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EFFECTS OF POLLUTION CONTROL ON THE FIRM

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The general public is not aware of the significant progress made recently by industrial programs directed at the improvement of environmental quality. It is estimated<sup>1</sup> that total investment outlays by American manufacturers for air and water quality control more than doubled over the past four years, and another doubling over the next four years is within reason. Industrial centers, such as Pittsburgh or Wheeling, have substantially reduced particulate matter into the atmosphere. Busy waterways, notably the Ohio River and its tributaries, have been cleaned of their grossest floating materials by primary and secondary waste treatment. And public health, so far as infectious diseases are concerned, has shown considerable progress. Yet many political pressures and editorials indicate that industry is neglecting its social responsibilities. Championing a cleaner environment, they proclaim that more abatement should, and will, be enforced on activities of the firm.

Legislation calling for stringent abatement programs necessitates considerable expenditure by companies. In response to these demands, management policies on optimal production schedules are challenged to

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the point where, in some cases, radically new approaches and improved technologies on abatement are required. By forcing the individual firm to comply with these standards, such regulation can effect diversion of resources from manufacturing operations into frequently nonprofitable control facilities. Industry reacts in one of several ways:

- o it maintains regular production levels,
- o it curtails these levels, or
- o it is forced out of business by intolerably high treatment expenses.

Although the first reaction is clearly the most common, cases of the other alternatives can be cited. For instance, a giant 50-year old phosphate plant in Florida closed down as a result (so its managers claim) of economic infeasibility of air quality control demanded by state officials.<sup>2</sup> Another firm in Pennsylvania reduced its labor force by one-half in retaliation to strict air pollution laws.<sup>3</sup>

Except for small and old marginal plants whose technology would face a radical re-orientation to accommodate waste treatment facilities, it appears that industry is both willing and able to provide necessary controls to meet current air and water quality criteria. According to frequent opinion, "The United States has both the technology and wealth to reduce pollution drastically."<sup>4</sup> Unfortunately, the lack of good publicity from management and the public's lack of awareness of complexities and costs in treating certain wastes conceal the advance of industry toward a better environment. While a small percentage of firms is indeed irresponsible, most companies are making significant efforts in this direction. Such progress is particularly evident in the Ohio River basin, where almost two thousand manufacturers discharge effluents

directly into the streams. Several decades ago hardly any firms treated effluents, but now over 90 percent comply with established standards.<sup>5</sup>

#### MONETARY EFFECTS OF ABATEMENT

The impact of environmental quality regulations on the financial position of a firm is conspicuous from at least three points of view:

- o *Treatment Costs.* Significant expenditures for equipment and their operation and maintenance often result from restrictions on waste discharges. The likely diversion of some capital and resources from production to waste control can decrease output and hence profit levels. The firm may respond by raising the price of its products, whereupon the consumer may retaliate by decreasing his demand.
- o *In-Plant Benefits.* Not all waste control programs are detrimental to the competitive position of a company, and some programs, in fact, account for additional sources of revenue. Valuable by-products are captured and sold, or they are re-used in manufacturing operations to improve efficiency of input utilization. Still other possible benefits include higher morale and productivity of labor as well as lower upkeep and maintenance costs from cleaner working conditions.
- o *External Economies.* Without adequate environmental quality standards, the cost to purify intake water or air for industrial use can be a significant portion of operating expenses. In the extreme case, unlimited pollution of inputs incapacitates the productivity of a plant or at least forces a temporary shut-down of operations until intake equipment and ductwork are cleaned.

These different viewpoints demonstrate opposite effects of pollution abatement on the firm. In one case, high costs of waste control could result, thereby impairing the financial well-being of industries. The economic infeasibility of restoring air and water to their original levels of purity endangers the profitability of some firms, especially marginal and older plants. Conversely, insufficient treatment by one plant could cause excessive diseconomies or harm to others and even itself.

The pecuniary effects are thus not necessarily constrained to one plant, even if the regulations are directed solely at its waste emissions. Initial impacts of such legislation at one firm could be the diversion of inputs from manufacturing into pollution control and the consequent reduction of output. Secondary effects of this decision could be a reduction of that firm's shipments to satisfy intermediate demand requirements at other industries. Tertiary effects could follow, in turn, from earlier ones. For example, income losses from local establishments, such as retail and service stores, could be traced to this slowdown of economic activity. After tertiary effects follow higher order consequences of the original legislation.

#### COSTS OF ABATEMENT

Measurement of the impact of waste control on any firm includes a cost analysis of the abatement programs, the calculation of which is a complicated problem. Accurate data on pollutant loads and associated

treatment expenses are seldom disclosed by companies. Some industries, in fact, do not record these costs and have little or no information on generated wastes. Moreover, any projection of future expenditures and potential waste quantities involves uncertainty. New inventions and technical advances raise the waste removal efficiency of equipment and can also decrease their operating and installation costs. Manufacturing processes sometimes change enough to cause drastic reductions or possibly even increases of residuals. Greater cooperation among industries can lead to the construction of regional treatment centers to take advantage of economies of scale. And future decisions on environmental quality constraints can drastically alter the efficiency and cost of industrial waste control.

Recent data compiled by the Environmental Protection Agency<sup>6</sup> give an estimated breakdown of investment into both air and water pollution control by all industries of the United States. Table 1 lists total 1967 and 1970 (planned) expenditures by industrial classification; the proportions spent on water pollution are also listed. According to these results, total investment outlays practically doubled over this period, and water quality control, on the average, is just slightly less important than air quality control costs. With respect to specific industries, the heaviest investments in 1970 are identified with electric and gas utilities, chemical, petroleum, and iron and steel manufacturers. The textiles and pulp and paper sectors spend the highest proportion on wastewater treatments, while the transportation equipment industry allocates the largest fraction of its resources to air quality control.

Table 1

INSTALLATION COSTS OF AIR AND WATER QUALITY CONTROL BY AMERICAN INDUSTRIES

Industry	Millions of Dollars		Proportion Spent on Water Quality 1970
	1967	1970	
Electric and gas utilities	\$215	\$544	N.A.
Chemical	92	226	48%
Petroleum	102	205	48
Iron and steel	130	199	48
Pulp and paper	94	184	65
Machinery	46	149	60
Mining	66	126	N.A.
Transportation equipment	76	120	20
Stone, clay, and glass	48	95	40
Food and products	42	91	55
Non-ferrous metals	43	84	N.A.
Textiles	23	7	75
Rubber	20	0	50
Durables N.E.C.	45	163	N.A.
Nondurables N.E.C.	53	57	N.A.
Total	1066	2284	N.A.

NOTE: 1970 costs are estimated on the basis of anticipated production volume and unit waste loads.

The abbreviation, N.E.C. means "not elsewhere classified," while N.A. means "not available."

Generally the cost of waste abatement and disposal is quite low relative to other production costs, even for heavy air- and water-using activities. It is common in many firms for water treatment expenses to average about 2.5 percent of total capital investment.<sup>7</sup> Corresponding values of air purification facilities are often comparable in size. Relative costs of air quality control are listed in Table 2 for typical American manufacturers.<sup>8,9</sup> Because these data pertain to treatment in the mid 1960s when environmental quality standards were less stringent, today's figures could well increase by 50 percent or more. In this table annual outlays for installation of facilities are related to total capital investment, while operation and maintenance

costs of treatment are treated as percentages of the replacement value of the waste control equipment. Repair costs are considerably large in some companies; the upkeep of electrostatic precipitators, for instance, necessitates highly skilled and consequently highly paid electricians and mechanics.

Table 2

TYPICAL RELATIVE COSTS OF AIR POLLUTION CONTROL

Industry	Installation Cost <sup>a</sup>	Operation and Maintenance Cost <sup>b</sup>
Cement	10%	--
Foundry melt shop	15-20	--
Integrated steel	3-5	10%
Metallurgical	1-1.5	--
Chemical	2.5-5	15-20
Petrochemical	6	--
Ceramics	--	18
Dry foods processing	--	14.5

<sup>a</sup>Proportion of total plant capital investment.

<sup>b</sup>Proportion of waste control equipment valuation.

ALTERNATE SOLUTIONS

With most firms it is unnecessary to rely exclusively on abatement as a means to solve pollution problems. Other approaches that merit consideration include:

- o improved process control,
- o input substitution for manufacturing,
- o better equipment design,
- o good housekeeping and maintenance,
- o relocation or careful initial site location.

Occasionally one of these methods alone achieves satisfactory results, but it is also possible, and quite often the case, that a combination of these policies is more advantageous.

Recirculation of water is a popular method of reducing costs of abatement. If the quantity of water needed is substantial, potential waste effluent volumes and treatment costs can be considerable. By means of water recirculation, however, the effluent load can be lowered, thereby cutting down the installation or operating expenses of treatment devices. But there generally is a limit to the extent of recirculation. Too much re-use leads to higher rates of corrosion, foaming, or plugging by particulate wastes, which thus hasten the depreciation of equipment and impair the quality of products in contact with wastewaters.

#### BENEFITS FROM ABATEMENT

Besides the cost side, there are also positive considerations in a company's decision to install waste control equipment. External and internal sources of pollutants account for malfunctions and increased corrosion of machinery and also scale formations and consequent clogging of drains and ductwork. In the steel industry, for example, rolling mills are seriously damaged by water containing chloride whose level is tolerable in drinking water. Dissolved or suspended matter, such as iron particles and coal dust, clogs and corrodes drains and pipes of intake facilities. Even pure water is corrosive in some industrial operations. Dissolved oxygen alters reactions of distilled water with metallic surfaces and then proceeds to damage piping and equipment. Water characterized by an oxygen deficiency is thus less corrosive, but more lethal to fish, than water with higher oxygen levels.

Although damages from pollutants occur frequently in some industries, such as commercial fishing and recreational activities, this source of expense is usually minor relative to other plant costs. Nevertheless, on an absolute scale these costs can run into millions of dollars for regional industries, and it is thus important to recognize advantages of abatement to the firm. The installation of waste treatment devices improves not only the environment, but it also provides worthwhile interrelated benefits to the company itself:

- o cleaner working conditions,
- o higher labor efficiency and productivity,
- o fewer losses of income from absenteeism,
- o reduced maintenance of buildings and yards,
- o better visibility in the vicinity of the plant, and
- o improved public and employee relations.

Typical contaminants encountered inside plants--dusts, smoke and fumes, and acid mists--produce adverse effects among exposed workers.<sup>10</sup>

Economic losses attributed to polluted water or atmosphere in the plant include decreased productivity and absenteeism of workers, inefficiencies due to incomplete combustion of fuels, higher costs of artificial illumination, repair or replacement expenditures for corroded equipment and supplies, and, of course, treatment costs for intake water and air supplies. Another conspicuous effect of wastes is deterioration of the quality of products in contact with polluted inputs; the accompanying reduction in final product value is significant in some companies.<sup>11</sup> It is also possible for pollutants to corrode machinery or clog drains and pipes to the point where the production rate in the

affected company decreases or even stops until the damages are remedied. As a result, the quantity of output is reduced, and sales income can likewise be less than anticipated.

Expenses of maintaining water of good quality for manufacturing activities vary widely among firms. But in most companies, operating costs for water intake are meager when compared to other expenses. For example, data from five chemical plants in the Midwest show that these costs (excluding pumping expenses) range from 0.1 to 0.3 percent of total production costs.<sup>12</sup> Moreover, expenditures of using low quality water are surprisingly insensitive to quality specifications within large ranges.<sup>13</sup> Two reasons for this insensitivity are: 1) the largest fraction of water is generally needed for cooling, which does not require clean water; and 2) processes that use high quality water, such as boiler feed water, ordinarily have special treatment of water regardless of its source.

A comparison of abatement costs for intake water versus wastewater from manufacturing processes is available for certain firms: "Waste treatment and disposal costs for the heavy water using and water pollution industries are generally several times intake water costs, the ratio being on the order of 3:1 to 6:1. Thus, the order of magnitude of the proportion of total production costs represented by total water utilization costs for these firms ranged perhaps from .1 percent to about 3 percent."<sup>14</sup> While the quality of intake water is a principal concern to companies, a more important consideration is the fluctuation of waste concentrations over any specified period.<sup>15</sup> A minimal variance of pollutant levels in supply water implies that less monitoring of

water quality and fewer alterations in treatment techniques are necessary, both of which result in extra savings to industry.

#### SUMMARY

The imposition of legal constraints on waste emissions has forced American industries to more than double their outlays for abatement facilities over the past five years. Future prospects of more stringent regulations imply that a doubling of present expenditures within the next five years is not improbable. The monetary impact of these constraints is usually viewed as negative or detrimental to the competitive position of a firm. Seldom are advantages evaluated or even considered in a company's cost account of waste control programs. But there are important benefits both internal and external to the firm. For example, worker morale and efficiency are likely to improve as a result of cleaner working conditions. Furthermore, production slowdowns or temporary stoppages from clogged ductwork and equipment are less probable with improved waste control. Other benefits include reduced costs of treating intake water and air, less emphasis on the maintenance and repair of polluted plant facilities or grounds, and better public relations. The effects of pollution control on a typical firm are thus two-sided. On the negative side is the likelihood of significant expenses to meet emission standards, but positive aspects are also probable, such as economic gains and publicity advantages from the reduction of harmful pollutants within the plant.

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