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Pollution Control: A Framework for Decision Making and Cost Control

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Everyone agrees on the necessity for pollution control; nearly everyone disagrees on how to pay for it. A Pollution Control Information System that gives facts leading to the maximum amount of control for the lowest cost is suggested —

POLLUTION CONTROL: A FRAMEWORK FOR DECISION MAKING AND COST CONTROL

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ALTHOUGH the social implications of the actions of American business have for some time been the subject of public attention, there are clear indications that we are entering an era when this attention will be intensified. The public's attention in the increasing social responsibilities of business is, perhaps, best exemplified in the issues of preserving the environment and controlling pollution. Clearly, the efforts of accountants are essential as business seeks to meet its increased social responsibilities of pollution control in a competitive economy.

The leaders of the accounting profession have acknowledged the obligation of accountants to contribute to an effective solution to the pollution control problem. Louis M. Kessler, past president of the American Institute of Certified Public Accountants, has said that businessmen and accountants must become involved "not because their creativity and productivity helped bring about the problem but because they possess the prestige and influence, the skills and talents to turn this country's proficiency for making tangible goods to the preservation of intangible values in our physical environment."[1]

In sum, those responsible for monitoring the financial health of an enterprise must have a firm grasp of the dimensions of the issues surrounding the control of pollution and the related costs.

This article seeks to present a Pollution Control Information System (PCIS) which identifies the internal and external constraints and critical decision points in handling the problem of pollution abatement. It suggests alternative methods of pollution abatement and examines the appropriateness of traditional accounting techniques in evaluating these alternatives. Finally, it provides a framework for developing a pollution control monitoring system.

The term "pollution" does not have a simple definition. It is usually associated with such terms as "undesirable," "unfavorable," or "obnoxious." The Environmental Pollution Panel of the President's

[1] "Pollution Control: How Much Will It Cost?" *Management Accounting*, July, 1970, p. 82.

Science Advisory Committee defined pollution as follows:

> Environmental pollution is the unfavorable alteration of our surroundings, wholly or largely as a by-product of man's actions, through direct or indirect effects of changes in energy patterns, radiation levels, chemical and physical constitution and abundances of organisms.[2]

Another way of viewing pollution is through the concept of "disproduct." Disproducts are the negative services which are generated by the same processes which create products. Noise is an undesirable result of airports; smog is an undesirable result of cars, industry, and other activities. Residual waste or pollution is an inevitable part of the process of production. In most analyses, this disproduct is ignored. Disproducts are not unusual results of production but are a normal and inherent part of the process; they become more important as the population and output increase. For this reason, the problems of pollution cannot be treated as isolated problems such as clear air or water, but must be related to the production processes which gave rise to them and to the products which were also created.[3] It should be observed that the term "final" consumption is a misnomer. All output eventually becomes waste[4] and is recycled into the system in one way or another. It either goes into the environment for eventual decomposition and reuse by the ecological system or is recycled directly back into the production system.

[2]Environment Panel of the President's Science Advisory Committee of *Restoring the Quality of Our Environment,* The White House, Washington, D.C., November, 1965.

[3]For a detailed exposition of this subject, see Robert U. Ayres and Allen V. Kneese, "Production, Consumption, and Externalities," *The American Economic Review,* June, 1969, pp. 282, 297.

[4]Disproduct, waste, non-useful products, and pollution are used interchangeably in this article.

A Pollution Control Information System is presented in Exhibit 1, page 26, and consists of three phases. Phase I is the pollution abatement decision process. Phase II is the evaluation of alternative processes which occurs once a decision has been made to take some action toward pollution abatement. Obviously, these two phases are highly interrelated, but it is convenient to view them separately here because of their unique information requirements. Phase III is the establishment and maintenance of a pollution control monitoring system which provides feedback into various components of the PCIS.

The decision to seek to control pollution and determination of the extent of the controls is a complicated one. Traditional economic theory suggests that a firm, in order to maximize income, should produce at a level where marginal costs equal marginal revenue. This concept is clearly inadequate when considering pollution because there is no easily measured benefit from additional expenditures on pollution control.[5] In fact, in many instances the less a company spends on pollution control the more its income will be, except in the very long run. For instance, consider a company which produces widgets and which disposes of the waste and smoke from production into a river and into the air. It has the alternative of processing the smoke and waste before disposal to prevent pollution or not to process further. The gross profit per widget under each alternative might be as follows:

	No Pollution Control	Pollution Control
Sales Price	$10.00	$10.00
Less:		
Manufacturing Costs	6.00	6.00
Costs of Pollution Control	–0–	1.00
Gross Profit	$ 4.00	$ 3.00

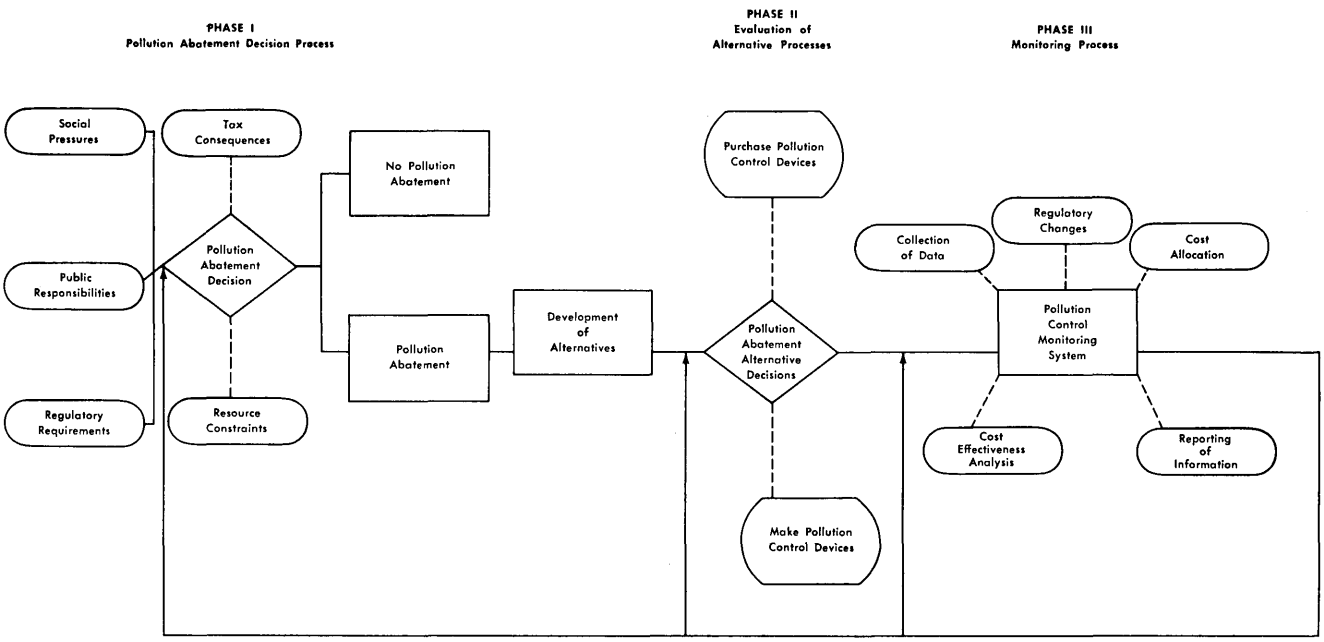
Clearly, under these circumstances if the company wishes to

[5]Some returns may come from sales of by-products or from the recycling process.

Another way of viewing pollution is through the concept of "disproduct." Disproducts are the negative services which are generated by the same processes which create products. Noise is an undesirable result of airports; smog is an undesirable result of cars, industry, and other activities.

EXHIBIT I

POLLUTION CONTROL INFORMATION SYSTEM



maximize profit at the prevailing market price, it should not initiate the pollution control, thereby passing the cost of the disproducts on to the public. Further, if this company is in a competitive market and if its competitors have pollution control processes but it can get by without them, then this company can undersell (say, at $9.00 per unit) its competitors and increase sales and profits at the expense of more pollution.

Competition and pollution

In either case, without the pollution controls, the company's costs may increase indirectly by additional taxes which are necessary because the government must now spend more for pollution controls. However, this increase in taxes would be borne by companies who install pollution controls as well as by those companies which by the nature of their businesses do not cause pollution. As one can see, competition, which is a strong incentive for producing better products at lower costs, can contribute to pollution. A company's costs are lower if it can pass the job of cleaning up to the consumer; consequently, it has a competitive advantage over companies that practice pollution control. Ultimately, the cost (benefit) to society as a whole of pollution (controls) must be measured and there must be tax incentives or penalties built into the economic system before the traditional economic models are applicable.

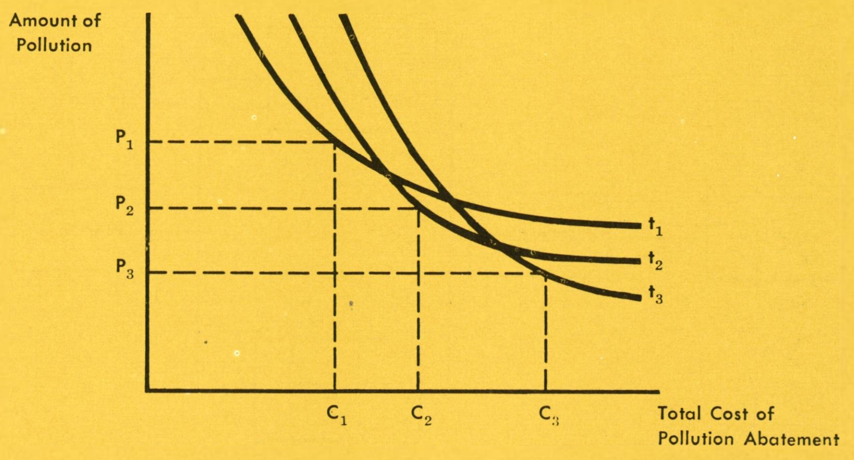
Thus, if one excludes the possibility of waste processing becoming profitable, as when a new use is found for it, there are three forces which independently or together cause a company to consider the possibility of increasing its pollution control efforts. These three factors are a sense of social responsibility, public pressures, and regulatory requirements. Two secondary factors are resource constraints and tax considerations.

Social Responsibility. No one likes or desires pollution and no one wants to be known as a polluter. Many companies, therefore, decide to instigate pollution controls simply because they feel that it is part of their social responsibility to do so. Unfortunately, because of competitive factors and lack of awareness of the problem, pollution in many industries has not been controlled adequately in the past.

Public Pressures. In addition, the public's unwillingness to pay higher prices for pollution control contributes to the problem. The public mood, however, has changed over the last five years. Concerned citizens are attempting to buy products from companies which are seeking to reduce pollution or produce products which cause less pollution than competing products. In some instances, the public is boycotting some businesses, fighting certain public projects, and lobbying for more legislation. Financial strategists of business must be aware of these movements for they provide vital input to the decision process. They limit alternatives and provide time constraints on the implementation of pollution control systems. Companies must provide a mechanism such as a

EXHIBIT 2

RELATIVE COSTS AND EFFECTIVENESS OF THREE METHODS OF POLLUTION ABATEMENT



committee of management which meets regularly to assess continually its own position, as well as the mood of the public.

Regulatory Requirements. The third major factor in pollution control analysis is the influence of government regulation. The informational needs with respect to this aspect of the pollution abatement decision are becoming increasingly acute because of two basic problems. First, a single company is usually subject to at least two agencies (one for air; one for water) at the city, county, and state levels. Each regulatory body has its own standards, which are frequently in conflict with those of other agencies, and they often compete with each other for jurisdiction. Second, spurred by the public outcry over pollution, government at all levels is toughening and expanding its laws, even those only a year or two old. Every company with a pollution problem should have an information-monitoring process to keep informed of changes in regulations.

Resource Constraints. In making the pollution abatement decision, management is faced with two resource constraints:

1) Monetary—There is a limited amount of money to divide among various kinds of pollution controls. Two allocations must be made: Among several means of controlling a particular type of pollution, which should be chosen? Among several types of pollution, how should available funds be allocated?

2) Technical—At any one time, there is a given state of technology which is a limiting factor, both from efficiency and cost standpoints. Different methods may have different cost or efficiency characteristics and it is possible that the desired level of pollution removal cannot be reached through presently known methods.

The trade-offs among accepted levels of pollution, costs, and technology can be seen in Exhibit 2, above. Each curve (t_1t_1, t_2t_2, t_3t_3) represents a different method or level of technology which is available. Although in many cases pollution can be eliminated, the cost is usually prohibitive. There must be a compromise with respect to the level of pollution.

If the level of pollution is the constraint, then a level of P_1, P_2, or P_3 would result in different methods being chosen. If cost is the constraint, then C_1, C_2, C_3 would also result in different control methods being selected.

Tax Considerations. Tax considerations are another decision variable in the pollution abatement system. As suggested earlier, it is obvious that if modifications can be made in the competitive system which will encourage pollution abatement, a powerful incentive will exist for pollution control. Two direct means used by state and Federal governments in creating incentives for pollution control are to (1) impose a special tax on people or companies in proportion to the severity of the pollution for which they are responsible (tax penalties) and (2) provide tax credits or other tax benefits such as accelerated depreciation to firms that install pollution control equipment (tax incentives).

Many states as well as the Federal Government have adopted an

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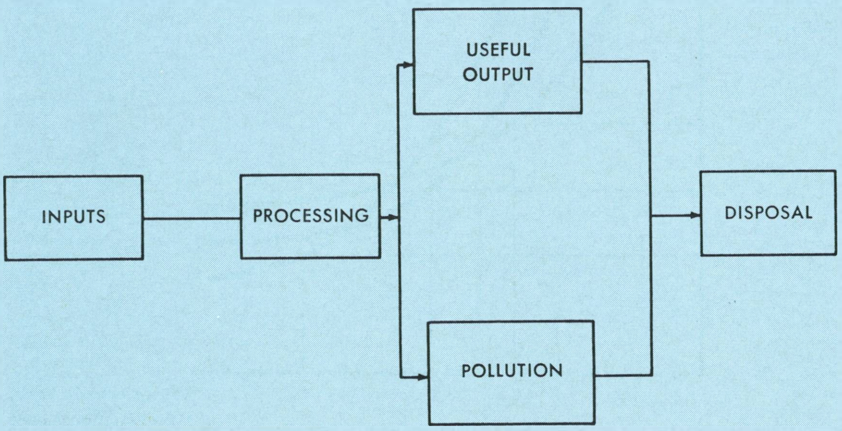
EXHIBIT 3

A GENERAL SYSTEM OF POLLUTION
IN A SIMPLIFIED PRODUCTION AND CONSUMPTION PROCESS



alternative approach for providing tax incentives. Several states exempt air and water pollution devices from sales and use taxes, franchise taxes, and/or property taxes. Many state income tax laws allow accelerated depreciation of pollution control devices. The Federal Tax Reform Act of 1969 allows individuals and corporations to write off the cost of certified pollution control facilities over a 60-month period. On the surface, the providing of tax credits as incentives for installing pollution control devices may appear to be an excellent means for reducing pollution. However, the equity of tax credits is open to question.

First, the size of the tax credit is not related to the reduction in the amount of pollution a particular investment causes but is related only to the number of dollars spent. Second, even though the tax credit system may succeed in reducing pollution, the company which is making the outlay ultimately will not bear the cost. The public will bear part of the costs, because those firms which do not pollute in the first place, and thus need no pollution control equipment, will pay full taxes, while those who do pollute recover a part of their cost through tax credits. To illustrate, a recent study of costs of pollution control equipment showed that a \$3 million crude oil distillation unit of 37,000 barrels per hour capacity required a vapor control system which cost \$10,000. Another liquid hydrogen unit required a pollution control device which cost \$17,700. On the other hand, a \$250,000 investment in pollution control equipment was required for a \$1,600,000 synthetic rubber operation. An electric precipitator to be used with an open-hearth furnace costs \$150,000 to \$200,000 for the furnace. In some cases, the required investment in pollution control equipment is actually greater than the investment required in the basic equipment.

The alternative method of taxing people and corporations in proportion to the amount of pollution they cause is more attractive. If the tax is high enough to make a substantial difference in cost of production for a polluter versus a non-polluter, companies would have a powerful incentive for installing pollution control equipment and for developing more efficient and economical methods of controlling pollution. The advantages of this method are that it places the burden on the polluter, and, psychologically, it appears to be a penalty whereas the tax credit seems more like a favor. Obviously, one of the problems with this method is measuring the amount of pollution.

After carefully examining all of the relevant considerations with respect to pollution abatement, management may decide that pollution is not a problem for its company and thus no further action except periodic review is needed. However, if the decision is made that pollution abatement is needed, the next step is to delineate and evaluate alternative ways of pollution abatement.

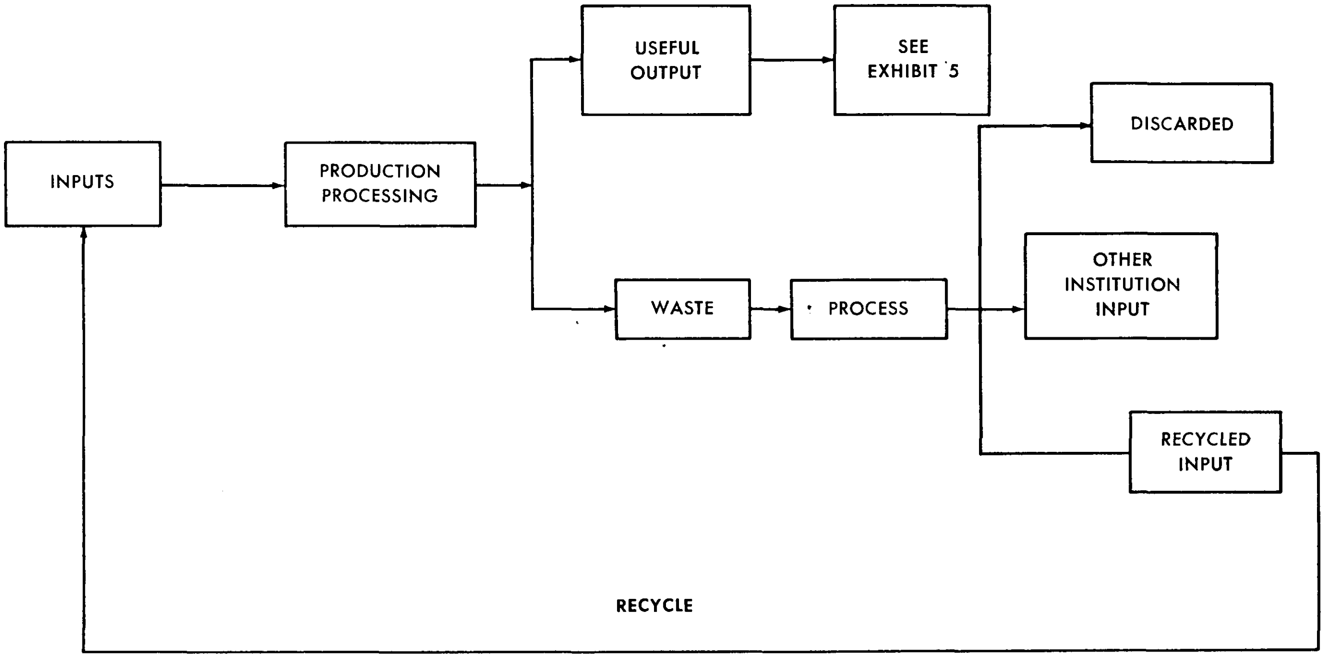
A thorough examination of pollution abatement alternatives requires a structural view of the system of which pollution is an integral part. To illustrate, the system, presented in Exhibit 3 at left, is a simplified version of the production and consumption processes and can represent any entity, whether business, government, or public. The system consists of inputs which may exist in inventory or raw form for industrial production or in product form for a consumer. The processing function may represent production, consumption, or some intermediate step. The output consists of a combination of useful output and waste. The relative amounts of each will vary. For example, in the consumption process, the physical output may be substantially all pollution. On the other hand, in certain efficient manufacturing transformations there may be very little waste. Ultimately, however, from the general systems viewpoint, the output, both the useful and waste portion, must eventually be discarded and/or recycled.

In designing a PCIS, explicit recognition must be given to the alternative processes for controlling pollution. These alternatives include: (1) processing the waste output, (2) processing the useful output, (3) changing the process, and (4) changing the input.

Processing the Waste Output. A common way that all levels of society, whether industry, government, or consumer, have passed on the cost of cleaning up waste to someone else is simply to discard

EXHIBIT 4

POLLUTION CONTROL ALTERNATIVES THROUGH WASTE PROCESSING



the waste. Industry and governments pollute streams and the air; consumers discard trash and drive untuned cars which discharge excess smoke and fumes.

It is obvious, therefore, that the proper processing of waste is an important alternative in its control. Exhibit 4, above, illustrates three alternatives for disposition of waste after it has been processed.

1. After processing, the waste can be discarded. Examples of this type of pollution control are: The cooling of hot water from atomic energy plants before discharge into the water, the treatment of sewage and garbage by local government, the treatment of discharge liquids and smoke by industry.

2. The processing of the waste may transform it into a useful product. Some examples are the sale of sawdust by a sawmill to a pressed board maker and the collecting and converting of sulfur oxides emitted by utility and smelter smokestacks for use in making sulfuric acid.

3. After processing, the waste may be recycled into the system. Some common examples include the recycling of water or other liquids used for cooling and the collecting of chemicals from smoke for subsequent use.

Processing the Useful Output. As illustrated in Exhibit 5, page 30, another means for controlling the amount of pollution is by further processing of the useful output after its consumption. Exhibit 5 shows the close relationship of useful output to waste. Since useful output becomes waste as soon as it is used, the alternatives after consumption are the same as the alternatives available when processing the waste.

For the industrial firm, however, waste processing is one step removed from waste control. Accordingly, waste processing has special implications, particularly for recycling. The firm or industry must arrange the return of the waste product. Some examples of this system are the use of returnable bottles by beverage manufacturers and the recycling of waste paper and scrap iron.

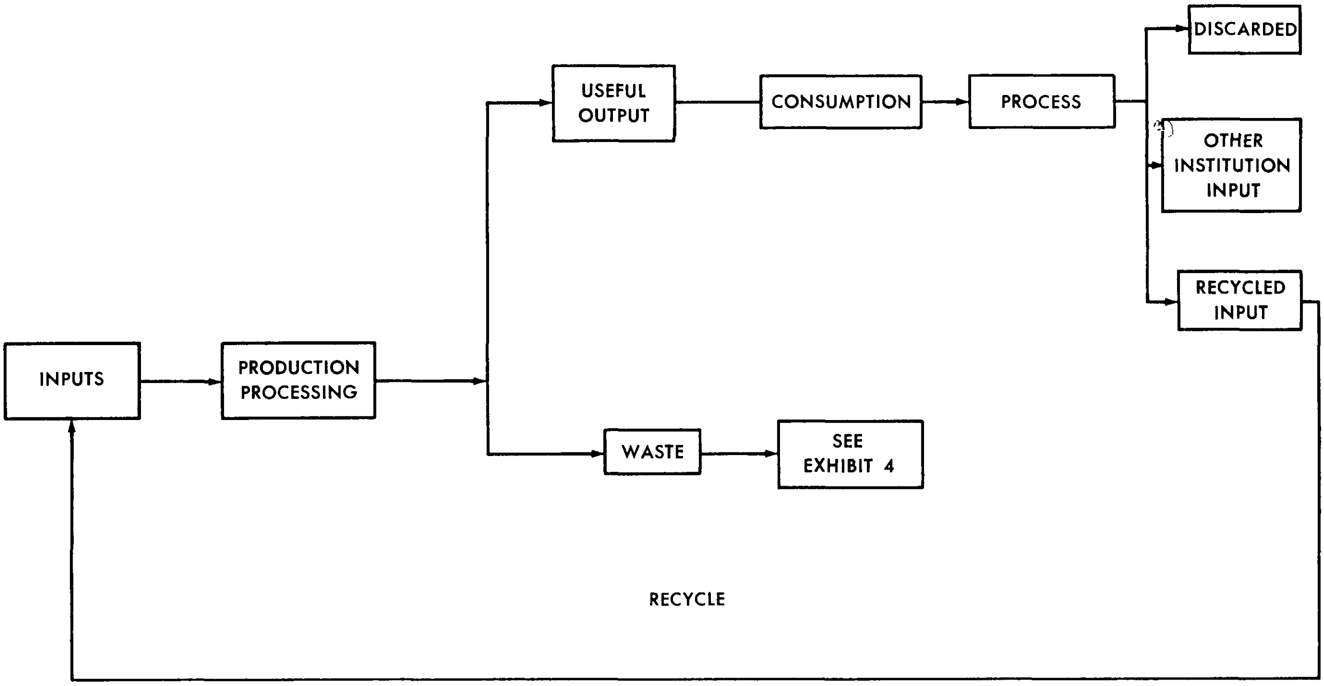
Changing the Process. Another alternative for controlling pollution is to change the manufacturing process itself, resulting in more useful output and/or less waste output. The range of possibilities is large under this alternative and the measurement problems for the accountant are equally great. A company may modify the manufacturing process in such a way that more useful product is obtained or it may manufacture a more efficient product such as a new engine design which emits fewer pollutants than a previous design.

Changing the Input. Finally, pollution may be reduced by changing the input to the system. Some common examples of this trend are: the switching of power companies from highly pollutant soft coal to hard coal and other fuels which cause less air pollution, the development of detergents which are phosphate-free, and the use of different raw materials in plastic containers making them suitable for most incinerators' disposal systems.

An integral part of the decision to embark on a major pollution abatement program includes an

EXHIBIT 5

POLLUTION CONTROL ALTERNATIVES THROUGH REPROCESSING USEFUL PRODUCTS AFTER CONSUMPTION



analysis of the financial resources required. In many instances, the question becomes one of whether the required technology and equipment should be developed in-house, or, if available, purchased externally. Although this type of decision has the earmarks of the familiar "make or buy" analysis, the decision variables are, in some respects, of a different complexity.

For example, in capital expenditure analysis the objective is to measure the profit potential of long-lived assets. The projected profitability of the alternatives depends on (1) the required investment, and (2) the net increase in future cash flows. Under conventional analysis, the project's return is usually determined and compared with the company's desired minimum return. If the projected return is equal to or greater than the minimum desired rate of return and if the other pertinent factors are positive the project is accepted.

However, pollution control projects may not provide returns measurable by conventional methods, and hence will not provide the information required for conventional capital budgeting models. As *Management Accounting* put it:

> . . . if millions must be spent to ensure that this generation is not the last on earth, assurances surely will be required that the enormous sums are spent wisely. For each dollar spent, there should be maximum return in the intangible values gradually disappearing: green forests, fresh air, clear sparkling lakes and streams. Money spent for the abatement of pollution must show tangible reductions in pollution.[6]

In large measure, capital expenditure analysis of pollution abatement must consider returns usually of an intangible nature, not only through preventing loss of clean water and air, but through maintenance of institutional responsibility and goodwill as well.

In addition to the intangible nature of the benefits of pollution control, a second complication enters into capital budgeting for pollution control projects. The unsettled public attitude toward pollution and rapidly changing regulations, coupled with the absence of a directly measurable benefit stream (either revenue or cost savings), contribute to the unusual uncertainty with respect to the *length* of any benefits which may accrue from such a project. Clearly, under these circumstances, conventional capital expenditure models must be modified, and in many instances new models developed, in analyzing capital outlays for pollution control.

After the decision has been made to undertake a pollution abatement program, a control system must be designed and implemented. Exhibit 1 (Phase III) presents a monitoring system for collecting relevant data and allocating common costs for the purpose of further cost effectiveness analysis and proper internal reporting.

The pollution control monitoring system should be designed in a

[6] "Pollution Control: How Much Will It Cost?" *Management Accounting,* July, 1970, p. 82.

manner consistent with the concept of responsibility accounting. For example, the direct costs for operating the pollution control system can be accumulated and allocated in an equitable manner to those departments or cost centers which caused this expenditure. Those charged with the responsibility of the various departments or cost centers can then determine their controllable cost with regard to pollution abatement and waste disposal, thereby striving to lower these costs while reducing pollution.

However, because of the diverse nature of pollution responsibility, great care must be exercised in designing a responsibility accounting system for pollution costs and assigning such costs to the appropriate cost centers. In some instances, cost responsibility can be readily identified and assigned to a specific center. In other instances, due to the raw material input or the product produced, pollution costs can only be identified at the entity level. Like capital budgeting analyses, conventional responsibility accounting systems may need modification for the purpose of monitoring pollution costs.

Still other modifications in the traditional accounting control systems may be required for application to a pollution control monitoring system.

Coordination essential

Madison C. Forbes, president of Associated Enterprise, Houston, believes that in the past the accounting function has played the dominant role in control systems but in the future the system should be the result of interdisciplinary action. He states:

> Formerly, decisions for allocations of cost followed accounting convention and were done almost entirely within the Accounting Department with only a casual reference to the engineering or management requirements of the system. Newer methods of allocation must be a careful blend of accounting, engineering, and management decisions that require not only agreement, but wholehearted cooperation if they are to be effective.[7]

An excellent example of a cost allocation problem arising from a pollution abatement program is the assignment of common costs to products. Allocation of common costs to products raises such familiar issues as accounting for waste, scrap, and by-products. A pollution control monitoring system must provide a means of allocating the common costs in the most meaningful and relevant manner for decision making purposes.

Reporting costs externally

Although it is readily recognized that a chief component of a pollution control monitoring system is reliable and timely reporting of the relevant costs internally, little attention has been directed toward reporting pollution costs externally. As public interest in businesses' social responsibilities continues to grow, and as pollution costs continue to multiply, requirements for external reporting of pollution costs are inevitable. An effectively designed pollution control monitoring system will provide for the capturing, assembling, and reporting of pollution costs to facilitate meaningful external corporate reporting of these outlays.

Finally, a well designed pollution control monitoring system should include provisions for a post-audit of the decisions made through continued cost effectiveness analysis; information should be obtained which will be helpful in evaluating whether the pollution control system is attaining the desired objective. These analyses must include costs for which the accounting process normally does not assign a monetary value. For example, a cost must be ascribed to antagonistic public reaction to ineffective pollution abatement efforts.

In summary, designing a Pollution Control Information System is a multidimensional task. First, an analysis of the economic forces of the industry is essential. Determining the potential impact of the absorption of additional costs of pollution controls, although difficult, is of paramount importance. Other variables include an analysis of the firm's social responsibilities, public pressure, and regulatory and tax requirements.

Internal variables of a Pollution Control Information System include resource constraints and available alternative methods for processing waste output.

Like other systems, an effectively designed Pollution Control Information System should include formal evaluation of the relative returns of waste processing alternatives, proper allocation of common costs, timely reporting of relevant data for internal decision making, meaningful external reporting of pollution costs, and thorough post-audits of the decisions surrounding pollution abatement. In many instances, however, conventional techniques of capital budgeting, responsibility accounting, cost allocation, and systems modeling must be modified, and, in some instances, new techniques and approaches developed.

It is readily apparent that because of the wide range of variables inherent in designing a Pollution Control Information System, the interactions of many individuals will usually be required. One strategy is the formation of a task force of, among others, accountants, systems analysts, economists, and engineers working in concert with top management. Such a team committed to the objective of pollution control would be capable of bringing to the task the myriad skills and insights needed to design an effective Pollution Control Information System – a task that is no longer discretionary with business.

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[7] Forbes, Madison C., "Cost Accounting for Pollution Control," *Hydrocarbon Processing*, October, 1969, p. 145.