☐

C. What percentage of pollution abatement TOTAL OPERATING COSTS in Item 4B was spent for each of the four pollution abatement activity categories for this facility in 2004? (See pages 4–5 in the guidelines for definitions.)

		Zero
a. Treatment	%	☐
b. Recycling	%	☐
c. Disposal	%	☐
d. Pollution prevention	%	☐

a + b + c + d = 100 %

Indicate which of the components to the right are included in the POLLUTION PREVENTION estimate you reported in Item 4Cd above. *(Check all that apply.)*

- ☐ Raw materials modifications
- ☐ Leak and spill prevention
- ☐ Process/equipment modification/redesign

D. What percentage of pollution abatement TOTAL OPERATING COSTS in Item 4B was spent for each of the four types of media for this facility in 2004? (See page 7 in the guidelines for definitions.)

		Zero
a. Air emissions	%	☐
b. Water discharges	%	☐
c. Solid wastes	%	☐
d. Multimedia pollutants (not included in other media categories above)	%	☐

a + b + c + d = 100 %

E. What percentage of TOTAL OPERATING COSTS in Item 4B for pollution abatement was spent for hazardous pollutants for this facility in 2004? (See page 7–8 in the guidelines for definition.)

	Zero
%	☐

Item 5 COSTS NOT INCLUDED IN PREVIOUS ITEMS

The questions in this section ask about other costs NOT included in previously provided estimates. Report in thousands of dollars. If your facility had no costs or costs less than $500 for pollution abatement in 2004 in a category below, check the box in the "Zero" column.

A. What were the total payments to government entities for PERMITS AND FEES related to pollution abatement for this facility in 2004? (See page 6 in the guidelines for definition.)

	Zero
$,000	☐

B. What were the capital expenditures and/or operating costs for SITE CLEANUP for pollution abatement for this facility in 2004? (See page 6 in the guidelines for definition.)

		Zero
a. Capital expenditures	$,000	☐
b. Operating costs	$,000	☐

C. What were the capital expenditures and/or operating costs related to PRODUCT REDESIGN or reformulation intended to reduce the pollution generated by consumers or users from products manufactured at this facility (downstream pollutants) in 2004? (See page 6 in the guidelines for definition.)

		Zero
a. Capital expenditures	$,000	☐
b. Operating costs	$,000	☐

D. What were the number of TRADABLE PERMITS bought from the government or another entity exercised and their total cost by the following types of tradable permits? (See page 6 in the guidelines for definition.)

	Number	Total Cost	Zero
a. SO_2		$,000	☐
b. NO_x		$,000	☐
c. Other *Describe:*_____		$,000	☐

Item 6 COST OFFSETS

Estimate the cost offsets for your facility in 2004. Include only cost offsets for activities whose primary purpose is pollution abatement. Do NOT include cost reductions from energy-efficiency improvements or revenue from recycling activities that are profitable in the absence of environmental concerns.

- Only cost offsets associated with the activities for the costs reported in Item 4 should be included.
- Do not reduce the costs reported in Item 4 by the estimates of cost offsets reported in this item.
- Report in thousands of dollars. If your facility had no cost offsets or cost offsets less than $500 in 2004, check the box in the "Zero" column.

A. What was the total value of cost offsets for this facility in 2004? (See page 6 in the guidelines for definition.)

	Zero
$,000	☐

B. Which types of cost offsets were included in COST OFFSETS in Item 5A above? *(Check all that apply.)*

- ☐ Revenue from recycling
- ☐ Energy cost savings
- ☐ Reduced material costs
- ☐ Other *Describe:*_____

Item 7 DEPRECIATION

Estimate depreciation expense for all pollution abatement equipment operating at this facility in 2004, including equipment installed prior to 2004. Report in thousands of dollars. If your facility had no deprecation costs or depreciation costs less than $500 for pollution abatement equipment in 2004, check the box in the "Zero" column.

A. What was your depreciation expense for pollution abatement structures and equipment in 2004? (See pages 6–7 in the guidelines for definition.)

	Zero
$,000	☐

B. What depreciation method was used to compute this estimate? *(Check only one box.)*

- ☐ Straight-line
- ☐ Accelerated (e.g., double declining balance)
- ☐ Other *Describe:*_____

C. What was the gross book value of pollution abatement capital at your facility at the beginning of 2004 (not adjusted for depreciation)? (See page 7 in the guidelines for definition.)

$,000 | Zero ☐

Item 8 BURDEN

Estimate the number of hours spent filling out this form. Include the time you and all other staff spent completing the survey form.

Item 9 REVIEW

Thank you for participating in the pretest of the PACE survey. To assist us in revising the questionnaire, please answer the following questions related to the Guidelines and Definitions document accompanying this survey form. Check one box for each question.

A. Did you read/use the Guidelines and Definitions document while completing this form?
☐ Yes ☐ No

B. Did the Guidelines and Definitions document and the instructions embedded in the survey form provide adequate/sufficient information to complete the survey?
☐ Yes ☐ No

C. Were the illustrative examples on pages 13–16 of the Guidelines and Definitions document useful?
☐ Yes ☐ No

One of the main objectives of the redesign of the survey is to better clarify the distinction between pollution treatment and pollution prevention. To help in this process, please provide your assessment of the following example projects as to whether they should be classified as

- pollution treatment expenditures,
- pollution prevention expenditures, or
- not to be included in PACE cost estimates because the primary motivation was not pollution abatement.

Check one box for each question.

D. A facility installs a new flotation clarifier as part of an on-site wastewater treatment unit. The capital expenditures for this project should be classified as

☐ Pollution treatment expenditures
☐ Pollution prevention expenditures
☐ Not to be included in PACE cost estimates because the primary motivation was not pollution abatement

E. Capital expenditures of $10,000 were made to install a unit to capture hazardous waste. The unit has a life expectancy of 10 years and has negligible operating costs. The collected waste can be recycled and will provide revenue of $5,000 per year. The primary purpose for implementing the project was to increase profitability. The capital expenditures of this project should be classified as

☐ Pollution treatment expenditures
☐ Pollution prevention expenditures
☐ Not to be included in PACE cost estimates because the primary motivation was not pollution abatement

F. To meet new regulations, existing boilers must be retrofitted so they can burn cleaner fuel. The fuel is slightly more expensive but has the same BTU content. The fuel would not have been changed without the regulation and does not increase profitability. The costs associated with this retrofit project should be classified as

☐ Pollution treatment expenditures
☐ Pollution prevention expenditures
☐ Not to be included in PACE cost estimates because the primary motivation was not pollution abatement

Item 10	CERTIFICATION

A. Provide the following information on the person to contact regarding this survey.

Name of person to contact regarding this report *(Please print)*	Telephone		
			Ext.
E-mail address	Fax number		

B. Provide the name, title, and signature of a person who verifies that the information reported in this survey is to the best of your knowledge accurate. The authorizing official may be a plant manager, vice president, or environmental health and safety official.

	Title
	Date

Feel free to add any comments about the survey in the space provided below. Thank you for your participation.

Comments:

The public reporting and recordkeeping burden for this collection of information is estimated to average 10 hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

Return this form by Month Day, 2005, in the enclosed prepaid envelope to

RTI International
Attention: PACE Survey
Post Office Box 12194
Research Triangle Park, NC 27709-2194

If you have any questions, contact Wanda Throneburg of RTI at 1-800-334-8571 (extension 6261) or by e-mail at wthroneburg@rti.org.

Guidelines and Definitions for Completing the Pollution Abatement Costs and Expenditures (PACE) Survey Pretest

Page

SURVEY GUIDELINES

BACKGROUND

The Pollution Abatement Costs and Expenditures (PACE) survey was conducted by the Census Bureau annually between 1973 and 1994 (excluding 1987) and again in 1999. This survey is a pretest of the redesigned survey instrument being considered for use in reinstating the annual PACE survey.

This survey collects information on costs and expenditures in 2004 for pollution abatement activities for a specific **facility** (the single location at the address listed on the front of the survey form). Pollution abatement includes treatment, recycling, disposal, and pollution prevention. Costs and expenditures include new capital equipment, annual operating costs, and other expenses, such as payments to the government in the form of charges, permits, and fees. Only activities whose primary purpose is pollution abatement (as opposed to activities undertaken primarily for financial reasons) are included.

The data from this survey are used by the Environmental Protection Agency (EPA) to satisfy legislative and executive requirements to track the costs of regulatory programs and to provide aggregate national statistics. Other users of these data include trade associations, manufacturers, marketing and research companies, universities, financial and environmental institutions, other federal agencies, state and local governments, and environmental reporters.

AUTHORITY AND CONFIDENTIALITY

Participation in the pretest of the PACE survey is voluntary. Facilities are not required to participate by law. However, the findings from the pretest will be used to develop the final version of the survey questionnaire, which historically has been administered by the Census Bureau, so your participation is important. For more information on previous PACE surveys, see http://www.census.gov/econ/www/mu1100.html.

The pretest of the survey is being conducted on behalf of EPA by RTI International (RTI), a not-for-profit research organization. Only project team members, including RTI employees, project consultants, and the two to three EPA employees who are developing the final version of the PACE survey form will have access to the survey responses. Information collected in the pretest will not be publicly available and will be destroyed after five years. If you have any questions about data confidentiality, please contact Wanda Throneburg of RTI at 1-800-334-8571 (extension 6261) or by e-mail at wthroneburg@rti.org.

WHO SHOULD REPORT

Complete the survey form only for the facility identified on page 1 of the survey form. If your company operates more than one location, REPORT ONLY FOR THE FACILITY TO WHICH THIS SURVEY WAS ADDRESSED. **DO NOT COMBINE** responses with other facilities owned by your company even though operations may jointly use the same pollution abatement equipment or staff. If such equipment or personnel sharing occurs, allocate the costs and expenditures according to the number of annual hours the pollution abatement equipment or staff are distributed across facilities.

This survey is directed to manufacturing, mining, and electric utility operations. The information requested supplements the data collected in the Annual Survey of Manufactures. If you think that your facility is ***not a manufacturing, mining, or electric utility establishment*****,** contact Wanda Throneburg of RTI at 1-800-334-8571 (extension 6261) or by e-mail at wthroneburg@rti.org.

REPORTING PERIOD

Report data for the 2004 calendar year. If your fiscal year ends between October 31 and February 28, fiscal-year figures are acceptable; otherwise report calendar year data.

WHEN AND WHERE TO REPORT

Complete the form and return it by Month Day, 2005, in the enclosed prepaid envelope to

RTI International
Attention: PACE Survey
Post Office Box 12194
Research Triangle Park, NC 27709-2194

If you need ***additional time*** to complete the form or if you need a ***duplicate form,*** please contact Wanda Throneburg of RTI at 1-800-334-8571 (extension 6261) or by e-mail at wthroneburg@rti.org.

RESPONSE TIME

The public reporting and recordkeeping burden for this collection of information is estimated to average 10 hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

HOW TO ESTIMATE

Answer all questions. If you cannot answer a question from your plant records, please estimate the answer carefully. In some cases, identification of pollution abatement expenditures may require the joint efforts of your facility's financial and environmental staff. If there were no expenditures or expenditures were less than $500 for a specific category, check the box in the "Zero" column.

Report the incremental capital expenditures and operating costs of pollution abatement. These are costs above and beyond what would have been incurred in the absence of environmental concerns.

When reporting costs, **please use actual costs whenever possible, and provide estimated costs if actual costs are not available**. For situations where environmental costs are not tracked separately from the facility-level operating costs, please use available resources and judgment to estimate how much of the facility-level costs are attributable solely to pollution abatement activities. Sources of data include accounting records and engineering estimates. For example, if estimated operating costs were provided by a pollution control device vendor as part of an investment proposal, these estimated operating costs could be used to help determine the portion of the facility-level actual operating costs that is attributable to pollution treatment.

Provide total cost estimates even if you are unable to provide estimates of each cost component. Specific instructions on how to complete each item are included in the survey instrument along with the page number referring to the key definitions in this document.

Round all figures to the nearest thousands of dollars. To facilitate rounding, "000" has been placed in each entry field.

KEY DEFINITIONS

Definitions are provided for the **activity** categories and **cost** categories used in the survey. Activity categories identify ongoing pollution abatement activities (i.e., treatment, recycling, disposal, and pollution prevention). Cost categories separate expenditures into components such as capital versus operating costs or wages versus fuel expenditures. Costs are also linked to various pollutant media and classifications (e.g., air, water, solid waste, hazardous, or nonhazardous).

Definitions are for the purpose of this survey only and are not intended to be representative of official federal, state, or local statutory language. In certain cases, the definitions may be similar to those found in a particular rule or regulation; however, for the purpose of this survey, please use the terms as they are defined in these guidelines.

Facility is a single physical location where business is conducted or where services or industrial operations are performed. Facilities are often referred to as establishments or plants. A company may have one or more facilities. For this survey, report only for the designated facility located at the address printed on the front of the survey form. Do NOT include data for other facilities owned by the same company when responding to the survey questions.

Pollution is the presence of a substance in the environment that because of its chemical composition or quantity prevents the functioning of natural processes and produces undesirable environmental and/or human health effects. For the purpose of this survey, consider only the pollutants generated at the designated facility as part of the production process.

ACTIVITY CATEGORIES

Pollution abatement refers to ALL pollution management activities that occur at the designated facility, whose primary purpose is protecting the environment. These activities may be in response to federal, state, or local regulations or voluntary initiatives. Investments or activities that increase profits or efficiency in the absence of environmental considerations should not be included, even if pollution abatement occurs as a side benefit. For the purpose of this survey, pollution abatement is divided into four major activities: treatment, recycling, disposal, and pollution prevention. All costs associated with pollution abatement, including monitoring, testing, administration of environmental programs, and permit preparation, should be distributed among these four categories.

- **Treatment** is any method, technique, or process designed to remove pollutants after their creation from air emissions, effluents, or solid waste. In general, pollution treatment includes the use of retrofit technologies, on-site management, and/or contract services (off-site) that are designed to change the physical, chemical, or biological character or composition of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released to the environment (including fugitive emissions) to render such waste nonhazardous or less hazardous or safer to transport, store, or dispose of. These pollution treatment activities are also commonly referred to as “end-of-pipe” activities.

- **Recycling** is the on-site (postproduction) processing or off-site processing of waste for an alternative use. Recycling includes recovering liquid, solid, or gaseous wastes and reusing them in the same or another production process and partially reclaiming materials (e.g., drying materials that contain recoverable metals for the purpose of enhancing a subsequent recovery activity). Activities that closely resemble treatment for the purpose of destruction or disposal and burning waste materials for fuel are not included in this category. Recycling only includes activities whose primary purpose is pollution abatement and does NOT include activities done primarily for financial reasons.

- **Disposal**, in an environmentally sound manner, is the final placement, destruction, or disposition of waste after pollution treatment or recycling has occurred. This includes the discharge of treated pollutants into the environment. For example, solid waste is often managed by landfill disposal, and certain liquid wastes may be disposed of using injection wells. **For the purpose of this survey, do not report disposal expenditures associated with municipal solid waste (e.g., office and cafeteria trash).**

- **Pollution prevention** includes any practice that reduces the amount of any pollutant generated during the production process *prior to* postprocess recycling, treatment, or disposal. Pollution prevention practices include equipment or technology modifications; process or procedure modifications; reformulation or redesign of products (to reduce pollution from the manufacturing process); substitution of raw materials; and improvements in housekeeping, maintenance, training, or inventory control that result in fewer emissions, effluents, or solid waste. The incremental cost of activities involving the redirection of "used" material inputs, which would otherwise be wasted, back into the production process (also called in-process recycling or closed loop recycling) should also be included in pollution prevention if the primary purpose of this activity is pollution abatement rather than for financial reasons.

  For the purpose of this survey, pollution prevention practices are grouped into the following three primary categories:

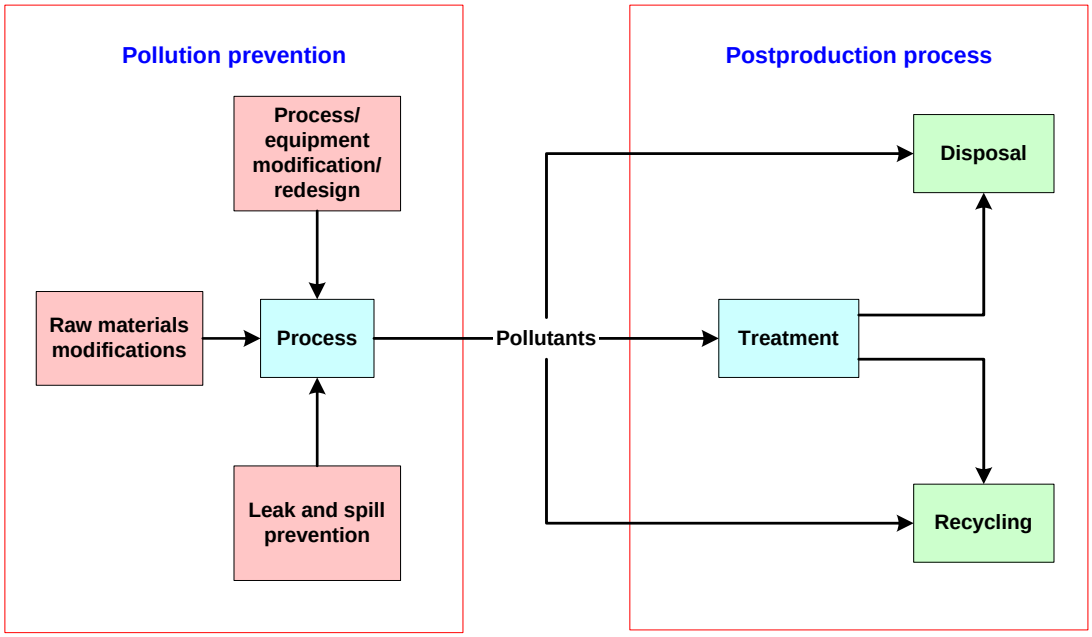
  - **Raw materials modifications**: altering inputs to reduce or modify pollutants during the manufacturing process. Also referred to as substitution of raw materials.

  - **Leak and spill prevention**: improvements in housekeeping, maintenance, training, or inventory control that result in decreased leaks/spills/disposal of raw materials, in-process materials, products, or by-products.

  - **Process/equipment modification/redesign**: equipment or technology modifications, process or procedure modifications, reformulation or redesign of products to reduce pollution from the manufacturing process, or in-process recycling.

As shown in Figure 1, a general distinction between pollution prevention and the other pollution abatement activities is that the latter (treatment, recycling, and disposal) are postproduction activities used to manage pollutants **after** they are generated by the production process. In contrast, pollution prevention activities reduce or eliminate the pollutants generated **during** the production process.

Figure 1. Overview of the Pollution Management System



COST CATEGORIES

The survey asks about three types of cost categories: **capital expenditures, operating costs,** and **other costs**:

- **Capital expenditures** include any installation and retrofit that occurred during 2004 for separately identifiable methods, techniques, or process technologies installed primarily to eliminate pollutants through pollution treatment, recycling, disposal, and/or pollution prevention. Total expenditures for equipment installation and startup are included. These expenditures are often referred to as "one-time-costs."

- **Operating costs** include annual costs for operating and maintaining all pollution abatement technology operating in 2004, including technology brought online prior to 2004. Operating costs include all costs of salaries and wages; fuels, electricity, and other utilities and energy costs; materials and supplies; and contract work, leasing, and other purchased services. Labor costs of administration of environmental programs and permit preparation should be included in operating costs.

- **Other costs** include expenditures not captured by total capital expenditures or total operating costs.

    - **Permits and fees**—Payments to local, state, and federal government agencies related to purchasing permits or paying fees associated with pollution abatement (e.g., Title V permit fees, publicly owned treatment works (POTW) fees, and landfill tipping fees). Tradable permits are not included in this category. In addition, labor costs associated with permit preparation should be excluded; these costs are captured in operating costs.

    - **Site cleanup**—Remediation of contamination due to leaks, spills, waste disposal, or other releases from current or past on-site production processes. Asbestos removal should be included in site cleanup. Costs of site assessments, sampling, analysis, and other activities associated with the site should also be included. The pollution must be on the site of the facility named on the survey form.

    - **Product redesign**—Expenditures and costs of product redesign or reformulation intended to reduce the pollution generated by consumers or users from products manufactured at the facility. This is also referred to as downstream pollutants. Product redesign to reduce pollution from the manufacturing process should be excluded; these costs are captured under pollution prevention.

    - **Tradable permits**—Number and cost of tradable permits exercised in 2004. Include permits bought from the government or another entity in a previous year that were exercised in 2004. Exclude permits that were purchased in 2004 and banked for future use. Average purchase price or current market value may be used if actual purchase price is not known. Do not subtract permits sold in 2004. Report for SO_2, NO_x, and other trading programs, including federal, state, and other regional regulatory permits (or credits).

Cost offsets are related to operating costs but reported in a separate item in the survey**.** Cost offsets are pollution abatement operating expenses recovered as a result or an offshoot of pollution abatement techniques. This is usually the value of recovered (recycled) materials or reduced energy. In addition, cost reductions from waste minimization for environmental protection and energy recovery for environmental protection are cost offsets. Cost offsets must be motivated by pollution abatement; cost reductions from energy-efficiency improvements or revenue from recycling activities that are profitable in the absence of environmental concerns are not to be included.

Depreciation is related to capital expenditures but reported in a separate item in the survey. Depreciation and amortization charged during the year is attributed to the wear and tear on equipment or structures and obsolescence due to changing technology. Depreciation expense recorded on the survey is for all pollution abatement equipment operating in the facility in 2004, including equipment installed prior to and during 2004. This includes the depreciation against fixed

assets acquired since the beginning of the year and those sold during the year or retired and no longer carried on the books at the end of the year. At the end of the expected life of the equipment or structure, the entire cost of the equipment or structure will have been depreciated. Common methods used include straight-line depreciation and accelerated depreciation (such as double declining balance). Custom methods may also be used.

Included under the item of depreciation is the **gross book value** of pollution abatement capital. This is the sum of the purchase prices of all pollution abatement equipment in place at the beginning of 2004. Do NOT adjust this figure for depreciation. Exclude the effects of inflation, deflation, and vintage. Do not include equipment retired prior to 2004.

ALLOCATION OF COSTS BY MEDIUM AND TYPE

The survey asks about total capital expenditures and total operating costs by type of medium and hazardous versus nonhazardous pollutants.

- **Medium** is used to link expenditures to the types of pollutants (air emissions, water discharges, and solid wastes) that are being managed by pollution abatement activities.

    - **Air emissions** are any substances released into the air that could, in high enough concentration, pose a threat to the environment and/or human health.

    - **Water discharges** are any substances or pathogens released into water that could, in high enough concentration, pose a threat to the environment and/or human health.

    - **Solid wastes** are any discarded materials, including solid, liquid, semi-solid, or contained gaseous materials, that pose a threat to the environment and/or human health by contaminating soil and groundwater.

    - **Multimedia pollutants** comprise the remaining pollution abatement category and are simply those expenditures not attributable primarily to one type of pollution or that deal with pollution affecting more than one medium.

- **Hazardous pollutants** are those regulated under Section 112 of the Clean Air Act, listed by the Clean Water Act (including toxic metals, toxic inorganic compounds, and toxic organic compounds), and defined within the Resource Compensation and Recovery Act (RCRA) Subtitle C. Examples of hazardous and nonhazardous pollutants are provided in Table 1.

    When estimating the share of costs associated with hazardous pollutants, the **incremental** capital and operating costs of abating hazardous pollutants should be used. Do NOT include the total cost if the equipment is used to abate both hazardous and nonhazardous pollutants, only the incremental components associated with the hazardous pollutants. Also, do NOT estimate the share of costs based on the relative volume (tons, gallons, etc.) of hazardous versus nonhazardous pollutants abated. For example, if 1% of the quantity of pollutants abated from a piece of equipment is hazardous, the cost associated with abating the hazardous pollutants is not necessarily equal to 1% of the total cost of the equipment (see the “Hazardous” section in the Examples for more detailed examples).

Table 1. Examples of Hazardous and Nonhazardous Pollutants

Media	Hazardous Pollutants	Nonhazardous Pollutants
Air	Metals, other particles, gases absorbed onto particles, and certain vapors from fuels and other sources. Examples include emissions of toluene, benzene, methanol, chlorine, and vinyl chloride. For this survey, lead and lead compounds fall under this category.	Criteria air pollutants and their precursors (except lead). Examples include emissions of particulate matter, sulfur dioxide, nitrogen oxide, carbon monoxide, and volatile organic compounds (VOCs). This category also includes Section 111-d designated air pollutants (e.g., total reduced sulfur compounds).
Water	Toxic metals and inorganic compounds including antimony, arsenic, beryllium, cadmium, chromium, copper, cyanide, lead, mercury, nickel, silver, thallium, and zinc. Examples of organic compounds include benzene, chlorethane, toluene, and xylene.	Discharges of nutrients, fecal coliform, and suspended solids and adverse changes in temperature and pH balance.
Solid	Hazardous solid wastes possess one or more of the following characteristics: ignitability, corrosivity, reactivity or toxicity; appear on special EPA lists; or are designated as hazardous under state hazardous waste laws. Mixed wastes are defined as any waste containing both RCRA Subtitle C hazardous waste and radioactive waste. The expenditures associated with mixed wastes are to be included with hazardous waste expenditures.	Industrial D wastes are wastes that are neither municipal wastes nor wastes that are currently identified as hazardous wastes under RCRA Subtitle C. Nonhazardous industrial wastes (Industrial D wastes) consist primarily of manufacturing process wastes, including wastewater, and wastewater and nonwastewater sludges and solids.

COSTS AND EXPENDITURES INCLUDED AND EXCLUDED FROM THE SURVEY

For this survey, include only those activities with the primary purpose of pollution abatement. Although certain expenditures may have multiple benefits, only consider those expenditures for which pollution abatement is the primary purpose. Investments or activities that increase profits or efficiency in the absence of environmental considerations should not be included, even if pollution abatement occurs as a side benefit. For example, some pollution prevention practices, particularly process modifications, may have been undertaken primarily as a financially motivated cost-cutting activity. In addition, do not report expenditures intended to meet worker safety and health requirements. Below is a list of general types of costs and expenditures that are excluded from the survey. Table 2 lists examples of included and excluded costs and expenditures by activity category.

The following are general examples of excluded costs and expenditures

- activities that are a normal operating procedure and whose primary purpose is not pollution abatement;
- costs that did not occur in 2004;
- research and development services;
- corporate expenditures that cannot be attributed to a specific facility;
- health, safety, aesthetics, or employee comfort (OSHA); and
- habitat protection.

Table 2. Capital Expenditures and Operating Costs Included and Excluded by Activity Category

Activity Category	Capital Expenditures	Operating Costs	Excluded Costs and Expenditures
Treatment	Purchase, installation, and startup costs of pollution treatment equipment and materials	Operating and maintaining pollution treatment equipment Fuel and utilities costs for operating pollution treatment equipment Leasing of pollution treatment equipment Cost for pollution treatment equipment replacement and repair	Manufacture of pollution treatment equipment for sale Manufacture of products related to pollution abatement (such as low-sulfur gasoline) for sale
Recycling	Equipment and other one-time costs for on-site (postproduction process) and off-site recycling	Annual costs of on-site (postproduction process) and off-site recycling	Recycling equipment if your primary product is recycling; that is, you are a recycling plant Recycling for profitability reasons (not with the primary purpose of pollution abatement)
Disposal	Equipment and other one-time costs associated with on-site and off-site disposal	Annual costs of on-site and off-site disposal Payments to a private or government contractor for solid waste disposal	Disposal of municipal solid waste (e.g., office and cafeteria trash)
Pollution Prevention	Purchase and installation of new or retrofit technology that reduces pollution generated Cost of leak prevention and monitoring equipment	Incremental cost increase of operating the new or retrofit technology relative to conventional technology Cost of running leak detection programs Incremental cost increase associated with using new raw material versus the conventional/standard raw material	Equipment or technology that reduces pollutants generated but was installed primarily for financial reasons Use of a new raw material that reduces pollutants generated but is less expensive than previously used raw material

COMPLETING THE SURVEY

STRUCTURE OF THE SURVEY

The survey is segmented into 10 items. Figure 2 illustrates how activity components and cost components discussed previously are included in each Item.

- **Item 1** asks about the operational status of the facility, the number of employees (including leased employees), production capacity, and value of production.

- **Item 2** identifies some of the different types of pollution abatement activities used at this facility in 2004.

- **Item 3** reports all capital expenditures related to pollution abatement in 2004. Capital expenditures include all one-time equipment, installation, and start-up costs; include labor only when contracted specifically for installation.

- **Item 4** reports all operating costs related to pollution abatement in 2004. Operating costs include all time spent by all facility staff supporting pollution abatement activities and all related expenditures for fuel, materials, and contract services. Cost offsets (Item 6) and depreciation (Item 7) should be excluded from operating costs.

- **Item 5** reports costs, NOT previously included in the previous items, of payments to government entities for permits and fees, capital expenditures and operating costs for site cleanup, capital expenditures and operating costs for product redesign, and number of tradable permits and their total cost. Associated labor costs should not be included because they are part of operating costs (Item 4).

- **Item 6** reports cost offsets of pollution abatement in 2004 and identifies what types of cost offsets are included. Cost offsets include revenue from recycling projects that are environmentally motivated. Recycling activities that are profitable in the absence of environmental concerns should be excluded.

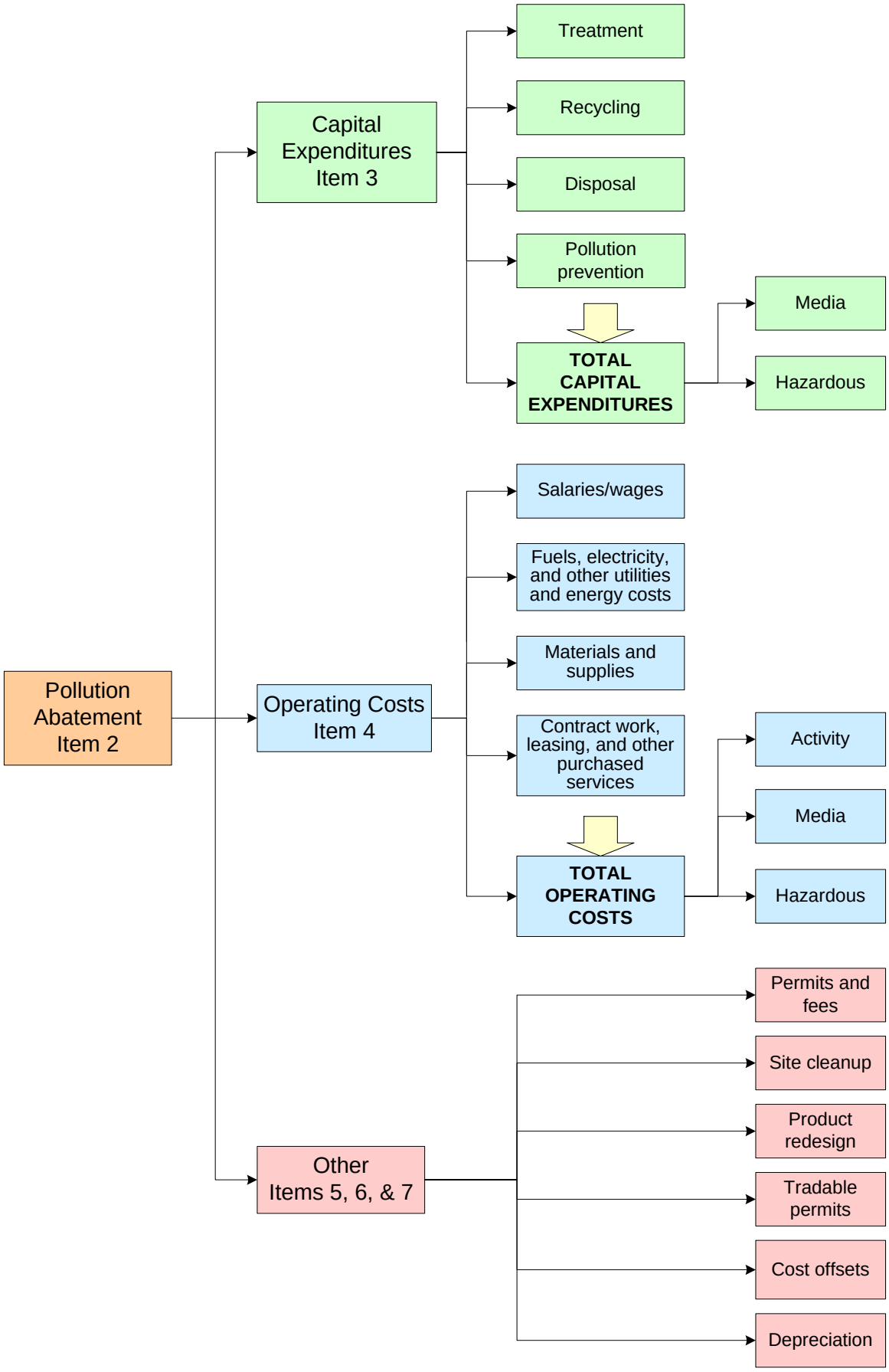
- **Item 7** reports depreciation expense of pollution abatement structures and equipment in place in 2004 and identifies the depreciation method used. Gross book value of pollution abatement capital is also reported in this item.

- **Item 8** reports the burden in terms of the number of hours it took to fill out the survey.

- **Item 9** asks several questions to assist the redesign of the survey instrument and instructions.

- **Item 10** provides certification information on the person at the facility to contact regarding this report and the name, title, and signature of a person who verified that the information reported in this survey is to the best of your knowledge accurate.

Figure 2. Overview of the Survey Structure



HOW TO REPORT

Specific instructions on how to complete each item are included in the survey instrument along with the page number referring to the key definitions.

Provide total cost estimates even if you are unable to provide estimates of each cost component. For example, if you have data for the total capital expenditures associated with pollution abatement but are unable to break down the total value into its component parts requested in Item 3A (i.e., treatment, recycling, disposal, and pollution prevention), please provide the total capital expenditures in Item 3B.

Round all figures to the nearest thousands of dollars. To facilitate rounding, "000" has been placed in each entry field.

Example: Capital expenditures for pollution treatment for 2004 are $25,652,950.

					Zero
INCORRECT	$	25,652,950	,000		☐
INCORRECT	$	25 MM	,000		☐
CORRECT	$	25,653	,000		☐

All **support activities**, such as monitoring and testing or administrative staff to support permitting, are to be included in total capital expenditures and operating costs and in the appropriate activity categories.

The number of **full-time equivalent (FTE) employees** (Item 1Da) is conceptually the number of total labor hours at the facility in 2004 divided by 2,000 hours (8 hours per day x 5 days per week x 50 weeks per year, assuming two weeks vacation). FTE does not mean the number of employees.

EXAMPLES

This section provides example activities and projects and indicates how they link to the definitions and the items in the survey instrument.

TREATMENT

- A facility installs an electrostatic precipitator (ESP) to reduce particulate matter (PM) emissions from one of its process units. The facility also installs a continuous opacity monitoring system (COMS) at the outlet of the ESP to monitor opacity as a surrogate for PM emissions. The total capital expenditure on the ESP (including installation, fans, and ductwork, for example) and the COMS should be included in the **capital expenditures** for pollution treatment. The costs associated with operating the ESP and the COMS (e.g., electricity costs to run the ESP and COMS and labor involved in collecting and reporting COMS data) should be included in the **operating costs** for pollution treatment.

- A facility installs a new flotation clarifier as part of its on-site wastewater treatment unit. All capital expenditures associated with the purchase, installation, and start-up of the new clarifier should be included in the **capital expenditures** for pollution treatment. All costs associated with operating the new clarifier (e.g., cost of electricity to run the compressor, cost of flocculating chemicals) plus the costs for operating the other wastewater treatment equipment should be included in the **operating costs** for pollution treatment.

- A facility hires an environmental consulting company to conduct an emission source test to measure air pollutant emissions from the facility's control device. The contractor costs associated with conducting this source test should be included as **operating costs**. The labor costs for facility personnel to supervise and assist in conducting this source test should be included as **operating costs**.

RECYCLING

- A facility installs and operates equipment used to recycle former waste streams to comply with environmental regulations or for other environmental reasons. Costs associated with installing the equipment (e.g., purchased equipment, engineering, site preparation, installation, and other associated costs) should be included as **capital expenditures.** Costs associated with operating the equipment (e.g., cost of electricity, operating labor, and maintenance labor) should be included as **operating costs.**

DISPOSAL

- A facility constructs a new on-site landfill for disposing of solid waste. All costs associated with constructing the landfill (including the capital expenditures of equipment and machinery necessary for managing the landfill) should be included as **capital expenditures** for disposal.

- A facility generates solid waste from several sources including sludge from an on-site wastewater treatment operation and solid waste generated during the manufacturing process. All of the solid waste is sent to an on-site landfill operated by a contractor. The payments to the on-site contractor should be reported as **operating costs** under disposal.

- A facility hires an outside contractor to periodically pick up spent process catalyst for disposal. Contract fees for disposing of spent process catalyst should be included as **operating costs**.

POLLUTION PREVENTION

- A facility switches to using a new, more expensive raw material that either contains fewer pollutants or releases fewer pollutants when used in the production process. The facility makes some slight modifications to the process to accommodate the use of the new raw material. The **capital expenditures** associated with the equipment modifications should be included in pollution prevention. The incremental cost increase associated with using the new raw material versus the conventional/standard raw material should be included as an **operating cost** for pollution prevention.

- A facility implements a new leak detection and repair (LDAR) program to reduce equipment leaks. The **capital expenditures** associated with the LDAR program (e.g., cost of equipment for leak prevention, such as pump seals, and the cost of leak monitoring equipment, such as handheld organic vapor detectors) should be included in pollution prevention. The **operating costs** associated with running the LDAR program (e.g., labor for staff to monitor for leaks and prepare periodic reports) should be included in pollution prevention.

- A facility installs a new technology that results in fewer air pollutants released per ton of product manufactured. The new technology has slightly higher electricity and labor costs than the conventional technology. The **capital expenditures** associated with purchasing and installing the new technology should be included in the capital expenditures for pollution prevention. The incremental cost of the new technology relative to the conventional technology should be included in the **operating costs** for pollution prevention.

HAZARDOUS

- A facility operates a process unit that emits both hazardous and nonhazardous air pollutants. An add-on air pollution control device was installed prior to 2004 to control the nonhazardous air pollutants. In 2004, the facility upgraded the existing control device to increase the overall pollutant reduction efficiency to a level required by a new regulation that targets the hazardous portion of the air emission stream. The **capital expenditures** of the upgrade would be included in the total capital expenditure for pollution abatement at the facility. Because the total cost of the upgrade was specifically targeted to hazardous air pollutants, 100 percent of the upgrade cost would be attributed to hazardous air pollutants. For **operating costs**, the percentage that is for hazardous pollutant control should be based on the incremental increase in the control device operating costs directly attributable to the upgrade of the control technology (including any increases in monitoring or record-keeping costs).

- A facility operates a process unit that emits both hazardous and nonhazardous air pollutants. An add-on air pollution control device was installed prior to 2004 to control the nonhazardous air pollutants. The performance of the air pollution control device is sufficient such that no changes were made to the device to comply with new regulations for the hazardous air pollutants. In this example, the **capital expenditures** are zero for 2004, and 0 percent of the control device **operating costs** are attributed to hazardous air pollutants.

OTHER COSTS NOT INCLUDED IN PREVIOUS ITEMS

Permits and Fees

- A facility plans a major expansion and completes and submits a new application to the state permitting agency for approval. The permit application fee should be reported under **permits and fees**.

Site Cleanup

- Capital expenditures and operating costs associated with Superfund site cleanup operations, replacement of leaking or inferior underground storage tanks (USTs), cleanup of leaks and spills of hazardous substances, and other soil or groundwater contamination cleanup are included as site cleanup. A facility should also report payments to a private company for site cleanup of the site on which the facility is located. Compliance and environmental auditing and environmental studies undertaken to assess the extent of the contamination prior to site cleanup are also included as costs of site cleanup. For example, if a facility decides to treat contaminated soil on-site via soil vapor extraction and, in the process, purchases a vacuum system and carbon treatment unit, the cost of the treatment equipment should be considered **site cleanup capital expenditures**. The cost to operate this equipment and labor and materials associated with conducting any follow-on soil testing and monitoring activities should be considered **site cleanup operating costs**. In many cases, the cleanup is conducted by a contractor, and the facility pays the contractor rather than purchasing any cleanup equipment itself. In these cases, the payments made to the contractor should be considered **site cleanup operating costs**.

Product Redesign

- A facility that sells petroleum products changes its production process to generate low-sulfur diesel and gasoline fuels that decrease pollution expelled by motor vehicles. This change was made to meet the requirements of environmental regulations. The capital expenditures and operating costs associated with changing the production process for the new product specifications are considered product redesign that reduces the pollution generated by consumers or users of the products manufactured. These costs should be reported as **product redesign capital expenditures** and **product redesign operating costs.**

- A surface coatings manufacturer reformulates its product to reduce the amount of hazardous air pollutants (HAP) contained in its coating product to help its customers comply with federal environmental regulations that require the use of low-HAP coatings in certain surface coating operations. This product reformulation does not reduce air emissions from the surface coatings manufacturing process; however, the use of the low-HAP coatings in its customers' surface coating operations will reduce air emissions from its customers' facilities. The capital expenditures and operating costs associated with reformulating the product should be considered product redesign. These costs should be reported as **product redesign capital expenditures** and **product redesign operating costs.**

Tradable Permits

- A facility purchased SO_2 permits prior to and during 2004. Three of the permits were exercised during the year. The number "3" should be recorded in the **number** column of the tradable permits item for SO_2. To calculate the **total cost** of the three exercised permits, the facility should estimate the average purchase price for SO_2 permits and multiply this figure by three.

COST OFFSETS

- As an environmental protection alternative to used oil disposal, a printing plant has used machinery oil picked up by a hazardous waste collection and treatment service. The service charges a fee. The fee is reported in disposal operating costs. The service returns the oil clean. Thus, the printer avoids buying new oil. The value of the oil is a **cost offset** to the service's fees.

- A manufacturer purchases a cardboard baler to recycle cardboard containers associated with the manufacturing process. The capital expenditure should be reported in recycling capital expenditures. The costs of operating the baler should be reported in recycling operating costs. The manufacturer sells the cardboard to a recycler. The activity is not a

potentially profit-making venture; it is conducted for pollution abatement. The revenues received from the recycler are **cost offsets**.

- A manufacturer installs a closed-loop recovery system in the production process to prevent the dumping of chemicals into the water system. Because the closed-loop recovery system recaptures and reuses the chemicals in the production process, it reduces expenses for chemicals. The pollution abatement portion of the capital expenditure pertaining to the closed-loop recovery system is reported in pollution prevention capital expenditures. The operating expenses to maintain the system are reported in pollution prevention operating costs. The value of the recovered chemicals should be reported as a **cost offset**.

APPENDIX B. RECOMMENDATIONS AND ISSUES

This appendix provides recommendations that were provided by the facilities and identified by RTI staff during the on-site visits. They are ordered by item number and include specific wording changes to questions and general comments indicating that additional instructions and clarification are needed for several key issues. Some, but not all, of these recommendations were integrated into the revised survey instrument and guidelines document.

B.1 PACE *Guidelines and Definitions* Document

- Suggested that language be added up front on what should be included regarding corporate (overhead) support and costs related to environmental programs. Need to clarify that off-site activities, such as R&D, and corporate environmental staff are not allowable as PACE expenditures (unless the facility is directly charged for this support).
- Consider restructuring the format of the *Guidelines and Definitions* document so that the instructions tie directly to each entry in the survey form.
- *Guidelines and Definitions* document should be simplified to focus the survey instructions on the specific information that the respondent needs to complete the survey.
- Suggested that some language be added up front on what should be included regarding ISO and other environmental certification programs.
- Instructions need to include a statement concerning costs associated with which voluntary environmental programs should be included and reported. For example, are tree planting and beautification voluntary environmental programs?

B.2 General Survey Comments

- Use electronic forms (if possible) because it would simplify data transfer, save time, and allow electronic submittal.
- Administer the survey annually and consistently, and do not significantly change the form from year to year.
- Add additional page number references to the survey instrument that link back to the instructions.

Item 1—Facility Information

- **Item 1C.** Clarify in the form that expenditures include both capital and O&M expenditures.
- **Item 1D.** Define "FTE" in the survey instructions the same way that the Occupational Safety and Health Administration (OSHA) defines it.
- **Item 1Da.** Add a question to ask how many FTEs are needed for environmental management.

- **Item 1Da.** Delete the question that distinguishes between "production workers" and all other workers.
- **Item 1Db.** Define electricity production as total megawatt hours (MWh) generated in the year (i.e., replace the current "megawatts per hour" with "megawatt hours per year").
- **Item 1Db.** Revise the question to give ranges for capacity relative to actual production (e.g., 0 to 5 percent above actual; 5 to 10 percent above actual; 10 to 20 percent above actual,) rather than asking for a single capacity figure.
- **Item 1Db and c.** Suggest we add "units produced" as a capacity/production option because this would be applicable for many manufacturing facilities.
- **Item 1Db and c.** Clarify in the instructions and/or examples that for steel mills, melt shop capacity is what is being requested in Item 1Db and 1Dc. The capacities for the melt shop and the rolling mill are very different.
- **Item 1Dc.** If a PACE survey is developed specifically for pulp and paper mills, consider adding a line under Item 1Dc next to the production units so that mills can specify the assumed moisture content of the finished paper (this would result in a more exact production value).
- **Item 1Dd.** Clarify the meaning of "value of production" for Item 1Dd, perhaps with an example in the instructions.

Item 2—Pollution Abatement Activities

- **Item 2A.** Ask if the facility has environmental cost centers that are used to track pollution abatement costs.
- **Item 2A.** Suggested that an example be provided regarding spray booths and how they should be listed as air pollution control equipment.
- **Item 2A.** Add a separate control device category for paint spray booths.
- **Item 2A. A**dd "process incineration" to the list of "control devices" to account for situations where process combustion equipment (such as power boilers and lime kilns) is used to reduce air emissions.
- **Item 2A.** Add a separate line for "other wet scrubbers" to account for wetted fan type scrubbers commonly used to control emissions from smelt dissolving tanks.
- **Item 2A.** Add continuous emissions monitoring systems (CEMS) to the list of air pollution equipment in Item 2A.
- **Item 2A.** Include a separate line for condensers that are not related to refrigeration.
- **Item 2A.** Add "process incineration" to the list of "control devices" to account for situations where process combustion equipments (such as power boilers and lime kilns) are used to reduce air emissions.
- **Item 2A.** Add a separate line for "other wet scrubbers" to account for wetted fan type scrubbers commonly used to control emissions from smelt dissolving tanks.

- **Item 2Ab.** Suggested that fabric filters should be a separate line item if there was sufficient room.
- **Item 2Ab.** Need to emphasize that even small baghouses should be included.
- **Item 2B.** Add "cooling" or "cooling towers" as a wastewater treatment to Item 2B.
- **Item 2Ba.** Suggested that "settling" and "oil-water separators" be added as examples in the parentheses or in the instructions as examples of physical techniques.
- **Item 2Be.** Delete "annual" because the units are to be specified in the box. A company indicated gallons/day even though the question was for annual quantity of wastewater.
- **Item 2Be.** Clarify in the instructions that wastewater discharge does not include discharges to the sanitary sewer (sewage).
- **Item 2Be.** Consider clarifying the instructions for reporting the quantity of wastewater treated and discharged in Item 2Be. The amount treated should be the amount treated on-site, and the amount discharged applies only to wastewater that is sent off-site without receiving treatment on-site.
- **Item 2C.** Add a category called "beneficial use" in Item 2C to account for solid waste that can be used in beneficial ways (e.g., wastewater treatment sludge that is sold for use in asphalt roof felt manufacture).
- **Item 2C.** Some facilities were confused about whether we were asking about on-site treatment, off-site treatment, or both. Mill scale (reported as 3,050 short tons/year) is treated on-site. Baghouse dust (reported as 11,322 short tons/year) is sent to a reclamation facility where it is treated and recycled off-site.
- **Item 2C.** It was suggested that the "yes" column of check boxes be broken out into two separate columns of check boxes: one for on-site and one for off-site activities.
- **Item 2C.** Add a units box of "short tons per year." "Per day" seemed strange for the only option.
- **Item 2Cd.** Add instructions to indicate how solid waste is to be reported; either a "wet" basis (total weight as generated or received) or "dry" basis (excluding the weight of any water). This is especially important in cases were the solid waste is a sludge for which the annual quantity on a wet basis can be significantly higher than on a dry basis.
- **Item 2Cd.** Delete "annual" because the units are to be specified in the box. The company indicated tons per day in the check box but, upon questioning, said the waste disposal value was tons for the year.
- **Item 2Dd.** Consider adding "amount recycled" as a solid waste quantity subtotal in item 2Dd (EPA's definition of solid waste includes a number of potentially recyclable materials—catalysts, organic liquids, cardboard, paper, scrap metals).

Item 3—Capital Expenditures

- **Item 3A.** The term "treatment" should be changed to "treatment or capture." This would help clarify that baghouse operations are not pollution prevention (also applies to Item 4C).
- **Item 3A.** Add more examples to help clarify the distinction between treatment, recycling, disposal, and pollution prevention. A large table/matrix of examples was suggested (also applies to Item 4C).
- **Item 3C.** Develop an example for the instructions to clarify that expenditures for items intended to prevent discharge of solid waste to water should be allocated to the solid waste category, not wastewater, in Item 3C.
- **Item 3D.** Replace questions regarding the percentage of costs attributed to hazardous pollutants with a "yes/no" question regarding whether the facility must comply with any regulations of hazardous pollutants (air, water, solid waste). Or replace it with a three-part, yes/no question that asks if any air, water, or solid waste generated by the facility is considered hazardous. Several facilities felt that the percentage hazardous question was too difficult (also applies for Item 4E).
- **Item 3A.** Include examples of process equipment (e.g., enhanced spray guns) being considered as pollution abatement equipment.

Item 4—Operating Costs

- **Item 4.** Clarify pollution prevention activities with specific examples of what is and is not pollution prevention.
- **Item 4.** Clarify waste hauling to be considered a pollution abatement activity.
- **Item 4A.** Facilities have been reporting a variety of loaded versus nonloaded wages; the survey instructions need to be clear on this point.
- **Item 4A.** Clarify, or provide examples, how a facility might account for production time losses—temporarily idle or prorated production costs (one facility noted downtime related to running new coating tests for environmental issues).
- **Item 4Ab.** Clarify what is considered "other utilities"? One facility included their water bill.
- **Item 4C.** Need better examples and explanations for off-site treatment, off-site disposal, and recycling. A good example would be baghouse dust:
  - Baghouse operations are included in "treatment and capture."
  - If dust is recycled on-site, then include these operations as "recycling."
  - If dust is recycled off-site, then include transportation/tipping costs as "disposal."

Item 5—Costs Not Included in Previous Items

- **Item 5A.** Put more detailed instructions in the actual document, such as how to handle permit fees if no abatement equipment is used at the plant.

- **Item 5A.** Add specific language in the instructions that indicates clean water discharge fees are not considered pollution abatement costs.
- **Item 5A.** Clarify that permit fees for uncontrolled emissions should be included as costs.
- **Item 5D.** Change the phrasing in the lead question to be "TRADABLE PERMITS AND/OR CREDITS."

Item 6—Cost Offsets

- **Item 6A.** Clarify in the instructions if cost savings associated with filling up their landfill sites more slowly as a result of recycling should be included.

Item 7—Depreciation

- **Item 7C.** Clarify how the gross book value of pollution abatement capital should be reported. Should installation costs be included? If capital equipment has been replaced and was covered by insurance, what is the book value?
- **Item 7C.** Need additional clarification regarding gross book value (calculated as the cumulative pollution abatement capital cost—using the actual purchase costs—not adjusted for inflation or depreciation).

APPENDIX C. 2005 PACE SURVEY AND *GUIDELINES AND DEFINITIONS* DOCUMENT

OMB No. 0607-0176: Approval Expires 04/30/2008

FORM **MA-200**
(3-14-2005)

U.S. DEPARTMENT OF COMMERCE
Economics and Statistics Administration
U.S. CENSUS BUREAU

2005 SURVEY OF POLLUTION ABATEMENT COSTS AND EXPENDITURES (PACE)

Mail your completed form to:

U.S. CENSUS BUREAU
1201 East 10th Street
Jeffersonville, IN 47132-0001

Please read the accompanying instructions and definitions before completing the form.

Need help, a copy of the instructions, or have questions about filling out this form?

Visit our Web site at www.census.gov/econhelp/pace

In correspondence pertaining to this report refer to the ID number (ID) (11 digits)

Please correct errors in name, address, and ZIP Code. ENTER street and number if not shown.

NOTICE – YOUR RESPONSE IS REQUIRED BY LAW (Title 13, United States Code). By section 9 of the same law, **YOUR REPORT IS CONFIDENTIAL.** It may be seen only by persons sworn to uphold the confidentiality of Census Bureau information and may be used only for statistical purposes. The law also provides that copies retained in your files are immune from legal process.

Item 1 FACILITY INFORMATION

A. Mark "X" the box that best describes the status as of December 31, 2005, of the facility identified in the address box above.

101 ☐ In operation as of December 31, 2005

102 ☐ Temporarily idle *(intend to resume operations)*
→ How long as of December 31, 2005? Months 103 ____

106 ☐ Permanently ceased operations
→ Date closed? Month Year 107 ____ ____

104 ☐ Sold or leased to another company
→ Date sold or leased? Month Year 105 ____ ____ } SOLD OR LEASED TO →

Name		
Street		
City	State	ZIP Code

B. Is the time period covered by this report a calendar year?

110 ☐ Yes

111 ☐ No – *Enter time period covered* →
From Month Year 112 ____ ____
To Month Year 113 ____ ____

CONTINUE WITH* Item 1 *ON PAGE 2.

HOW TO REPORT DOLLAR FIGURES

Dollar figures should be **rounded to thousands** of dollars.

If a figure is **$1,025,628.79**: . . . . . .*Report* → ☐

If a value is "0" *(or less than $500.00)*. . . . . .*Report* → ☒

	Mark "X" if less than $500.00	$Mil.	Thou.	Dol.
			1 0 2 6	

Item 1 **FACILITY INFORMATION – Continued**

C. Report the following information for this facility in 2005.

		Mark "X" if less than $500.00	$Mil.	Thou.	Dol.
1.	Capital expenditures, including all outlays during the year for buildings and other structures, machinery, and equipment that are chargeable to the fixed asset account and for which depreciation or amortization reserves are maintained 133	☐			
2.	Total value of products shipped, including interplant transfers, exports, and other receipts. 132	☐			

		Mark "X" if Zero	Number
3.	Total employment, including full- and part-time and leased employees 131	☐	

D. Mark "X" the box that best describes this facility's pollution abatement expenditures for 2005. *Include pollution abatement capital expenditures and operating costs for treatment, disposal, recycling and pollution prevention.*

120 ☐ These expenditures were $0 in 2005. *(There were NO pollution abatement expenditures for 2005.)*

121 ☐ These expenditures were included in rent, taxes, or lease agreements.

122 ☐ These expenditures were between $1 and $999.

Go to **Item 8** *on page 7.*

123 ☐ These expenditures were more than $999. → *Go to* **Item 2** *on page 3.*

Item 2 **POLLUTION ABATEMENT ACTIVITIES**

A. In column (1), report the number of air pollution treatment control devices that were operating at the beginning of 2005. In column (2), report the number of newly installed devices during 2005. *(See page 7 in the guidelines for instructions.)*

Control Device	Mark "X" if Zero	(1) Total Number of Devices Operating Facility-Wide *(Beginning of 2005)*	Mark "X" if Zero	(2) Number of Devices Newly Installed *(During 2005)*
1. Electrostatic precipitators (ESP)	201 ☐		214 ☐	
2. Baghouses	202 ☐		215 ☐	
3. Fabric filters	226 ☐		227 ☐	
4. Venturi scrubbers	203 ☐		216 ☐	
5. Non-Venturi wet scrubbers	228 ☐		229 ☐	
6. Acid-gas scrubbers	204 ☐		217 ☐	
7. Carbon adsorbers	205 ☐		218 ☐	
8. Incinerator/thermal oxidizers/ catalytic oxidizers	206 ☐		219 ☐	
9. Low-NOx burners	239 ☐		240 ☐	
10. Flares	207 ☐		220 ☐	
11. Process incinerators/boilers	253 ☐		254 ☐	
12. Refrigerated condensers	208 ☐		221 ☐	
13. Biofilter/bioreactor	209 ☐		222 ☐	
14. Selective non-catalytic reduction (SNCR)	210 ☐		223 ☐	
15. Selective catalytic reduction (SCR)	211 ☐		224 ☐	
16. Continuous Emissions Monitoring Systems (CEMS)	255 ☐		256 ☐	
17. Other	212 ☐		225 ☐	

→ *Describe* – 213

B. Mark "X" the water pollution abatement techniques that were used at this facility in 2005. *(See page 7 in the guidelines for instructions.)*

230 ☐ Physical *(containing, screening, filtration, UV disinfection, underground injection, etc.)*
231 ☐ Biological *(activated sludge, aeration lagoon, biological filter, etc.)*
232 ☐ Chemical *(oxidation, reduction, neutralization, etc.)*
233 ☐ Thermal *(incineration, pyrolysis, etc.)*

		Gallons per year
1. What quantity of wastewater was treated **on-site**?	234	
2. What quantity of wastewater was treated **off-site**?	235	

C. Mark "X" the solid waste pollution abatement techniques that were used at this facility in 2005. *(See page 7 in the guidelines for instructions.)*

270 ☐ Physical *(containment, dewatering, landfilling, underground injection, etc.)*
271 ☐ Biological *(composing, landfarming, phytoremediation, etc.)*
272 ☐ Thermal *(incineration, pyrolysis, etc.)*

		Indicate units. *(Mark "X" only one box.)*
1. What quantity of solid waste was treated **on-site**?	273	275 ☐ Short tons
2. What quantity of solid waste was disposed of **on-site**?	274	276 ☐ Other – *Describe*
3. What quantity of solid waste was disposed of **off-site**?	278	277

Item 3 POLLUTION ABATEMENT CAPITAL EXPENDITURES

Report the value of **TOTAL POLLUTION ABATEMENT CAPITAL EXPENDITURES** in **Item 3 B** below even if you are unable to provide separate values for each component of pollution abatement capital expenditures in **Item 3 A.**

- Report only the incremental capital expenditures for pollution abatement activities. *(See page 5 in the guidelines for a discussion of "incremental" costs and page 8 for an example.)*
- Include only the incremental cost of facility/process upgrades/modifications for which the primary purpose is pollution abatement. *(See page 5 in the guidelines for a discussion of "primary purpose.")*
- Include all installation and start-up costs for pollution abatement expenditures. Include labor only when contracted specifically for installation.
- Include capital expenditures related to monitoring and testing.
- Do NOT include pollution abatement capital expenditures from a previous year.
- Do NOT include depreciation. *(Depreciation expenses should be reported in* **Item 4** *A5.)*
- Do NOT include capital expenditures related to site cleanup. *(Site cleanup costs should be reported in* **Item 5** *B.)*
- Do NOT include capital expenditures related to product redesign or reformulation intended to reduce the pollution generated by consumers or users of products manufactured at this facility. *(Product redesign and/or reformulation costs should be reported in* **Item 5** *C.)*

A. Report the value of pollution abatement capital expenditures by the following four activity categories for this facility in 2005. *(See page 3 in the guidelines for definitions and pages 8 and 13–14 for examples.)*

	Mark "X" if less than $500.00	$Mil.	Thou.	Dol.
1. Treatment/capture. . . . 301	☐			
2. Recycling 302	☐			
3. Disposal. . . . 303	☐			
4. Pollution prevention 304	☐			

a. Indicate which components are included in the POLLUTION PREVENTION value you reported in **Item 3 A4** above. *(Mark "X" all that apply.) (See page 3 in the guidelines for definitions.)*

- 305 ☐ Raw materials substitution or modifications
- 306 ☐ Leak and spill prevention
- 307 ☐ Process/equipment modification/redesign
- 308 ☐ Other

B. Add **Item 3 A1–4** to calculate TOTAL POLLUTION ABATEMENT CAPITAL EXPENDITURES in 2005. Report the value of TOTAL POLLUTION ABATEMENT CAPITAL EXPENDITURES even if you are unable to provide separate values for **Item 3 A1–4.**

	Mark "X" if less than $500.00	$Mil.	Thou.	Dol.
TOTAL POLLUTION ABATEMENT CAPITAL EXPENDITURES 310	☐			

C. What percentage of TOTAL POLLUTION ABATEMENT CAPITAL EXPENDITURES in **Item 3 B** was spent for each of the three types of media for this facility in 2005? *(See page 3 in the guidelines for definitions and page 9 for instructions.)*

	Mark "X" if Zero	Percent	
1. Air emissions 321	☐		%
2. Water discharges 322	☐		%
3. Solid waste 323	☐		%
4. Total		100	%

D. Report the gross book value *(acquisition costs)* of pollution abatement capital assets at your facility as of December 31, 2005 *(adjusted for assets sold, retired, scrapped, and destroyed; not adjusted for depreciation charges). (See page 9 in the guidelines for a definition.)*

	Mark "X" if less than $500.00	$Mil.	Thou.	Dol.
GROSS BOOK VALUE OF POLLUTION ABATEMENT CAPITAL ASSETS 707	☐			

Item 4 POLLUTION ABATEMENT OPERATING COSTS

Report the value of **TOTAL POLLUTION ABATEMENT OPERATING COSTS** in **Item 4 B** below even if you are unable to provide separate values for each component of pollution abatement operating costs in **Item 4 A**.

- Report only the incremental operating costs for pollution abatement activities. *(See page 5 in the guidelines for a discussion of "incremental" costs and page 9 for an example.)*
- Include operating costs related to monitoring, testing, and on-site administration costs associated with environmental protection.
- Do NOT include operating costs related to site cleanup. *(Site cleanup costs should be reported in* **Item 5 B**.*)*
- Do NOT include operating costs related to product redesign or reformulation intended to reduce the pollution generated by consumers or users from products manufactured at this facility. *(Product redesign and/or reformulation costs should be reported in* **Item 5 C**.*)*
- Cost offsets, such as revenue from recycling, should NOT be deducted from costs reported in this item. *(Cost offsets should be reported in* **Item 6 A**.*)*

A. Report the value of pollution abatement operating costs by the following five cost categories for this facility in 2005. *(See pages 9–12 in the guidelines for definitions and examples.)*

		Mark "X" if less than $500.00	$Mil.	Thou.	Dol.
1. Salaries, wages, and benefits *(for all time spent by professional, administrative, operating, and maintenance employees on pollution abatement activities)*	401	☐			
2. Energy costs *(electricity, fuels, and other energy costs)*	402	☐			
3. Materials and supplies *(treatment chemicals, catalysts, replacement parts, etc.)*	403	☐			
4. Contract work, leasing, and other purchased services *(including payments to government for industrial sewage services and solid waste disposal, and recycling)*	404	☐			
5. Depreciation	428	☐			

B. Add **Item 4 A1–5** to calculate TOTAL POLLUTION ABATEMENT OPERATING COSTS in 2005. Report the value of TOTAL POLLUTION ABATEMENT OPERATING COSTS even if you are unable to provide separate values for **Item 4 A1–5**.

		Mark "X" if less than $500.00	$Mil.	Thou.	Dol.
TOTAL POLLUTION ABATEMENT OPERATING COSTS	410	☐			

C. What percentage of TOTAL POLLUTION ABATEMENT OPERATING COSTS in **Item 4 B** was spent for each of the following four pollution abatement activity categories for this facility in 2005? *(See page 3 in the guidelines for definitions and pages 13–14 for examples.)*

		Mark "X" if Zero	Percent	
1. Treatment/capture	421	☐		%
2. Recycling	422	☐		%
3. Disposal	423	☐		%
4. Pollution prevention	424	☐		%
5. Total			100	%

a. Indicate which components are included in the POLLUTION PREVENTION value you reported in **Item 4 C4** above. *(Mark "X" all that apply.) (See page 3 in the guidelines for definitions.)*

425 ☐ Raw materials substitution or modifications
426 ☐ Leak and spill prevention
427 ☐ Process/equipment modification/redesign
429 ☐ Other

D. What percentage of TOTAL POLLUTION ABATEMENT OPERATING COSTS in **Item 4 B** was spent for each of the three types of media for this facility in 2005? *(See page 3 in the guidelines for definitions and page 12 for instructions.)*

		Mark "X" if Zero	Percent	
1. Air emissions	405	☐		%
2. Water discharges	406	☐		%
3. Solid waste	407	☐		%
4. Total			100	%

Item 5 COSTS NOT INCLUDED IN PREVIOUS ITEMS

A. What were the total payments to government entities for PERMITS AND FEES related to pollution abatement for this facility in 2005? *(See page 12 in the guidelines for instructions and page 14 for an example.)*

	Mark "X" if less than $500.00	$Mil.	Thou.	Dol.
501	☐			

B. What were the capital expenditures and operating costs for SITE CLEANUP for this facility in 2005? *(See page 12 in the guidelines for instructions and page 14 for an example.)*

	Mark "X" if less than $500.00	$Mil.	Thou.	Dol.
1. Capital expenditures 503	☐			
2. Operating costs 505	☐			

C. What were the capital expenditures and operating costs related to PRODUCT REDESIGN or reformulation intended to reduce the pollution generated by consumers or users of products manufactured at this facility *(downstream pollutants)* in 2005? *(See page 12 in the guidelines for instructions and page 14 for examples.)*

	Mark "X" if less than $500.00	$Mil.	Thou.	Dol.
1. Capital expenditures 507	☐			
2. Operating costs 509	☐			

Item 6 COST OFFSETS

Report the value of cost offsets for your facility in 2005. *(See page 12 in the guidelines for instructions and page 14 for examples.)*

- Include only cost offsets from activities whose primary purpose is pollution abatement.
- Include only cost offsets associated with the activities for the costs reported in **Item 4**.
- Do NOT include cost reductions from energy-efficiency improvements or revenue from recycling activities that are profitable in the absence of environmental concerns.

A. What was the total value of cost offsets for this facility in 2005?

	Mark "X" if less than $500.00	$Mil.	Thou.	Dol.
COST OFFSETS 601	☐			

B. Which types of cost offsets were included in **Item 6 A** above? *(Mark "X" all that apply.)*

603 ☐ Revenue from recycling
604 ☐ Energy cost savings
605 ☐ Reduced material costs
606 ☐ Other – *Describe:* 607

Item 7 **BURDEN**

Estimate the number of hours spent filling out this form. Include the time you and all other staff spent reviewing the instructions, preparing the estimates and completing the survey form.

Hours

801 [ ]

Item 8 **CERTIFICATION**

A. Provide the following information on the person to contact regarding this survey.

Name of person to contact regarding this report *(Please print)*	Telephone		
	Area code	Number	Ext.
E-mail address	Fax number		

B. Provide the name, title and signature of the person who verifies that the information reported in this survey is to the best of their knowledge accurate. The authorizing official may be a plant manager, vice president, or environmental health and safety official.

Name of authorized manager *(Please print)*	Title
Signature of authorized manager	Date

Feel free to add any comments about the survey in the space provided below. Thank you for your participation.

Comments:

U.S. DEPARTMENT OF COMMERCE
Economics and Statistics Administration
U.S. CENSUS BUREAU

2005 Pollution Abatement Costs and Expenditures (PACE) Survey Guidelines

U S C E N S U S B U R E A U

FREQUENTLY ASKED QUESTIONS

What is the purpose of this survey?

This survey collects information on the pollution abatement costs and expenditures related to environmental protection at your specific facility in 2005. Pollution abatement includes treatment/capture, recycling, disposal, and pollution prevention. Pollution abatement costs and expenditures include new capital equipment, annual operating costs, and certain other expenses. The PACE survey only includes expenditures whose primary purpose is environmental protection.

How are these data used?

The Environmental Protection Agency (EPA) uses these data to calculate the costs of regulatory programs. Trade associations, manufacturers, marketing and research companies, universities, financial and environmental institutions, other federal agencies, state and local governments, and environmental reporters also use PACE data.

Is your response to this survey mandatory?

Yes. Responding to the PACE survey is required by law (Title 13, United States Code, Sections 131, 182, 193, 224, and 225). You may visit our website at www.access.gpo.gov/uscode/title13/title13.html.

Are my data kept confidential?

Yes. Section 9 of Title 13, United States Code, guarantees that your data are kept confidential. It may be seen only by persons sworn to uphold the confidentiality of Census Bureau information, and may be used only for statistical purposes. The law also provides that copies of your report retained in your files are immune from legal process. You may visit our website at www.census.gov/privacy/files/data_protection/004032.html.

What establishments fill out this form?

Manufacturing establishments. If you think that your facility is not a manufacturing facility, please call 301-763-1907.

Complete the survey only for the designated facility located at the address printed on the front of the survey form. If your company operates more than one facility, report only for the facility to which this survey was addressed. Do not combine responses with other facilities owned by your company even if operations jointly use the same pollution abatement equipment or staff. Include only corporate expenditures that are billed directly to your facility.

What is the reporting period for this survey?

Report data for the 2005 calendar year. If you cannot report 2005 calendar year data, report data for your 2005 fiscal year.

Where do I return the completed form?

Return your completed form in the enclosed prepaid envelope to:

U.S. Census Bureau
1201 East 10th Street
Jeffersonville, IN 47132-0001

If you need additional time to complete this form or if you need a duplicate form, please contact the U.S. Census Bureau at 1-800-528-3049.

What is the response burden for this survey?

The public reporting burden for this collection of information is estimated to average 8 hours per response. Send comments regarding the response burden estimate and any suggestions for minimizing respondent burden, to:

Paperwork Project 0607-0176
U.S. Census Bureau
4700 Silver Hill Road, Stop 1500
Washington, DC 20233-1500

Include the OMB control number in any correspondence. Do NOT send the completed form to this address. You may email comments to paperwork@census.gov; use "Paperwork Project 0607-0176" as the subject.

SURVEY DEFINITIONS

For this survey, please use the following definitions:

Facility is a single physical location where business is conducted or where services or industrial operations are performed. Facilities are often referred to as establishments or plants. A company may have one or more facilities. For this survey, report only for the designated facility located at the address printed on the front of the survey form. Do NOT include data for other facilities owned by the same company when responding to the survey questions.

Pollution is a substance in the environment that, because of its chemical composition or quantity, prevents the functioning of natural processes and produces undesirable environmental and/or human health effects. For this survey, report only for the pollutants generated by your facility's production process.

For this survey, pollution is divided into three types of media: air emissions, water discharges, and solid waste.

> **Air emissions** are any substances released into the air that could, in high enough concentrations, pose a threat to the environment and/or human health.
>
> **Water discharges** are any substances or pathogens released into water that could, in high enough concentrations, pose a threat to the environment and/or human health.
>
> **Solid waste** includes any waste materials from the production process, including solid, semi-solid, contained liquids, and contained gaseous materials. It includes wastes produced as a result of air and water pollution abatement.

Pollution abatement activities are for the purpose of treating, capturing, reducing, eliminating, or disposing of pollution, as defined above. These activities may be in response to federal, state, or local regulations or voluntary initiatives. In addition to the cost of purchasing, installing, and operating pollution abatement equipment, all related **support activities,** including but not limited to monitoring and testing and environmentally-related administrative activities, are to be included in total pollution abatement capital expenditures and operating costs.

For this survey, pollution abatement is divided into four activities: treatment/capture, recycling, disposal, and pollution prevention.

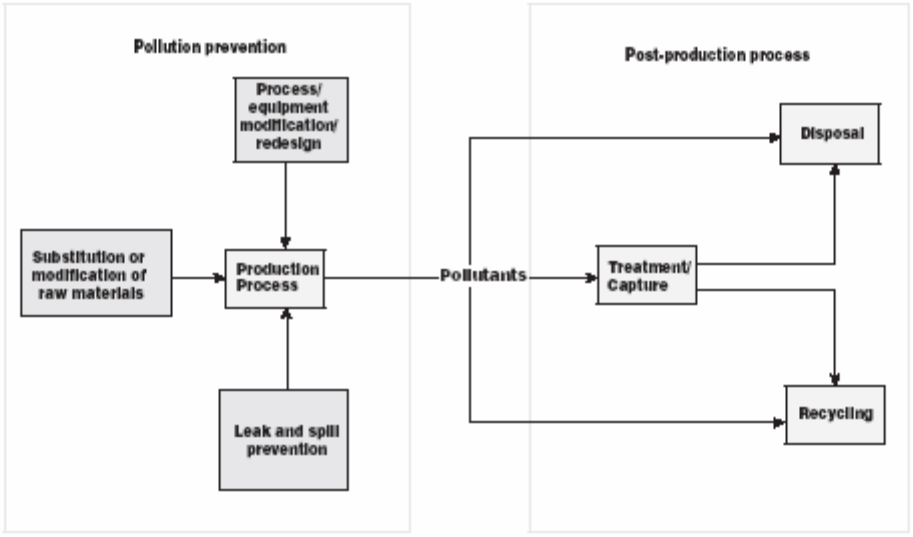
> **Treatment/capture activities** are any method, technique, or process designed to remove pollutants, **after** their generation in the production process, from air emissions, water discharges, or solid waste. In general, pollution treatment/capture activities include the use of retrofit technologies, such as baghouses, thermal oxidizers, and oil/water separators. Treatment/capture activities also include those activities designed to change the physical, chemical, or biological character or composition of any pollutant prior to disposal or release into the environment.
>
> **Recycling activities** are the postproduction on-site or off-site processing of waste for an alternative use. Recycling activities include the recovery of liquid, solid, or gaseous wastes and their reuse in the same or another production process. Recycling activities also include the partial reclamation of materials (e.g., metal recovery or the burning of flammable wastes for energy recovery). For this survey, recycling only includes activities whose primary purpose are pollution abatement and NOT activities motivated by profit.
>
> **Disposal activities** involve the final placement, destruction, or disposition of waste after pollution treatment/capture and/or recycling has occurred. Disposal, in an environmentally-sound manner, can include landfill disposal or the use of injection wells. To the extent possible, do not report disposal expenditures associated with waste generated outside the production process, such as office and cafeteria trash, and sanitary sewage. If you are unable to exclude these costs, report all disposal costs.
>
> **Pollution prevention activities** are any method, technique, or process that reduces the amount of pollution generated during the production process. Pollution prevention activities can include various equipment and technology modifications; process and procedure modifications; reformulations and redesigns of products (to reduce pollution generated by the manufacturing process); substitutions toward less-polluting raw materials and fuels; and improvements in housekeeping, maintenance, training, and inventory control that result in fewer air emissions, water discharges, or solid waste. The cost of activities involving the redirection of "used" material inputs back into the production process (such as closed-cycle systems) should also be included in pollution prevention if the primary purpose of this activity is pollution abatement rather than to increase profit.

For this survey, pollution prevention activities are grouped into three primary categories:

- **Raw materials substitution or modifications** are activities that alter inputs or allow the use of alternative inputs in order to reduce or modify pollutants during the manufacturing process.
- **Leak and spill prevention** are improvements in housekeeping, maintenance, training, and inventory control that result in fewer accidental releases of polluting raw materials, products, or by-products.
- **Process/equipment modification/redesign** includes equipment and technology modifications, process and procedure modifications, reformulations and product redesigns, and in-process recycling to reduce pollution from the manufacturing process.

As shown in Figure 1, a general distinction between pollution prevention and the other pollution abatement activities is that pollution prevention reduces or eliminates pollutants generated **during** the production process, while treatment/capture, recycling, and disposal are post-production activities used to manage pollutants **after** their generation by the production process.

Figure 1. Overview of Pollution Abatement Activities



GENERAL INSTRUCTIONS

Complete this form only for your facility. If your company operates more than one facility, report only for the facility to which this survey was addressed. Do not combine responses with other facilities owned by your company even if operations jointly use the same pollution abatement equipment or staff. Include only corporate expenditures that are billed directly to your facility.

Report the value of total pollution abatement costs (Items 3B and 4B) even if you are unable to report the values of each separate cost component.

Report actual costs whenever possible. If an actual cost is not available, estimate the cost. Possible sources for your estimate can include accounting records or engineering estimates.

> **Example:** If estimated operating costs were provided by a pollution control device vendor as part of an investment proposal, these estimated operating costs could be used to help determine that portion of your facility's operating costs attributable to pollution abatement.
>
> **Example:** If electricity usage for pollution abatement air handling units is not metered separately, use information on the number of motors and total horsepower to estimate that portion of your facility's energy costs attributable to pollution abatement.

Report only *incremental* capital expenditures and *incremental* operating costs associated with pollution abatement activities. Incremental costs of pollution abatement are the additional costs associated with the *environmental portion* of an investment or of annual operating and maintenance costs. For example, pollution abatement equipment may be integrated into larger investment projects, pollution abatement technologies may be integrated into production equipment, or pollution abatement operating costs may be combined with other costs in a larger cost center. Estimate and report only the portion of capital expenditures and operating costs related to pollution abatement, as illustrated in the examples on pages 8-10 and pages 13-14.

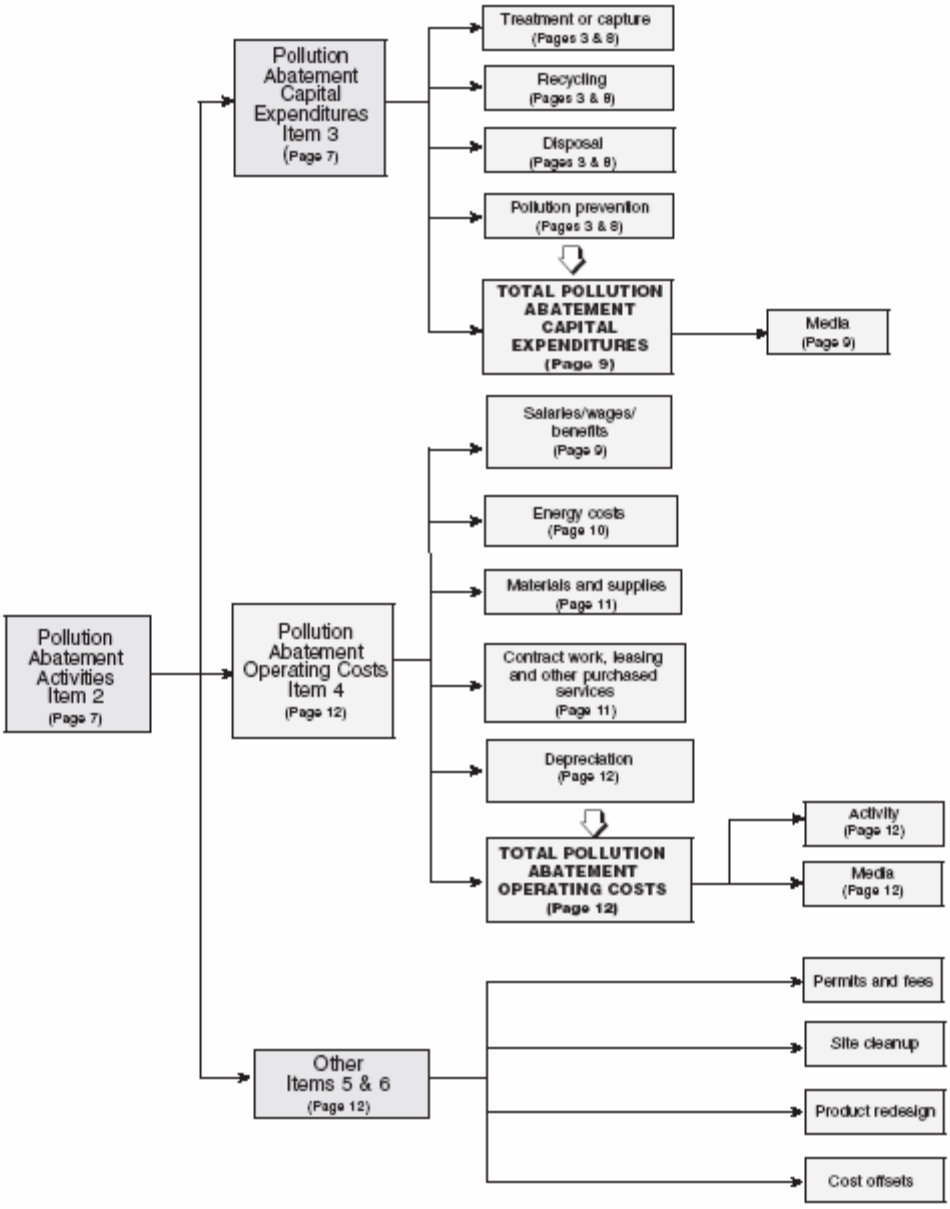
For this survey, include only those expenditures with the *primary purpose* of pollution abatement. Although certain expenditures may have multiple benefits, only consider those expenditures for which pollution abatement is the primary purpose. Investments or activities that increase profits or efficiency in the absence of environmental considerations should not be included, even if pollution abatement occurs as a side benefit. For example, some pollution prevention practices, particularly process modifications, may have been undertaken primarily as a cost-cutting activity. However, if any portion of an investment or activity can be specifically identified as pollution abatement, then those costs *should* be reported in this survey.

The following are general examples of costs and expenditures to be *excluded* from this survey:

- activities that are motivated by profit and whose primary purpose is not pollution abatement;
- costs that did not occur in 2005;
- corporate expenditures for pollution abatement that are NOT directly billed to your facility;
- activities related to health, safety, aesthetics, and employee comfort (OSHA); and
- habitat protection.

Round all cost estimates to the nearest thousands of dollars. If expenditures were less than $500.00 for a specific item, then mark the appropriate box.

Figure 2. Overview of the Survey Structure



Note: Page numbers provide links to definitions and examples.

ITEM BY ITEM INSTRUCTIONS

The PACE survey has eight items. Item 1 asks about your facility. Item 2 asks about your facility's pollution abatement activities. Items 3–6 ask about your facility's pollution abatement costs including capital expenditures, operating costs, costs not included in previous items, and cost offsets. Item 7 asks about the amount of time spent completing this form. Item 8 is the survey certification. Figure 2 provides an overview of the survey's main items.

Item 1: Facility Information

See the survey form.

Item 2: Pollution Abatement Activities

Item 2A asks about your facility's air pollution control devices in operation in 2005. This item has two columns: (1) one column for the total number of control devices in operation at the beginning of 2005, and (2) one column for the total number of control devices newly installed in 2005. If your facility uses air pollution control devices that are not listed, then write in those devices under "other" and report the number of devices.

> **Example:** A facility operates five continuous emissions monitoring systems (CEMS) to measure sulfur dioxide. Four monitors were installed in 1990 and one was installed in 2005. On line 16 (Continuous Emission Monitoring Systems), the facility should report '4' in column (1) and '1' in column (2).

For this item, **Process incinerators/boilers** (line 11) are devices that treat air emissions using a boiler or other combustion device. These devices are primarily installed to provide heat or steam but can also be used as an air pollution control device.

> **Example:** A facility routes air emissions generated during the manufacturing process to (1) a coal-fired boiler, that primarily is used to produce heat and steam for the manufacturing process, and (2) a rotary kiln that is used to produce lime. Both the boiler and kiln began operation prior to 2005. On line 11 (Process incinerators/boilers), the facility should report '2' in column (1) and mark the zero box in column (2).

Item 2B asks you to report a value for the quantity of wastewater treated on-site and off-site during 2005.

> **Example:** A facility generates 10 million gallons of wastewater per day, for a total of 3.65 billion gallons per year. Sixty percent of the wastewater is treated by the facility and is discharged into a nearby river, while the other forty percent is sent to a municipal wastewater treatment plant. The facility should report 2.19 billion gallons per year for "treated on-site" and 1.46 billion gallons per year for "treated off-site".

Item 2C asks you to report a value for the quantity of solid waste treated on-site, disposed of on-site, and disposed of off-site during 2005.

> **Example:** A facility generates 100,000 tons of solid waste per year: 90,000 tons of wastewater treatment sludge and 10,000 tons of boiler ash. Approximately 50,000 tons of the wastewater treatment sludge is burned in an on-site boiler as fuel. The remaining 40,000 tons is disposed of in an on-site landfill. A contractor is paid to remove the boiler ash and recycles some of it for metals. The facility should report 50,000 tons per year for "treated on-site", 40,000 tons per year for "disposed of on-site", and 10,000 tons per year for "disposed of off-site", even though some of the ash is being recycled.

For this survey, *beneficial reuse* is the reuse of solid material generated by the manufacturing and/or pollution abatement process that would otherwise be considered a solid waste. Co- or by-products *sold* for beneficial reuse should not be included in this item.

> **Example:** A facility generates 60,000 tons per year of wastewater treatment sludge that contains some usable raw material. Approximately 3,000 tons of the sludge is recycled and sold for profit; 27,000 tons is disposed of in an on-site landfill; and 30,000 tons is sent to another facility that uses the sludge as a raw material to manufacture a new product. The facility also produces 2 tons per year of hazardous waste that is sent off-site for disposal. The facility should report 27,000 tons per year as "disposed of on-site" (landfilled) and 2 tons per year as being "disposed of off-site". (Neither the 3,000 tons nor the 30,000 tons should be reported in these items because they are disposed of at no cost to the facility.)

Item 3: Pollution Abatement Capital Expenditures

Pollution abatement capital expenditures include any installation or retrofit of structures or equipment that occurred during 2005 with the primary purpose of treating, capturing, recycling, disposing, and preventing pollutants. These expenditures are often referred to as "one-time costs" and include total expenditures for equipment installation and startup.

For this item, report only those pollution abatement capital expenditures made during 2005, not the final equipment value or the total project budget. Report only the incremental costs associated with pollution abatement. (See page 5 for the definition of incremental costs.) If pollution abatement capital expenditures are not budgeted or tracked separately for some projects, *estimate* the portion of total capital expenditures associated with pollution abatement.

Example (incremental pollution abatement capital expenditures): A facility operates a rotary material dryer that is equipped with a multiclone and an electrostatic precipitator (ESP) at the dryer exhaust. The multiclone, ESP, and an emissions stack were installed at the same time as part of a dryer system upgrade in 2005. The total capital expenditures for the multiclone/ESP system (including the emissions stack) is $8 million as follows:

- $1.8 million for the multiclone
- $5.2 million for the ESP
- $1.0 million for the emissions stack

The ESP and stack were installed to comply with state and federal air emissions standards. The ESP reduces particulate emissions that remain in the air stream exiting the multiclone. The primary purpose of the multiclone is to separate the dried material from the air; thus, the multiclone is considered an integral part of the dryer process and is necessary in the absence of environmental regulations. Therefore, the facility should only report the total cost of the ESP and the stack. Since this upgrade is a treatment/capture activity, $6.2 million should be included in Item 3A1. It should also be included in total pollution abatement capital expenditures (Item 3B) and pollution abatement capital expenditures for air emissions (Item 3C1).

Item 3A: Activity Categories (Treatment/Capture, Recycling, Disposal, Pollution Prevention)

The following table provides examples of pollution abatement capital expenditures by activity category. (See page 3 for definitions of these activity categories.) Capital expenditures associated with **testing and monitoring** should be distributed across some or all of the activity categories, as appropriate. Capital expenditures to be excluded are also listed below. Note: Do NOT include capital expenditures related to site cleanup or product redesign/reformulation (these expenditures are to be reported in Item 5). Note also that these lists are intended as examples and are not necessarily exhaustive.

Activity Category	Examples of Pollution Abatement Capital Expenditures	Capital Expenditures to be Excluded
Treatment and capture	Purchase, installation, and startup costs of "end of pipe" pollution abatement equipment, such as baghouses, scrubbers, absorbers, and flares Oil/water separating systems Dewatering systems, compactors, and balers	Manufacture of pollution treatment equipment for sale Equipment installed for the purpose of increasing profits or efficiency Interest for financing pollution abatement capital expenditures Improvements for health, safety, aesthetics, or employee comfort (OSHA) Equipment related to site cleanup [report in Item 5B1] Facilities or equipment for research and development
Recycling	Water filter systems to recover waste to be reused for its material value Air handling and injection systems for the capture and use of waste gas with energy value	Capital equipment if your primary product is recycling; that is, you are a recycling plant Recycling equipment when the primary motivation is profit
Disposal	Purchase of material handling equipment Construction of on-site landfills Construction of waste storage facilities or retention ponds	Equipment purchased by an on-site contractor (who manages all solid waste handling at the facility) that is not billed directly to the facility
Pollution prevention	Installation of low NO_x burners Equipment modifications to burn lowsulfur coal Closed-cycle water systems Cost of leak prevention and monitoring equipment Storage and delivery systems for environmentally-friendly inputs The pollution abatement ***portion of*** production process enhancements, such as increased energy efficiency or lean manufacturing, intended for environmental protection	Purchase of new equipment that is more energy efficient and thus, theoretically would reduce offsite pollution at the local utility as a result of lower electricity production Equipment and structures related to product redesign or reformulation intended to reduce the pollution generated by the consumers or users of the facility's products (downstream pollutants), such as reformulated gasoline [report in Item 5C1]

Item 3B: Total Pollution Abatement Capital Expenditures

See the survey form.

Item 3C: By Pollution Medium (Air, Water, and Solid Waste)

In **Item 3C,** divide your total pollution abatement capital expenditures into three media types: air emissions, water discharges, and solid waste. (See page 3 for definitions of these pollution media.) For capital expenditures that affect multiple media categories, assign the costs across individual media categories to the best of your ability.

> **Example:** During 2005, a facility purchases and installs an electrostatic precipitator (ESP) at a cost of $6.5 million, replaces a continuous emissions monitor (CEMS) for sulfur dioxide (SO_2) at a cost of $125,000, replaces two aerators in its wastewater aeration lagoon at a cost of $30,000 each, and purchases a new excavator for dredging out an on-site ash pond at a cost of $220,000. These costs should be categorized as follows:

Equipment	Capital Expenditures	Pollution Abatement Medium
ESP	$6,500,000	96% of costs for air emissions
SO_2 CEMS	$125,000	
Aerators	$60,000	1% of costs for water discharges
Excavator	$220,000	3% of costs for solid waste
TOTAL	$6,905,000	100%

Item 3D: Gross Book Value of Pollution Abatement Capital Assets

Item 3D asks you to report your facility's gross book value of pollution abatement capital assets as of December 31, 2005. This is the sum of the purchase prices of all pollution abatement equipment installed as of December 31, 2005. For this item, adjust for assets sold, retired, scrapped, and destroyed; however, do not adjust for depreciation charges.

Item 4: Pollution Abatement Operating Costs

Pollution abatement operating costs include all annual costs (such as salaries and benefits, costs of materials and energy, contract work, and the operation, maintenance, and depreciation of capital assets) that occurred during 2005 with the primary purpose of treating, capturing, recycling, disposing, and preventing pollutants.

For this item, report only the incremental costs associated with pollution abatement. (See page 5 for definition of incremental costs.) If pollution abatement operating costs are not budgeted or tracked separately for some categories, *estimate* the portion of total costs associated with pollution abatement.

> **Example (incremental pollution abatement operating costs):** A facility's manufacturing process requires $100,000 per year in labor costs and $10,000 in solvents (materials). However, because of environmental regulations (or other environmental concerns), labor costs increase to $125,000 per year and material costs increase to $15,000 because of a switch from oil-based to water-based solvents. As a result, the facility should report the following incremental pollution abatement operating costs:
>
> - $25,000 – Salaries, wages, and benefits (Item 4A1)
> - $5,000 – Materials and supplies (Item 4A3)
> - $30,000 – Total pollution abatement operating costs (Item 4B).

Do NOT include, in any of these categories, costs associated with site cleanup or product redesign/reformulation. Also, do NOT include the cost of permits and fees. These costs are to be reported in Item 5 of the survey.

Item 4A: Cost Categories (Labor, Energy, Materials, Contract Work, Depreciation)

In **Item 4A,** total pollution abatement operating costs are divided into five cost categories: salaries, wages, and benefits; energy costs; materials and supplies; contract work, leasing, and other purchased services; and depreciation.

> **Salaries, wages, and benefits** include staff time associated with pollution abatement activities. Report the salaries and wages you use for calculating the withholding tax, plus benefits. Salaries, wages, and benefits to be included and excluded in Item 4A1 are listed below. Note that these lists are intended as examples and are not necessarily exhaustive.

Include salaries, wages, and benefits for	*Exclude salaries, wages, and benefits for*
• The share of time environmental managers and engineers spend on pollution abatement activities • The share of time production and maintenance staff spend on pollution abatement activities, including the operation and maintenance of pollution abatement equipment • Staff time spent performing on-site disposal and recycling • Staff time spent on leak detection programs • Staff time for permit preparation and meetings with environmental regulators • Staff time for environmental auditing and plant certification (such as ISO 14000) • Staff time spent on completing environmental reporting requirements • Staff time spent conducting environmental studies for development or expansion	• Environmental staff at corporate headquarters. If billed directly to your facility, report those costs in Item 4A4 (contract work). • Research and development activities

Example (salaries, wages, and benefits): During 2005, a facility employs 3 full-time staff and 1 wastewater treatment operator in its environmental department. (The facility's solid waste management activities, including an on-site landfill, are managed by a contractor.) The facility also employs 1 lab technician who is responsible for performing sampling and testing of wastewater and sludge, which requires about 2 hours of labor each day. The facility also operates 5 air pollution control devices, each of which requires about 10 hours of labor each week to operate and maintain (by production staff). The annual salary for each of the 3 full-time staff and 1 wastewater treatment operator is $80,000. The lab technician's wage is $30 per hour, and the production workers' wages average about $20 per hour. All salaries are multiplied by 35 percent to account for benefits. Therefore, the total salaries, wages, and benefits for pollution abatement are estimated to be:

Environmental department staff:	4 x ($80,000/year) x 1.35 = $432,000 per year
Lab technician wages:	(2 hours/day) x (365 days/year) x ($30/hour) x 1.35 = $29,565 per year
Operator wages:	(10 hours/week) x (5 devices) x (52 weeks/year) x ($20/hour) x 1.35 = $70,200 per year
TOTAL:	**$532,000** per year (rounded to nearest thousand)

Energy costs include electricity, fuels (oil, natural gas, coal), and other energy costs. This includes both fuel and power for operating pollution abatement equipment as well as the incremental costs associated with the purchase of environmentally-friendly fuels. (See page 5 for definition of incremental costs.) If pollution abatement energy costs are not metered or tracked separately from facility-wide energy costs, *estimate* the portion of total energy costs associated with pollution abatement. Energy costs to be included and excluded in Item 4A2 are provided below. Note that these lists are intended as examples and are not necessarily exhaustive.

Include energy costs for	*Exclude energy costs for*
• Electricity for operating pollution abatement equipment, such as baghouses, scrubbers, ESPs, wastewater treatment pumps and aerators, etc. • Fuel costs for thermal oxidizers installed for air pollution control • Electricity generated on-site that is used by pollution abatement equipment • Difference in costs (incremental costs) resulting from the use of a more environmentally-friendly fuel (such as low-sulfur coal)	• Fuel costs for boilers that operate primarily to provide steam/heat/electricity for the production process, but are also used to incinerate air emissions • Electricity costs associated with production equipment

Example (incremental fuel costs): A facility purchases 1,000 tons of coal per year. To lower its emissions it purchases low-sulfur coal at $30 per ton instead of higher sulfur coal available at $20 per ton. The pollution abatement energy costs associated with the purchase of the low-sulfur coal are:

(1,000 tons/year) x ($10 incremental cost/ton) = **$10,000** per year

Example (estimating energy costs): A facility does not track pollution abatement electricity costs separately from total facility-wide electricity costs. Therefore, the facility must estimate electricity costs for pollution abatement. Based on information found in equipment manuals, the facility knows that the total horsepower (hp) requirement for the wastewater

treatment system pump is 760 hp. The on-site wastewater treatment facility also includes 25 aerators, each rated at 75 hp, for a total of 1,875 hp. The air pollution control devices and associated fans and pumps have a total horsepower requirement of 1,475 hp. The facility operates 365 days per year, 24 hours per day, and pays an average industrial electricity rate of $38.77 per megawatt-hour (MWh). (Note: 1 MW = 1,341 hp.) The facility also operates a thermal oxidizer that uses 100 million cubic feet (ft^3) of natural gas per year at a cost of $6.41 per 1,000 ft^3. Therefore, the total energy costs for pollution abatement are estimated as follows:

Total electricity usage for pollution abatement = 760 + 1,875 + 1,475 = 4,110 hp

Total electricity usage in MWh per year = (4,110 hp) x (365 days/year) x (24 hours/day) x (1 MW / 1,341 hp) = 26,848 MWh per year (rounded)

Total electricity cost for pollution abatement = (26,848 MWh/year) x ($38.77/MWh) = $1,041,000 per year (rounded)

Total fuel (natural gas) cost for pollution abatement = (100,000,000 ft^3) x ($6.41/1,000 ft^3) = $641,000 per year

Total energy costs for pollution abatement = $1,041,000 + $641,000 = **$1,682,000**

Note: If you do not have horsepower information with which to derive pollution abatement electricity costs, *estimate* the portion of your facility's total electricity costs associated with pollution abatement. If your electricity is generated on-site, *estimate* the portion of this self-generated electricity used by pollution abatement equipment and value this electricity at the appropriate or average market price of electricity in your region.

Materials and supplies include the delivered cost of materials, parts, and components used as operating supplies for pollution abatement or in the repair and maintenance of pollution abatement capital assets. In addition, this includes the incremental costs associated with the purchase of environmentally-friendly materials and supplies. (See page 5 for definition of incremental costs.) Materials and supplies to be included and excluded in Item 4A3 are provided below. Note that these lists are intended as examples and are not necessarily exhaustive.

Include material and supply costs for	*Exclude material and supply costs for*
• Parts for pollution abatement equipment maintenance and repair	• Laboratory chemicals used for testing products in various stages of the manufacturing process
• Wastewater treatment chemicals	• Use of a new raw material that reduces pollution but is *less* expensive than the *raw* material it replaces
• Caustic used in wet scrubbers	
• Laboratory chemicals and supplies used for sampling and testing for environmental compliance	
• Difference in costs (incremental costs) resulting from the use of a more environmentally-friendly raw material (such as a switch from oil-based to water-based solvents)	

Contract work, leasing, and other purchased services include payments made to private and public service providers for both on-site and off-site pollution abatement activities, as well as leasing costs for capital equipment associated with pollution abatement. Also include pollution abatement expenditures by your corporate headquarters on behalf of your facility, but only *if* those expenditures are billed directly to your facility. Costs to be included and excluded in Item 4A4 are provided below. Note that these lists are intended as examples and are not necessarily exhaustive.

Include contract and purchased service costs for	*Exclude contract and purchased service costs for*
• Collection and disposal of waste created by the production process, by a private contractor	• Collection and disposal of office and cafeteria waste (If you cannot separate from costs for industrial waste, report the entire amount)
• Sewage and solid/contained waste collection and disposal paid to federal, state, or local governments	• Sanitary sewage (If you cannot separate from costs for industrial wastewater, report the entire amount)
• Management of an on-site (industrial) landfill, by a private contractor	• Research and development services
• Pollution abatement activities performed by your corporate headquarters that WERE billed directly to your facility	• Pollution abatement activities performed by your corporate headquarters that WERE NOT billed directly to your facility
• All costs that would be included in Item 4A1 if the activity were done by your own staff	• Environmental permits, fees, fines, penalties, taxes, and contributions
• Air emissions and water discharge testing services	• Legal fees
• Off-site laboratory analysis of water samples	
• Leasing of capital equipment used for pollution abatement purposes	

Depreciation is related to capital expenditures (in Item 3) but is reported in this section of the survey. In Item 4A5, report year-end accumulated depreciation and amortization charges for depreciable assets used in pollution abatement activity. Include charges against depreciable pollution abatement equipment acquired during the year as well as any charges against pollution abatement equipment sold or retired during the year. Depreciation and amortization charged during the year is attributed to the wear and tear on equipment and structures as well as obsolescence due to changing technology. At the end of the expected life of an asset, the entire cost of the asset will have been depreciated.

Item 4B: Total Pollution Abatement Operating Costs

See the survey form.

Item 4C: By Activity Categories (Treatment/Capture, Recycling, Disposal, Pollution Prevention)

In **Item 4C,** divide your total pollution abatement operating costs into the four major activity categories: treatment/capture, recycling, disposal, and pollution prevention. (See page 3 for definitions of these activity categories as well as the examples in Item 3A on page 8.) Operating costs associated with **testing and monitoring** should be distributed across some or all of the activity categories, as appropriate. Do NOT include the costs of permits and fees or the operating costs associated with site cleanup and product redesign/reformulation (these costs are to be reported in Item 5).

Item 4D: By Pollution Medium (Air, Water, and Solid Waste)

In **Item 4D,** divide your total pollution abatement operating costs into three media types: air emissions, water discharges, and solid waste. (See page 3 for definitions of these pollution media.) For operating costs that affect multiple media categories, assign the costs across individual media categories to the best of your ability.

Item 5: Costs Not Included in Previous Items

In **Item 5A, permits and fees** include payments to local, state, and federal government agencies for permits and fees associated with pollution from your production process (e.g., Title V permit fees; emission fees). For this item, do NOT include the cost of tradable permits or emission credits. Also, do NOT include fines, penalties, or contributions. Do NOT include the labor costs or contract work associated with permit preparation; these costs should be reported in Item 4. (See example on page 14.)

In **Item 5B, site cleanup** includes expenditures and costs related to the remediation of contamination due to leaks, spills, waste disposal, or other releases from current or past production activities. Also include the costs of site assessment, sampling, and analyses associated with the site cleanup. The pollution must be on the site of the designated facility located at the address printed on the front of the survey form. (See example on page 14.)

In **Item 5C, product redesign** includes expenditures and costs of product reformulation intended to reduce the pollution generated by consumers or users of this facility's products. This is also referred to as downstream pollutants. Examples of product redesign include reformulated gasoline and the reformulation of paint from oil-based to latex. In both cases, emission reductions occur at the point where the product is used, not at the facility where it is produced. Costs associated with the redesign and reformulation of products to reduce pollution *at the manufacturing facility* should NOT be included here; these costs should be reported under pollution prevention in Items 3 and 4 above. (See examples on page 14.)

Item 6: Cost Offsets

Cost offsets are related to operating costs (in Item 4) but are reported in this section of the survey. Cost offsets are operating expenses recovered as a result of pollution abatement activities. Cost offsets are usually the value of recovered/recycled materials or recovered energy. Cost reductions from such waste minimization/recycling and energy recovery should be reported here, but only if these activities were motivated by pollution abatement and NOT by production efficiency or profit. That is, revenues from recycling and cost savings from reduced material or fuel purchases should NOT be included if these activities are profitable in the absence of environmental concerns. (See examples on page 14.)

Item 7: Burden

See the survey form.

Item 8: Certification

See the survey form.

ADDITIONAL EXAMPLES

This section provides additional examples of pollution abatement activities and projects and indicates how they relate to the items and definitions in this survey.

Treatment/Capture

- A facility installs an electrostatic precipitator (ESP) to reduce particulate matter (PM) emissions from one of its production units. The facility also installs a continuous opacity monitoring system (COMS) at the outlet of the ESP to monitor opacity (as a surrogate for PM emissions). The total capital expenditure on the ESP (including installation, fans, and ductwork, for example) and the COMS should be included in the **pollution abatement capital expenditures** for treatment/capture. The costs associated with operating the ESP and the COMS (e.g., electricity costs to run the ESP and COMS and labor involved in collecting and reporting COMS data) should be included in the **pollution abatement operating costs (labor, energy, materials, contract work, depreciation)** for treatment/capture.

- A facility installs a new flotation clarifier as part of its on-site wastewater treatment unit. All capital expenditures associated with the purchase, installation, and start-up of the new clarifier should be included in the **pollution abatement capital expenditures** for treatment/capture. All costs associated with operating the new clarifier (e.g., cost of electricity to run the compressor, cost of flocculating chemicals) plus the costs for operating the other wastewater treatment equipment should be included in the **pollution abatement operating costs (labor, energy, materials, contract work, depreciation)** for treatment/capture.

- A facility hires an environmental consulting company to conduct an emission source test to measure air pollutant emissions from the facility's control device. The contractor costs associated with conducting this source test should be included in **pollution abatement operating costs (contract work)**. The labor costs for facility personnel to supervise and assist in conducting this source test should be included in **pollution abatement operating costs (salaries, wages, and benefits).**

Recycling

- A facility installs and operates equipment used to recycle its waste streams in order to comply with environmental regulations or for other environmental reasons. Costs associated with installing this equipment (e.g., purchased equipment, required engineering, site preparation, installation, and other associated costs) should be included in **pollution abatement capital expenditures** for recycling. All costs associated with operating and maintaining the equipment should be included in **pollution abatement operating costs (labor, energy, materials, contract work, depreciation)** for recycling.

Disposal

- A facility constructs a new on-site landfill for the disposal of its solid waste. All costs associated with constructing the landfill (including the equipment and machinery necessary for managing the landfill) should be included in **pollution abatement capital expenditures** for disposal.

- A facility generates solid waste from several sources, including sludge from an on-site wastewater treatment operation and scrap metal generated during the manufacturing process. All of the solid waste is sent to an on-site landfill that is operated by a contractor. The payments to the contractor should be included in **pollution abatement operating costs (contract work)** for disposal.

- A facility hires an outside contractor to periodically pick up spent process catalyst for disposal. Contract fees for this disposal should be included in **pollution abatement operating costs (contract work)** for disposal.

- A facility pays its local government to accept its industrial wastewater at a public water treatment facility. These payments should be included in **pollution abatement operating costs (contract work)** for disposal.

Pollution Prevention

- A facility switches to a new, more expensive raw material that either contains fewer pollutants or releases fewer pollutants when used in the production process. To accommodate the use of this new raw material, the facility must make some slight modifications to its production process and manufacturing equipment. The costs associated with the equipment modifications should be included in **pollution abatement capital expenditures** for pollution prevention. The incremental cost (i.e., the cost difference) associated with using the new raw material versus the conventional/standard raw material should be included in **pollution abatement operating cost (materials and supplies)** for pollution prevention.

- A facility implements a new leak detection and repair (LDAR) program to reduce equipment leaks. The cost of the equipment associated with the LDAR program (e.g., pump seals, monitoring equipment, such as handheld organic vapor detectors) should be included in **pollution abatement capital expenditures** for pollution prevention. The costs associated with running the LDAR program (e.g., staff to monitor for leaks and prepare periodic reports) should be included in **pollution abatement operating costs (labor, energy, materials, contract work, depreciation)** for pollution prevention.

- A facility installs a new technology with the primary purpose of reducing the amount of air pollutants released per ton of product manufactured. The new technology requires more electricity and more staff time than the conventional technology. The costs associated with purchasing and installing the new technology should be included in **pollution abatement capital expenditures** for pollution prevention. Only the *additional* energy and labor costs (i.e., the incremental costs) of operating this new technology relative to the conventional technology should be included in **pollution abatement operating costs (labor, energy)** for pollution prevention.

Costs Not Included in Previous Items

Permits and Fees

- A facility undertakes a major expansion that triggers new environmental requirements. The fees associated with obtaining or updating its environmental permits from the state or federal government should be reported in **permits and fees**. The staff time spent on this permitting process should be reported in **pollution abatement operating costs (salaries, wages, and benefits),** while any fees paid to consultants on this activity should be included in **pollution abatement operating costs (contract work, leasing, and other purchase services).**

Site Cleanup

- A facility treats its contaminated soil via soil vapor extraction. For this purpose, it purchases a vacuum system and carbon treatment unit. The cost of this equipment should be included in **site cleanup capital expenditures.** The costs of operating this equipment, and the labor and materials necessary to conduct any testing and monitoring activities should be included in **site cleanup operating costs.**

- A facility hires a contractor to remove contaminated soil. The payments made to the contractor should be included in **site cleanup operating costs.**

Product Redesign

- A petroleum refinery changes its production process to allow it to produce low-sulfur diesel and gasoline fuels, which decrease the pollution emitted by motor vehicles. This change to the production process has no effect on the amount of pollution generated by the facility and therefore it is not considered a pollution abatement activity for the purposes of this survey. Instead, the facility's costs associated with this change should be reported in **product redesign capital expenditures** and **product redesign operating costs.**

- A manufacturer of surface coatings reformulates its coating products to reduce the amount of hazardous air pollutants (HAPs) they contain in order to help its customers comply with certain federal environmental regulations. While these new low-HAP coatings will reduce the air emissions in its customers' surface-coating operations, this product reformulation has no effect on the air emissions from its own facility and therefore is not considered a pollution abatement activity for the purposes of this survey. Instead, the facility's costs associated with this product reformulation should be reported in **product redesign capital expenditures** and **product redesign operating costs.**

Cost Offsets

- As an alternative to disposing used oil, a manufacturing plant has its used machinery oil picked up by a hazardous waste collection and treatment service. This service provider charges a fee. This fee should be reported in **pollution abatement operating costs (contract work)** for disposal (Item 4A4). The service provider returns the oil fully cleaned. Thus, the plant avoids having to buy new machinery oil. The value of the returned oil should be reported in **cost offsets.**

- A manufacturer purchases a cardboard baler to recycle cardboard containers associated with the manufacturing process. The capital expenditure should be reported in **pollution abatement capital expenditures** for recycling (Item 3A2). The costs associated with operating and maintaining the baler should be reported in **pollution abatement operating costs (labor, energy, materials, contract work, depreciation)** for recycling (Item 4). The manufacturer sells the cardboard to a recycler. The activity is not a potentially profit-making venture; it is conducted for pollution abatement. The revenues received from the recycler should be reported in **cost offsets.**

- A manufacturer installs a closed-cycle water recovery system in the production process to prevent the dumping of chemicals into the water system. Because the closed-cycle recovery system recaptures and reuses the chemicals in the production process, it reduces the expenses for these chemicals. The pollution abatement portion of the capital expenditure related to the closed-cycle recovery system should be reported in **pollution abatement capital expenditures** for pollution prevention (Item 3A4). The costs associated with operating and maintaining the system should be reported in **pollution abatement operating costs (labor, energy, materials, contract work, depreciation)** for pollution prevention (Item 4). The value of the recovered chemicals should be reported in **cost offsets.**

APPENDIX D. FACILITY-LEVEL COST COMPARISONS

Table D-1. Facility-Level Cost Comparisons: Facility 1

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	100.0%	88.7%
Treatment	100.0%	56.3%
Recycling	—	—
Disposal	—	—
Pollution prevention	100.0%	100.0%
Operating Costs	96.3%	97.7%
Salaries/wages	100.0%	100.6%
Fuels	100.0%	47.6%
Materials and supplies	92.1%	100.0%
Contract work	96.7%	111.8%
Costs Not Included Previously	100.0%	100.0%
Permits and fees	100.0%	100.0%
Site cleanup	—	—
Cost Offsets	0.0%	—
Total Costs	96.4%	97.5%

Table D-2. Facility-Level Cost Comparisons: Facility 2

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	0.0%	—
Treatment	—	—
Recycling	—	—
Disposal	0.0%	—
Pollution prevention	—	—
Operating Costs	50.4%	101.9%
Salaries/wages	32.9%	100.0%
Fuels	0.0%	—
Materials and supplies	92.8%	103.5%
Contract work	100.0%	101.5%
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	0.0%	—
Cost Offsets	0.0%	—
Total Costs	37.2%	101.9%

Table D-3. Facility-Level Cost Comparisons: Facility 3

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	0.0%	—
Treatment	—	—
Recycling	—	—
Disposal	—	—
Pollution prevention	0.0%	—
Operating Costs	36.9%	141.2%
Salaries/wages	100.0%	141.2%
Fuels	0.0%	—
Materials and supplies	0.0%	—
Contract work	0.0%	—
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	—	—
Cost Offsets	0.0%	—
Total Costs	33.9%	141.2%

Table D-4. Facility-Level Cost Comparisons: Facility 4

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	0.0%	—
Treatment	0.0%	—
Recycling	—	—
Disposal	—	—
Pollution prevention	0.0%	—
Operating Costs	99.4%	200.8%
Salaries/wages	100.0%	82.8%
Fuels	98.1%	502.4%
Materials and supplies	100.0%	—
Contract work	100.0%	—
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	—	—
Cost Offsets	0.0%	—
Total Costs	89.1%	200.8%

Table D-5. Facility-Level Cost Comparisons: Facility 5

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	98.5%	92.9%
Treatment	100.0%	92.8%
Recycling	—	—
Disposal	—	—
Pollution prevention	100.0%	141.9%
Operating Costs	0.0%	0.0%
Salaries/wages	0.0%	—
Fuels	—	0.0%
Materials and supplies	0.0%	—
Contract work	0.0%	—
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	—	—
Cost Offsets	0.0%	—
Total Costs	88.8%	72.9%

Table D-6. Facility-Level Cost Comparisons: Facility 6

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	98.6%	94.7%
Treatment	100.0%	94.7%
Recycling	—	—
Disposal	—	—
Pollution prevention	0.0%	—
Operating Costs	1.8%	1.8%
Salaries/wages	0.0%	—
Fuels	100.0%	1.8%
Materials and supplies	0.0%	—
Contract work	0.0%	—
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	—	—
Cost Offsets	0.0%	—
Total Costs	88.0%	85.4%

Table D-7. Facility-Level Cost Comparisons: Facility 7

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	—	—
Treatment	—	—
Recycling	—	—
Disposal	—	—
Pollution prevention	—	—
Operating Costs	98.0%	55.8%
Salaries/wages	100.0%	96.4%
Fuels	0.0%	—
Materials and supplies	100.0%	56.7%
Contract work	100.0%	31.0%
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	—	—
Cost Offsets	—	—
Total Costs	61.6%	55.8%

Table D-8. Facility-Level Cost Comparisons: Facility 8

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	—	—
Treatment	—	—
Recycling	—	—
Disposal	—	—
Pollution prevention	—	—
Operating Costs	33.3%	100.1%
Salaries/wages	0.0%	—
Fuels	100.0%	100.1%
Materials and supplies	84.0%	100.0%
Contract work	0.0%	—
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	—	—
Cost Offsets	0.0%	—
Total Costs	31.0%	100.1%

Table D-9. Facility-Level Cost Comparisons: Facility 9

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	—	—
Treatment	—	—
Recycling	—	—
Disposal	—	—
Pollution prevention	—	—
Operating Costs	44.6%	90.5%
Salaries/wages	100.0%	92.6%
Fuels	100.0%	74.4%
Materials and supplies	0.0%	—
Contract work	0.0%	—
Costs Not Included Previously	100.0%	100.0%
Permits and fees	100.0%	100.0%
Site cleanup	—	—
Cost Offsets	0.0%	—
Total Costs	51.9%	92.7%

Table D-10. Facility-Level Cost Comparisons: Facility 10

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	0.0%	—
Treatment	0.0%	—
Recycling	—	—
Disposal	—	—
Pollution prevention	0.0%	—
Operating Costs	36.9%	154.2%
Salaries/wages	100.0%	195.0%
Fuels	38.5%	133.8%
Materials and supplies	85.1%	229.9%
Contract work	0.0%	—
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	—	—
Cost Offsets	45.7%	100.0%
Total Costs	34.5%	154.2%

Table D-11. Facility-Level Cost Comparisons: Facility 11

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	—	—
Treatment	—	—
Recycling	—	—
Disposal	—	—
Pollution prevention	—	—
Operating Costs	18.3%	136.2%
Salaries/wages	100.0%	100.5%
Fuels	9.5%	132.5%
Materials and supplies	90.6%	162.8%
Contract work	40.5%	137.9%
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	—	—
Cost Offsets	—	—
Total Costs	18.3%	136.2%

Table D-12. Facility-Level Cost Comparisons: Facility 12

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	0.0%	—
Treatment	—	—
Recycling	—	—
Disposal	—	—
Pollution prevention	0.0%	—
Operating Costs	54.4%	162.8%
Salaries/wages	100.0%	150.5%
Fuels	100.0%	166.4%
Materials and supplies	0.0%	—
Contract work	0.0%	—
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	—	—
Cost Offsets	0.0%	—
Total Costs	49.3%	162.8%

Table D-13. Facility-Level Cost Comparisons: Facility 13

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	81.1%	100.0%
Treatment	87.4%	100.0%
Recycling	—	—
Disposal	—	—
Pollution prevention	0.0%	—
Operating Costs	100.0%	294.5%
Salaries/wages	100.0%	506.8%
Fuels	100.0%	100.0%
Materials and supplies	100.0%	883.6%
Contract work	100.0%	250.0%
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	—	—
Cost Offsets	0.0%	—
Total Costs	98.2%	286.2%

Table D-14. Facility-Level Cost Comparisons: Facility 14

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	58.0%	113.6%
Treatment	58.0%	113.6%
Recycling	—	—
Disposal	—	—
Pollution prevention	—	—
Operating Costs	49.4%	72.0%
Salaries/wages	100.0%	119.3%
Fuels	100.0%	38.2%
Materials and supplies	0.0%	—
Contract work	0.0%	—
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	—	—
Cost Offsets	—	—
Total Costs	49.6%	75.4%

Table D-15. Facility-Level Cost Comparisons: Facility 15

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	96.5%	100.0%
Treatment	100.0%	100.0%
Recycling	—	—
Disposal	—	—
Pollution prevention	—	—
Operating Costs	61.5%	86.2%
Salaries/wages	100.0%	112.1%
Fuels	100.0%	78.1%
Materials and supplies	0.0%	—
Contract work	0.0%	—
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	—	—
Cost Offsets	—	—
Total Costs	59.7%	88.6%

Table D-16. Facility-Level Cost Comparisons: Facility 16

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	78.5%	101.7%
Treatment	100.0%	100.0%
Recycling	—	—
Disposal	—	—
Pollution prevention	0.0%	—
Operating Costs	71.5%	80.0%
Salaries/wages	100.0%	79.5%
Fuels	100.0%	86.6%
Materials and supplies	100.0%	15.8%
Contract work	0.0%	—
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	—	—
Cost Offsets	0.0%	—
Total Costs	72.6%	92.3%

Table D-17. Facility-Level Cost Comparisons: Facility 17

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	92.9%	113.0%
Treatment	94.2%	113.0%
Recycling	—	—
Disposal	—	—
Pollution prevention	0.0%	—
Operating Costs	52.4%	129.2%
Salaries/wages	100.0%	129.2%
Fuels	—	—
Materials and supplies	—	—
Contract work	0.0%	—
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	—	—
Cost Offsets	—	—
Total Costs	69.3%	114.9%

Table D-18. Facility-Level Cost Comparisons: Facility 18

Cost Type	Cost Checks	
	% of Cost Estimated by RTI	Facility Estimate as % of RTI Estimate
Capital Expenditure	—	—
Treatment	—	—
Recycling	—	—
Disposal	—	—
Pollution prevention	—	—
Operating Costs	3.5%	19.3%
Salaries/wages	100.0%	19.3%
Fuels	0.0%	—
Materials and supplies	0.0%	—
Contract work	—	—
Costs Not Included Previously	0.0%	—
Permits and fees	0.0%	—
Site cleanup	—	—
Cost Offsets	—	—
Total Costs	3.4%	19.3%