CHAPTER 11

Impacts of EPA and OSHA Regulations on Technology Use

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Summary

In the past, the policies of the Environmental Protection Agency (EPA) have had a greater impact on the steel industry than those administered by the Occupational Safety and Health Administration (OSHA). In the future, however, OSHA policies will grow in importance as more regulations become operational.

Congress has expressed a strong interest in regulatory technologies that are more cost effective than present ones and that will further reduce public health hazards. It is the steel industry's position that available control technologies are generally capable of meeting regulatory standards, but Federal agencies suggest that considerable environmental R&D is still needed. EPA spends less than $1 million per year on steel-specific R&D, but much larger sums on environmental R&D that is incidentally applicable to the steel industry. Industry reports that its environmental R&D spending is about $75 million per year, although a considerable amount of this appears to be for engineering work. Regulatory technology R&D by the steel industry suffers in part because of the high costs and limited private gains associated with it.

Some regulatory approaches, such as the use of technology-based standards, were developed to encourage private-sector improvements in abatement technologies. Other statutory provisions go beyond encouragement by requiring or "forcing" private-sector development of new regulatory technologies. The various environmental statutes and the Occupational Safety and Health Act (OSHA Act) encourage the use of technology-based performance standards. Although these standards allow industry more flexibility they have not encouraged major industrial innovations that are the subject of this report. Available regulatory incentives, such as delayed compliance, have generally been inadequate in encouraging fundamentally new and cleaner steelmaking technologies such as continuous casting or direct casting of sheet or strip. Regulatory incentives have been more successful in providing the initial impetus for incremental improvements in abatement technologies. Examples include improved coke oven controls.

There has been considerable disagreement about the economic and technical feasibility of the regulatory technologies that Federal agencies have identified as being capable of attaining specified control levels. EPA's technology-forcing approach allows for diffusion of new environmental technologies that are not yet commonly used by the steel industry, but judicial decisions have directed EPA to give greater weight to economic considerations when identifying feasible control technologies for nontoxic pollutants. EPA has yet to develop guidelines for private-sector environmental technology R&D. OSHA's technology transfer authority is more limited: OSHA may not require major private-sector R&D efforts, but it may call for the diffusion of the latest techniques within any given industry whenever toxic or hazardous materials are involved.

The steel industry has reported EPA- and OSHA-related capital investments during the 1970's of about $365 million per year, or about 17 percent of its total annual capital investments. * These expenditures have placed greater limits on steel industry modernization

*These estimates have not been adjusted downward for regulatory overlap between agencies.

than has been the case with other basic industries. Annualized capital and operating costs for environmental requirements alone typically add between 4 and 6 percent to production costs.

EPA and OSHA regulations applicable to the steel industry will impose major capital investments and operating changes on the industry well into the mid-1980's because of statutory requirements. Federal projections of steel industry regulatory investments during the 1980's suggest only modest increases compared to the 1970's, while industry estimates suggest that average levels of regulatory investment would almost double between now and the mid-1980's. Differences between industry and Government projections result from differences in the assumptions underlying their estimates. Among the factors affecting future levels of regulatory investment are: facility replacement rate, expansion plans, technological choices affecting investment decisions, interpretation of regulations, the scheduling of regulatory investments, and broader industry trends with respect to profitability and shipments.

EPA data indicate that industrial development bonds (IDBs) have in the past been used for half of all environmental capital spending. Assuming this pattern continues, industry will need to generate from internal sources between $275 million and $400 million annually, in addition to similar amounts financed with IDBs to finance regulatory compliance through the mid-1980's. These expenditures are relatively modest compared to the massive total capital needs that the industry expects during the next several years.

The need for regulatory compliance has accelerated industry decisions to phase out and replace aging facilities. Thus, economic and regulatory forces have tended to reinforce one another to some extent. Regulatory policies have had the most severe impact on integrated plants, which have a high proportion of aging equipment and high production costs. The impact on nonintegrated electric furnace facilities has been less severe. These newer mills have a narrower and less complex range of processes to control, and most of their control equipment was designed for installation at the time of construction.

Recent regulatory reform initiatives may be more effective in encouraging steel industry development and use of improved regulatory technologies. EPA's "revised offset" policy may create difficulties for companies wishing to expand, because it requires high abatement investments in existing plants to offset future pollution increases for the new plant in the same region. The Agency's "bubble" concept could make facility replacement more cost effective, although some concerns remain about allowable tradeoffs between different types of pollutants generated in the same plant. Moreover, EPA's current "limited life facilities" policy may require some hard decisions about the continued operation of marginal facilities by the early 1980's. And finally OSHA appears to have a growing interest in using its authority to issue variances to standards for innovative purposes.

Introduction

The direct and indirect effects of EPA and OSHA regulations on the domestic steel industry are significant. In part this is because most of the process technologies the industry uses were developed around the turn of the century, at a time when awareness of the impact of industrial pollution on public and occupational health and safety was very limited. Pollution abatement and hazard reduction were therefore relatively minor considerations in the design of steelmaking equipment.

The steel industry is one of the largest sources of pollution in the Nation, with the integrated segment alone accounting for nearly

one-fifth of all domestic industrial pollution. The industry is increasingly coming into compliance. Nevertheless, more than half of the steel industry's operations but less than half of its plants are now in compliance with environmental requirements. * Steel mills present a wide range of environmental problems—conventional and harmful solid waste, excess liquids, gases, and noise. High-temperature water, zinc, manganese, lead, and suspended oil and grease also present major difficulties. Coke ovens, blast furnaces, and sinter plants in particular pose complex environmental problems because they emit sulfur dioxide, tar vapors, coal, coke, dust, and other organic compounds. The industry also has very high rates of occupational injury and illness, Steelworkers are exposed to a variety of harmful and toxic emissions (table 139), generally in much higher concentrations, more frequently, and for longer periods than is typical of the general population. [1]This results in high medical expenses, and high compensation payments for death and disability among the industry's half a million employees. United Steelworkers of America data indicate that

*For instance, 45 percent of domestic iron and steel facilities are out of compliance with air pollution control regulat ions. (EPA, Industrial Analysis Branch, letter to OTA, Mar. 18, 1980.)

'E. J. Calabrese, *Methodological Approaches to Deriving Environmental and Occupational Health Standards*, New York, Wilev, 1978, p. 223.

Table 139.—Occupational Health Hazards in Steel making

Operation	Contaminants	Medical condition
Coking	Coke oven emissions	Cancer and respiratory disease
	Heat	Heat stroke and heat exhaustion
	Silica	Silicosis
Byproduct	Benzene	Leukemia and lymphoma
	Coal tar pitch	Skin cancer
	Organic chemicals	Liver and nervous system damage
Blast furnace	Blast furnace gas	Carbon monoxide poisoning
	Iron oxide fumes	Siderosis
	Heat	Heat exhaustion
Steelmaking furnaces	Metal fumes	Possible cancer and siderosis
	Noise	
	Heat	
Molten metal pouring	Metal fumes	
	Heat	
	Lead	
	Fluorides	
	Asbestos	Asbestos is and masothelioma
	Silica	
Rolling mill	Noise	
	Heat	
	Oil mist	Nose and throat irritation
Steel conditioning	Metal fumes	
	Metal dust	
Pickling	Hydrochloric acid	Mucous membrane irritation
	Sulfuric acid	Mucous membrane irritation
		Chemical pneumonitis
		Heart disease
Maintenance	All hazards	
Galvanizing	Zinc oxide fumes	Metal fume fever
	Lead	
Forging	Noise	
	Heat	
	Oil mist	
Foundry	Silica	
	Heat	
	Noise	
	Oil mist	
	Organic chemicals	
	Metal fumes	

SOURCE Unifed Steelworkers of America, Safety and Health Department

131 deaths took place from August 1977 to December 1979 as a result of occupational hazards. Excess death rates have been reported for some phases of steelmaking. For instance, OSHA's final environmental impact statement (EIS) on coke ovens found an excess of over 200 cancer deaths per year among coke oven workers.

Industry's regulatory obligations have emerged during a period of declining competitiveness on the international steel market (see ch. 4). The U.S. share of the world export market has declined during the past decades, while imports have grown in volume. The industry's most recent modest expansion took place during the early 1960's, and a large number of domestic plants are now relatively old, small, and inefficient. Projected capital requirements for regulatory compliance are a relatively small portion of total capital needs for the next decade (see ch. 10), but the industry's capital shortfall affects its efforts to meet regulatory compliance goals as well as its larger modernization programs.

Dealing effectively with the particular hazards that accompany steelmaking raises many issues concerning: 1) the development and costs of fundamentally new regulatory technologies, and 2) the interaction between Government regulations and the operation and modernization of the industry. It may not always be possible to carefully distinguish R&D for regulatory compliance from other R&D efforts, capital investments for compliance from other capital investments, and, innovations due to regulation from other innovations. In addition, comprehensive and verifiable cost data are not always available.

Consider also the following interconnected factors. The goal of Federal regulatory policies is to encourage the development and use of improved abatement or process technologies. Limited replacement and modernization of facilities, however, may make the development of new technologies more difficult. Federal economic and regulatory policies have a major influence on industry's levels of both capital spending and operating costs for modernization and compliance. On the other hand, a vigorous replacement and modernization program might make newer, more cost-effective compliance options available, thereby lowering those costs. In short, broader trends of industry operation and profitability, as well as Federal tax, trade, and pricing policies, have major impacts on both the development and the adoption of new regulatory technologies by the steel industry. Thus, Federal environmental and occupational hazard regulations are contributing factors rather than forces singularly affecting and affected by industry modernization.

Statutes That Regulate Steelmaking

Summary

EPA regulations are based on a number of specific statutes, while OSHA is guided by general authorizing legislation rather than a series of specific statutes. Compared to current investment levels and industry practices, major regulatory technology investments and operating changes will have to be made from now until the mid-1980's to meet requirements of the Clean Air Act, the Federal Water Pollution Control Act, and the Resource Conservation and Recovery Act. The OSHA Act also imposes certain requirements, but their impacts have been limited so far and their future impacts are uncertain, in part because of regulatory overlap.

A growing number of regulatory standards applicable to the steel industry are technology based. This allows industry some flexibility and encourages innovation in complying with the regulations. Vigorous industry innovation has not yet been attained, however, in part because the economic incentives appear limited relative to potential benefits for companies considering abatement R&D. Recent regulatory reforms such as EPA's "bubble"

policy, attempt to incorporate economic incentives in regulatory measures. OSHA's authority to issue variances to standards could perhaps also play a greater role in technology development aimed at improved or cheaper regulatory compliance. In addition to standards that encourage new technology, EPA and OSHA also have the authority to "force new technology" when toxic or hazardous pollutants are involved. EPA's approach allows for the diffusion of the latest environmental technologies between industries while OSHA may call for the transfer of promising new technologies within or between industries such as steel.

Questions of economic and technological feasibility have been of great concern in developing standards. Compared to its earlier actions, EPA must now give greater weight to economic considerations. OSHA must narrowly consider the technological feasibility of proposed standards. Both agencies have to assess economic impacts of proposed major regulations in compliance with Executive Order 12044.

Statutes

The basic policy framework for steel industry regulation is provided by several statutes, particularly the Clean Air Act (CAA) and the Federal Water Pollution Control Act (FWPCA). CAA and FWPCA will continue to have considerable impact on steel operations at least until the mid-1980's, when high-performance abatement technologies or in-process changes will have to be installed. EPA's Resource Conservation and Recovery Act (RCRA) and the OSHA Act will also have a growing impact on existing steelmaking technologies.

EPA has an ongoing process of promulgating air emission standards for specific steelmaking processes in order to adequately protect public health and property as required under CAA. The Agency is also in the process of revising steel effluent guidelines for the regulation of waterborne pollutants so that all pollution may be eliminated from navigable waters by 1985, as required by FWPCA.

RCRA also is of growing importance to the steel industry. This statute directs EPA to regulate the disposal of hazardous solid waste, and final steel industry guidelines have only recently been promulgated. This legislation may become the major impetus towards increasing the steel industry's use of recycling and other in-process changes that reduce the volume of solid, hazardous waste it generates.

OSHA's principal responsibility is to ensure safe and healthful conditions in the workplace. OSHA is guided by general authorizing legislation embodied in the Occupational Safety and Health Act of 1970 rather than by a set of specific statutes, as is the case for EPA. The OSHA general duty clause, hazard-specific standards, and judicial interpretations are the basis for most OSHA compliance requirements applicable to the steel industry. Specific OSHA standards having an impact on the steel industry include those concerning sulfur dioxide and machine guarding. The fire and electrical codes are also significant. However, OSHA's impact on the steel industry has thus far been rather limited because its major standards are narrower and more recent than those of EPA. The coke oven standard, for instance, has only been in effect for a short time, * and a number of others are not yet fully operational, including the benzene standard and the proposed noise standard.** Some future impacts of OSHA standards have already been felt, to varying degrees, under environmental regulations that apply to the same steelmaking processes, as in the case of the coke oven standard.

EPA and OSHA performance standards are technology based to the extent this is possible. Such standards identify demonstrated control technologies and, to a lesser extent, in-process changes that are capable of meet-

*The final coke oven standard, promulgated in 1976, did not become enforceable until January 1980 because of extended litigation.

** The benzene standard is being contested by a number of industries. The interim noise standard is based on voluntary industry standards and OSHA has actively considered revising this and other interim standards.

ing minimum abatement levels. CAA and FWPCA call for three types of standards that vary in degree of stringency. Steelmaking facilities not emitting hazardous pollutants generally must be equipped with environmental technologies capable of meeting low- and medium-stringency levels in existing and new plants, respectively. Any steelmaking facilities or point sources emitting hazardous pollutants must be equipped with the high-stringency, high-performance environmental technologies. Compliance schedules for the two lower stringency standards were set for the late 1970's, and standards regulating hazardous pollutants will have to be met by 1982-83.

OSHA's approach is similar to EPA's in that it also requires more stringent performance levels for new facilities and for all existing point sources emitting hazardous pollutants. Specification standards, commonly adopted at the outset of the OSHA program, are now being revised to provide industry with greater flexibility in attaining compliance. Recent OSHA standards have generally been of the performance type. It is OSHA's view that the rigidity of existing specification standards is frequently overstated. Section 6(d) of the OSHA Act enables employers to obtain a variance from any standard. Such variances allow employers among others to select innovative means while providing for optimum employee protection as required by the standard. Such variances may apply to a single location or they may be extended to all employers within an industry, as in the case of a soon-to-be published variance dealing with arsenic and lead exposures in the automobile industry.

EPA has the responsibility of stimulating private-sector development of innovative process or control technologies that will result in greater pollution abatement or lower cost systems. To encourage the diffusion of new technologies, EPA may call for one industry to share an equipment development it uses if that equipment can be applied effectively in another industry. [2] When calling for the transfer of such technology, EPA must keep in mind a proper balance between health impacts and questions of economic and technological feasibility.

The OSHA Act has given OSHA the general authority to require industry implementations of regulatory technology that is "looming on the horizon."[3] If forcefully implemented, this approach could have the effect of stimulating the development of technologies capable of improved or cheaper performance whenever hazardous substances are involved. The scope of OSHA'S major technology-forcing mandate applicable to steelmaking is now being considered for review.

Feasibility of Standards

Industry feels that both EPA and OSHA have gone too far with their technology-based standards,[4] and its objections, often presented before the courts, are generally based on considerations of technical or economic unfeasibility. The American Iron and Steel Institute (AISI) and individual companies have challenged a number of standards, including those governing water pollution and the OSHA coke oven standard. The statutes originally appeared to have given EPA greater latitude than OSHA with respect to technological and economic requirements for the control of toxic or hazardous pollutants; subsequent court interpretations, however, seem to have reduced the authority of both agencies.

In general, EPA now has to give greater prominence to economic considerations, although it may still require technology transfer between industries. OSHA, on the other hand, now has narrower authority over the stimulation of technological innovations that reduce occupational risks. OSHA is considering to promulgate an interpretive field memorandum governing the steel industry that could place constraints on OSHA's ability to require major R&D efforts for improved coke

[2] Suggested in-process changes do not have to be common industry practice whenever toxic pollutants are involved. (EPA, office of the General Counsel, letter to OTA, Nov. 30, 1979.)

[3] OSHA Act, Public Law 91-596, sec. 6(b)(5),

[4] AISI, letter to OTA, November 1979.

oven compliance, EPA notes on the subject of feasibility that:

> Although the Court rejected all challenges to the technical and economic feasibility of the BPT [best practicable technology) limitations, it held that certain BAT (best available technology) and NSPS (New Source Performance Standards) limitations were "not demonstrated. " In addition, the Court remanded all of the regulations because, in its view, EPA had not adequately considered the impact of age of plants on the costs or feasibility of retro-fitting controls, or the impact of the regulations on water scarcity in arid and semi-arid regions of the country.[7]

Commenting about court review of steel-finishing effluent guidelines, EPA notes:

> Here again, the Court rejected all challenges based on technical feasibility. But here, too, the Court held that EPA had failed to adequately consider the age/retrofit and water scarcity issues. In addition, the Court held that the agency had failed to adequately consider ''site-specific' costs and the economic posture of the industry. (However,) the Court's remand was not based on the severity of economic impacts, but on the ground that EPA promulgated the regulations on the basis of a draft economic analysis.'[7]

Thus, while EPA's authority over questions of technological feasibility has been generally unchanged, * these and other court cases have given greater prominence to economic issues and local concerns.

State agencies can be more responsive to local concerns than EPA, because they have greater latitude than EPA to consider the economic or technological implications of environmental requirements affecting specific plants in polluted areas, For instance, in the past few years a number of States have granted variances to individual steel plants solely on the basis of economic burden or technological feasibility, while still planning to meet statewide goals for improved environmental protection. The role of State governments in regulating steel plant construction will probably expand in response to a June 1979 Federal court decision, while EPA is likely to be excluded from reviewing construction standards for smaller emitting sources.

OSHA considers both economic and technical feasibility when developing proposed standards. When several court rulings indicated that OSHA was not limited to issuing standards based solely on devices already fully developed,' OSHA interpreted the rulings as enabling it to "force industry to develop control technology whenever quick action is needed to regulate worker exposure to toxic and hazardous materials."[8] The steel industry, concerned about OSHA's ability to require industrial development of new technologies as a means of improved compliance, initiated its own court challenge to the concept. In a 1978 case, the court invalidated OSHA's R&D requirement for coke oven engineering and work-practice controls with respect to fundamentally new technologies.[9]

As a result of the appeals court decision, OSHA will not place an industrywide requirement on steel companies to research and develop new technology for improved compliance with the coke oven standard. Instead OSHA will require controls for noncomplying batteries in addition to those specified in the standard as necessary and feasible for individual batteries. This may require the use of additional controls that have been shown to be potentially adaptable to individual batteries being considered, OSHA is now preparing an interpretative field memorandum which may indicate that it can request of steel firms

[7]EPA. Office of the General Counsel, letter to OTA, Nov. 30, 1979. p. 7 (basic steel effluent guidelines].

[8]Ibid.

*Informal comments from within and outside EPA occasionally suggest that the Agency has not yet vigorously pursued its "technology forcing" mandate. For related comments, see "Limited Private and Public Sector Effects, " p. 34o.

'Society *of* Plastics industries v. Occupational *Safety* and *Health Administration,* 509, F. 2d 1302, 1309 (1 975); *American* Federation *of* Labor v. *Brennan,* 53o F. 2d log, 131 (1975): American Iron *and Steel institute v. Occupational Safety and Health* Administration, 577 F. 2d 825,830-839 (1978).

"W. Grover, ''OSHA Now Technology-Forcing Agency,"' Occupational *Safety* and *Health* Reporter, p. 453.

[9]The court also noted that the steel industry had not made sufficient effort to make use of already operating technologies. (*AISI* V. *OSHA,* 577 F. 2d 825,834-835 (1978).)

incremental improvements in engineering and work-practice controls applicable to particular batteries without requiring major R&D efforts.[10] As a result of these and other challenges to its technology-forcing powers, it appears that OSHA'sauthority to require major private sector R&D efforts aimed at improved compliance with the coke oven standard now has been reduced. [11]

It is conceivable that in the long term EPA could play a stronger role than OSHA in stimulating new technology when worker protection from toxic materials is at stake. Only EPA, under narrowly specified conditions described in the 1976 Toxic Substances Control Act, can require a firm to discontinue use of toxic or hazardous materials. The need to substitute alternate raw materials could, under certain conditions, stimulate new process design and the development of safer substitute materials and processes.

OSHA'sinfluence over regulatory cost impacts may also be changing. Thus far, OSHA standards have been judged economically infeasible only if they are likely to cause serious disruption of an industry. But standards may be deemed economically feasible even though they are financially burdensome, reduce profitability, or affect the continued viability of individual companies.[12] In order to enforce a greater consideration of macroeconomic issues by OSHA, the petroleum industry has sued OSHA, asking that cost-benefit analyses be required for major proposed regulations such as those concerning benzene. The steel industry joined the petroleum industry as one of six co-parties in this case. Industry argues that provisions analogous to risk assessment or cost-benefit analysis are found in most environmental statutes (including the OSHA Act), that most regulatory agencies undertake such analysis of major proposed regulations, and that OSHA should therefore do the same by identifying the tradeoffs between employee protection and regulatory cost impact when developing standards. The Supreme Court is now considering an OSHA appeal, which argues that the petroleum industry view is incorrect as a matter of both statutory mandate and policy. OSHA does not accept the assumption that costs and benefits from regulations are comparable since human life and health do not have an applicable dollar value.

Innovation

The premise underlying technology-based performance standards is that they provide an incentive to innovation by identifying, rather than prescribing, technologies capable of attaining specific standards. Such innovation, in turn, could help lead industry to use improved or cheaper regulatory technologies. EPA and OSHA have therefore been concentrating on technology-based performance standards. Performance standards are periodically reviewed with the objective of revising allowable emission limits in cases where improved abatement or process technologies have been developed during a given time frame.

Despite their inherent flexibility, however, performance standards alone do not appear to have been an effective mechanism for encouraging industrial innovation of regulatory technologies. Instead of encouraging the development of new technologies, performance standards may actually encourage the risk-averting strategy of adopting technologies that qualify under the technology-based limits established by the agencies. At that point there is no further incentive for the private sector to develop new technologies that might make possible more effective—or even cheaper—environmental compliance. '3

The following findings illustrate the limitations of the innovation incentives that performance standards have provided in prac-

[10] "Discussion with OSHA staff in the Office of Field Coordination, Feb. 22, 1979.

[11] " Occupational Exposure to Lead, " Federal *Register*, *Nov.* 21, 1979, pp. 54474-54475,

[12] Industrial Union Department, AFL-CIO v. *Hodgson*, C.A. D.C. 1974: 499 F. 2d 467; USCA 29655 (notes of decisions). See also OSHA legislative history.

13A, Merrick III, Freeman, The *Benefits of* Environmental Improvement: Theory and Practice, Resources For The Future, Johns Hopkins University Press, 1979, pp. 56-57.

tice. A comprehensive 1977 review of EPA effluent standards concluded that industry installed abatement technologies equivalent to EPA-suggested technologies, rather than new equipment specifically designed for further improvements in compliance.[14] New technology development has also been rather slow in the area of occupational hazard reduction. For instance, OSHA's forthcoming requirements for new coke ovens are expected to be similar to those for existing batteries because there has been so little subsequent development* of new control technologies.

It is possible that recent regulatory reform initiatives will provide supporting incentives needed to more effectively encourage private sector innovation. But only a thorough review of the application of these reforms over time can provide documentation concerning their full impact on the development of new technologies. Some of these reforms, such as EPA's bubble approach and the offset policy are expected to provide economic incentives that conventional regulations appear to be lacking. They give industry the flexibility to select the least costly measures for pollution abatement.[16] OSHA also has some regulatory flexibility by means of variances that may be issued to applicable standards under certain conditions. The first major industrywide variance to a standard is expected to be issued shortly to the automobile industry. Procedures may need to be developed for variances specifically aimed at new technology development. Variances could be issued on a case-by-case-basis. Another approach would be to consider the issuance of industrywide innovation variances based on steelmaking equipment replacement cycles. If properly applied and supported by economic advantages, variances also might provide more effective innovation incentives than some of OSHA's prevailing regulatory approaches.

[14] "National Commission on Water Quality, staff report PII-68, 1977.

*Incremental improvements such as magnetic lid lifters and water-sealed sandpipe caps have been developed during this time.

[15] "Discussion with OSHA staff in the Office of Field Coordination, Aug. 13, 1979.

[16] EPA, "Proceedings: First Symposium on Iron and Steel Pollution Abatement Technology," Interagency Energy/Environmental R&D Program report, Chicago, Ill., 1979, p. 11.

Conclusion

Statutory requirements administered by EPA have imposed definite compliance schedules requiring major steel industry investments through the mid-l980's. The industry is also faced with a growing number of OSHA-administered compliance schedules. These have been set administratively, however, and reasonably could also be changed at that level,

Although the development of cheaper and more effective control technologies is an important goal, there has been little such activity because of limited economic incentives. Instead, in order to reduce private-sector engineering and development work, industry has focused its attention on the adoption of available regulatory technology. As part of its cost-cutting goals, the steel industry has developed a strong interest in cost-benefit analysis of proposed technical standards that regulate steelmaking processes. A pending Supreme Court decision should help resolve this issue. Recent regulatory reform initiatives may be a first step towards more effective innovation incentives made available to the industry.

Pollution Abatement R&D

Summary

Congressional interest in R&D for regulatory technology and less polluting steelmaking processes stems from growing concerns about the cost effectiveness of regulatory requirements and about environmental and occupational health hazards. There is a belief that new, high-performance regulatory or cleaner process technologies will also create

additional flexibility for economic growth in heavily polluted regions by making attainment of environmental standards more feasible. *

In addition to improving production efficiencies, several major new steelmaking processes reviewed in this report are also less polluting than complementary or substitute conventional technologies. Pollution abatement is brought about either directly through reduced energy or raw materials use or indirectly through reduced discharges. Cleaner steelmaking technologies still in various stages of development and adoption include: continuous casting, coal-based direct reduction, direct casting of sheet and strip, formcoking, and electric furnace steelmaking.

Of the major technologies considered in this report, formcoking and electric furnace steelmaking have been affected most by Federal encouragement. The former primarily by means of DOE support and the latter mainly by EPA and OSHA. In general, however, Federal agencies have had a greater impact on incremental rather than on fundamental technology change. Modest technological improvements have tended to result from the initial "push" provided by Federal regulations. Examples include: pushing emission controls and improved door seals for coke ovens. Developmental work, induced by regulations, is still underway in areas such as biological treatment of coke oven plant waste and basic oxygen furnace (BOF) fugitive emissions control technology. However, private sector efforts to make abatement still cheaper or more effective, have generally not been widespread or successful once standards have been in existence for some time. For instance, nonfugitive emissions control technology for BOFs has not changed significantly during the past 5 years. [17]

*New facility construction can be most readily accommodated when regional environmental standards have been attained. OSHA does not have the authority to approve industry construction plans for regulatory impact, Thus, regional economic growth potential is not directly affected by OSHA policies.

[17] Ibid., p. 39.

The steel industry estimates it now spends about 15 percent, or $75 million, of its annual R&D budget on environmental matters. EPA supports only a small amount of regulatory technology R&D, and OSHA maintains no program in this area. Applicable statutes imply that the private sector is primarily responsible for regulatory technology development, although these responsibilities are not specified. The steel industry believes the responsibilities should fall mainly on equipment suppliers, but it also contends that already available technology can deal adequately with virtually all environmental problems. The agencies argue otherwise.

There are some major problems affecting regulatory technology R&D, including: unclear EPA directives regarding private-sector R&D, an emphasis on costly "end-of-line" technology, inadequate regulatory incentives, including lack of economic incentives.

Limited Private and Public Sector Efforts

Regulatory technology RD&D is aimed at developing improved control systems or in-process changes that will make steelmaking processes environmentally or occupationally less hazardous or that will reduce the cost of compliance with Federal requirements. The steel industry has conducted regulatory technology research for many years, but it is difficult to ascertain how much work has actually been done. A limited amount of environmental technology research is underway in company laboratories and in an AISI-sponsored program.[18] Informal 1979 AISI data would suggest that about 15 percent of steel industry R&D expenditures are devoted to pollution abatement projects. With about $500 million of steel R&D per year, this would amount to about $75 million annually for regulatory R&D by the steel industry. It is difficult to quantify the extent of this research, however, because often it is connected with

[18] During the past 5 years, the cost of the AISI program has averaged about $600,000 per year, AISI letter to OTA, November 1979.

other process development projects. A considerable portion of industry environment R&D appears to involve engineering work. Thus, actual environmental technology R&D undertaken by the steel industry is likely to be significantly less than $75 million annually. A small amount of OSHA-stimulated research is undertaken in universities, by industry, and by the industry-sponsored Industrial Health Foundation, which concentrates on technical assistance to industry.

The industry feels that pollution control equipment makers have first responsibility for new regulatory technology development. Furthermore, industry contends that, with the exception of a few technically complex situations such as coke oven controls, technology already exists to handle steel's environmental problems.[19] Recent EPA studies, on the other hand, suggest an overwhelming need for environmental technology R&D covering a variety of steelmaking processes.

> virtually every process in the iron and steel industry currently requires environmental technology R&D to either improve the level of control, lower the costs or both. The most significant concerns are for cokemaking, blast furnaces and basic oxygen furnaces. Continued assessment of discharges from the various steelmaking processes are urgently needed to uncover hazardous and toxic situations that need applications of controls or RD&D if controls are not available.[20]

The Federal Government plays a limited role in regulatory technology development for steelmaking, OSHA offers technical support to other agencies and individual companies concerning the feasibility of engineering controls necessary for compliance.[21] OSHA has the general authority to conduct or sponsor research and demonstration projects relating to innovative techniques for dealing with occupational safety and health problems. * However, OSHA's interpretation of the legislative history accompanying its authorizing statute is that Congress did not give OSHA a substantial mandate for regulatory technology R& D.* This consideration, along with budget constraints, appears to have been responsible for the lack of an OSHA regulatory technology R&D program, EPA, on the other hand, does undertake and sponsor some environmental technology R&D, Since fiscal year 1976, EPA has provided slightly more than $500,000 annually on a cost-sharing basis with the industry for improved environmental controls, largely for coke ovens. The Agency also cosponsors with AISI a very modest R&D program.[22] However, EPA does support a larger amount of industrial environmental technology R&D that is applicable to the steel industry.

The electric utility industry and pollution abatement equipment manufacturers have developed regulatory technologies, such as ''scrubbers, that are now being used by the steel industry. Foreign steel industries, particularly in Japan, also have developed several advanced control technologies. EPA currently has a foreign technology evaluation project underway to identify potential applications in the domestic steel industry. Technologies being evaluated include control of fugitive air emissions from the BOF, control of wastewater from coke plants and blast furnaces, and general identification of technology to increase recycling or reuse of materials. EPA has already identified some exemplary technologies and will support engineering work to determine domestic applicability; findings and cost evaluations are expected in 1980.[23]

Constraints Affecting Regulatory Technology R&D

Regulatory technology R&D conducted by or for the steel industry suffers from several

[19] Ibid.
[20] EPA, Industrial Environmental Research Laboratory, Metallurgical Processes Branch, letter to OTA, Nov. 13, 1979.
[21] OMB, U.S. *Budget* for FY *1979*, p. 656.
*29 U.S. Code 669,
*Discussion with staff at the OSHA Office of Solicitors. June 2, 1980.
[22] This program has been funded during the past 4 years at approximately $150,000 annually. (Nov. 13, 1979 EPA letter to OTA.)
[23] EPA, Industrial Environmental Research Laboratory, Metallurgical Processes Branch, letter to OTA, Nov. 13, 1979.

weaknesses, including limited policy guidance on private-sector R&D, emphasis on "end of the line" (EOL) control technologies, and lack of economic incentives.

Limited Policy Guidance on Steel Industry R&D.—Although EPA has the authority to stimulate the development of innovative environmental technologies, the Agency does not have any guidelines detailing what circumstances call for steel industry environmental technology R&D. This option could be used whenever available technologies are inadequate for meeting new facility standards or controlling toxic pollutants. OSHA, as a result of its 1978 AISI court case, does have clear policy guidance. OSHA's "technology forcing" policy concerning coke ovens is now limited to the diffusion of marginal technological improvements within or between industries; this decision could set a precedent for other OSHA "technology forcing" regulations.

Emphasis on EOL control technologies.— Both EPA and the steel industry concentrate their R&D programs on EOL technologies that capture pollutants produced by existing processes, rather than technologies that modify the processes so that they produce less pollution in the first place. Very little work has been done on major "changes in process" (CIP), such as recycling, alternative uses of water, and materials recovery from wastewater streams. Limited steel industry replacement and expansion activities also direct industry interest towards available retrofit technologies.

The prevailing EOL orientation is reflected in pollution abatement capital expenditures. From 1973 to 1977, the industry reported spending on the average only 5 percent, or $25 million, of its pollution abatement funds on CIP equipment (table 140). Compared to EOL technologies, CIP equipment leads to more cost-effective environmental control because more efficient use is made of raw materials and waste products, but often it also calls for more technologically complex changes. Furthermore, CIP equipment is most efficiently installed at the time of plant construction. But the slow pace of steel industry modernization and expansion has been a major constraint on the pursuit of this more cost-effective abatement approach. Industrial groups have argued that EPA exceeds its statutory authority whenever it considers in-process modifications. Nevertheless, the growing concern about toxic pollutants is likely to lead to increased research and investment in CIP technologies. *

One area receiving even less attention than CIP research is the development of process alternatives. ** For instance, EPA has not yet

*EPA's fiscal year 1980 environmental research budget was doubled to almost $12 million to support a greatly increased industrial wastewater program.

**Concerned about EPA's concentration on immediate problems, and responding to National Academy of Sciences and OTA findings, Congress directed EPA for the first time in 1977 to allocate 15 percent of each R&D program to a separate long-term environmental R&D program.

Table 140.—Air and Water Pollution Abatement Expenditures as Reported by the Basic Steel Industry, 1973-77 (millions of dollars)

	Air				Water				Air and water			
	Total	EOL	CIP	CIP%	Total	EOL	CIP	CIP%	Total	EOL	CIP	CIP%
1973 .....,	$142.0	$110.5	$31.3	22.18	$ 58.4	$ 54.1	$4.3	7.4	$200.4	$164.6	$35.8	17.86
1974	179.2	155.9	23.3	13.0	105.3	101.7	3.6	3.41	284.5	257.6	26.9	9.47
1975	302.5	295.2	7.3	2.41	279.0	17.5	2.8	1.0	581.5	312.7	10.1	1.73
1976	339.7	325.1	14.6	4.29	301.9	26.4	7.3	2.41	641.6	351.5	21.9	3.41
1977	317.5	302.9	14.7	4.62	283.4	29.9	3.1	1.09	600.9	332.8	17.8	2.96
Annual average (1973-77) . .	256.18				217.28							

NOTE: EOL—end-of-llne methods, involvlng the separation, treatment, or reuse of pollutants after they are generated but before they are emitted from the firm's property. CIP—changes.in-process methods, involving the modification of existing production processes or the substitution of new processes to reduce or eliminate the pollutants generated

SOURCE. U S Department of Commerce, Bureau of the census, *Current Industrial Reports Pollution Abatement Expenditures, 1973.77,* (table 2A)

issued air performance standards and cost-impact analyses for the promising new technology of continuous casting. OSHA does not have a strong long-term regulatory research program either: although it has encouraged small improvements in coke oven control technologies, * it has not actively considered less hazardous processes that could reduce industry's dependence on cokemaking. The limited initiatives that have largely been taken in this area have been taken by EPA, whose regulatory actions have tended to reinforce presently available options, such as the electric furnace as a partial replacement of coke-based steelmaking, rather than fundamentally new processes,

Until last year, the National institute for Occupational Safety and Health (NIOSH) did not undertake any evaluation of emerging technologies,** even though the Institute has a clear mandate to explore the safety and health implications of new process technologies.[24] During 1977 congressional testimony, NIOSH representatives discussed attempts to strike a balance between short- and long-term research in support of future standards development. NIOSH 1980 program plans indicate that a number of new technologies will be assessed.[25]

EPA also has started a modest anticipatory R&D program aimed at exploring the environmental impacts of fundamentally new process technologies. For instance, EPA has evaluated coal-based direct reduction (DR) and concluded that pollution abatement capital costs are one-third less and operating costs one-fifth less than for the conventional coke oven-blast furnace-BOF-hot metal route. Recirculation of fuel gas is expected to bring about even lower pollution levels compared to conventional DR processes. The environmental cost advantages of coal-based DR steelmaking result mainly from reduced water pollution problems. Reducing steel industry reliance on coke ovens by increasing the use of electric arc furnaces (EAFs) involves process changes that can make a major contribution to the lowering of pollution levels .2'

In continuing support of anticipatory research, EPA noted in its 1979 Research Outlook that:

> EPA research to examine the mineral problem must shift from a focus on existing mineral processing industries to evaluations of new technologies and the corresponding development of environmentally sound control approaches.

Perhaps even more significantly, the Agency added that:

> In the long term, environmental criteria must become an inherent part of a design of new methods and technology for minerals production.

Companies, such as 3M in its "Pollution Pays" program, strongly advocate the integration of regulatory criteria into the investment decisionmaking process. This approach could also be considered by the steel industry because potential cost-saving advantages are associated with the timely consideration of regulatory requirements in investment planning.

EPA now supports limited R&D aimed at evaluating substitute pollution control methods or "cleaner" steelmaking processes. Nevertheless, neither EPA nor OSHA are in a strong position to encourage steel industry demonstration or use of these new steelmaking technologies. Industry is already concerned about regulatory consideration of in-process changes; even greater resistance

*EPA's role has been equally—or more—important in this area, in part since the Agency has a longer history of enforceable steel industry regulations.

**Some work is now underway on new energy technologies, but no long-term research has been proposed by NIOSH on emerging steelmaking technologies.

[24]The OSHA Act directs NIOSH to undertake special RD&D related to occupational safety and health as is necessary to explore new problems, including those created by new technology in occupational safety and health, which may require ameliorative action beyond that which is otherwise provided for in the operating provisions of the Act, (OSHA Act, Public Law 91-596, sec. 20(a)(4).)

[25]Discussion with Dr. John Froines, deputy director, NIOSH, Aug. 22, 1979.

[26]The EPA-sponsored report (600/ 7-76-034C) compares coal-based DR/EAF steelmaking with the conventional alternative coke oven-blast furnace-BOF route, American *Metal* Market, Oct. 2, 1979.

could be expected should regulatory agencies also actively encourage the industry to adopt new process technologies.

Limited Economic Incentives.—Perhaps the most important barrier to regulatory technology development by the private sector is the lack of strong economic incentives. Available regulatory incentives, in and of themselves, have been insufficient to encourage low-profitability industries to innovate in environmental technology. These incentives, developed during the early 1970's, provide for extended compliance in existing plants or temporary waivers for new plants that will incorporate innovative technologies.[27]

Unlike EPA, OSHA is not bound by statutory deadlines, and it can set compliance deadlines adminstratively, taking into account factors such as occupational risks, industry economics, and technology development. The coke oven standard, for example, provides for delayed compliance schedules on the basis of economic feasibility. Once deadlines have been set, however, OSHA may only issue variances to specific operations that need time to respond to material, equipment, or staffing problems.[28] Although innovation is not specifically identified, it could perhaps be subsumed under the allowable category of equipment problems. Thus far, however, the steel industry has not actively responded to available regulatory incentives like deadline extensions. During the past few years, the steel industry has only submitted two proposals to EPA for innovative controls in existing plants; EPA did not approve these proposals because similar control technologies were already being used by other industries.

It is clear that the temporary waivers and deadline extensions are not attractive enough to induce companies to assume the technical, financial, and strategic risks involved in innovating. The only cost protection EPA's innovation incentives provide to participating companies is to free them from noncompliance penalties of up to $25,000 per day while demonstration work is going on. Neither EPA nor OSHA legislative mandates provide regulatory guarantees or financial support should the innovative approach fail to meet regulatory requirements. There is also a strategic mismatch between potentially broad economic and environmental benefits resulting from successful innovation and the limited private gains to be made by the innovative firm. Under these circumstances, investment in such innovation may promise too much risk and too little profit from a private point of view. The low rate of new facility construction and replacement is also a major constraint on the development of improved regulatory or process technologies. Without effective public-private risk sharing, there is little incentive to bring new technologies online.

Conclusion

The steel industry has only a limited environmental R&D effort, a considerable portion of which appears to be devoted to engineering work, and Federal R&D is also very limited. Applicable statutory provisions for regulatory incentives designed to stimulate the development of improved and cheaper regulatory technologies have not been very successful, thus far, with the steel industry. A number of applicable technologies have been developed by foreign steel industries or other domestic industries such as the electric utility industry, Several process modifications and alternatives hold considerable promise for reduced pollution. Increased incentives for R&D and innovation, perhaps including public-private risk sharing, may be needed to bring these technologies online.

"The Clean Air Act gives EPA the authority to extend compliance of existing mills by 5 years ("delayed compliance order") to allow for the demonstration of improved or cheaper control technologies. For new facilities demonstrating innovative process or control technologies, EPA may grant variances from applicable standards for up to 7 years (innovation waivers). Should the new system fail during this time, the Agency will grant an additional temporary compliance waiver to give the company time to install conventional controls. For innovative water pollution abatement technology, EPA is authorized to issue a 3-year waiver for innovative production or control technologies having the potential of industrywide application for companies wanting to replace existing production capacity. There do not appear to be any regulatory incentives for retrofitting existing plants with innovative control technologies. (Public Law 95-95, sec. Ill(j), l13(d)(4); U.S. Code and Admin News, legislative history of Public Law 95-95, p. 1276; U.S. Code and Admin News, Public Law 95-217, p. 4375.)

[28] U. S. Code Annotated 29, subsec. 655(d), Labor—Safety and Health, "Variances From Standards."

Regulatory Cost Impacts

Summary

EPA and OSHA regulations affect modernization and competition most directly by imposing additional capital requirements and increasing production costs. However, it is difficult to measure the extent of these burdens; data availability is a problem. During the 1970's, the steel industry reported spending on average 13.1 percent, or $280 million, of its annual capital investments for environmental compliance and about 5.8 percent, or $85 million, of its annual capital investments for industrial health and safety purposes. Actual spending levels have been lower than for several other industries, but the opportunity cost of regulatory requirements vis-a-vis industry modernization has been higher for steel because of its relatively low total capital spending. Annualized capital, operating, and maintenance costs for environmental requirements presently add between 4 and 6 percent to production costs.

Regulatory cost projections are based on considerable uncertainty. Available cost-impact studies generally show different costs for the same proposed regulatory requirements. Federal agencies have estimated that EPA and OSHA capital costs for air, water, and coke oven compliance will total approximately $550 million annually until the mid-1980's, while AISI has estimated total regulatory capital costs at $800 million annually.[29] Reliable cost estimates may not become available until just prior to implementation of standards, when requirements will be final and qualifying control technologies will be known. Furthermore, cost savings resulting from improvements in regulatory technologies may not occur until after the standards are promulgated. A recent EPA report underscores the point that steel industry expenditures for abatement equipment are generally less than was expected on the basis of projections. The increase in production costs as a result of environmental capital and operating costs is expected to remain rather stable, ranging between 4 and 6 percent. About 48 percent of regulatory capital costs have in the past been financed through IDBs. Assuming a similar pattern in the future, between $275 million and $400 million will need to be generated annually outside the bond market for investments in regulatory equipment.

Past and Current EPA and OSHA Compliance Costs

There are several series of data for steel industry reported capital expenditures on regulatory investments. The Department of Commerce and AISI have series relating to environmental equipment, and McGraw-Hill has one reflecting investments for occupational health and safety equipment. All these sources depend on industry data. Reporting procedures suggest that costs be allocated on the basis of the productive or regulatory function the equipment serves, in an effort to limit the data base to purely regulatory investments. No attempt is made to differentiate investments required by statute from those made voluntarily or to differentiate investments made in response to more than one regulatory requirement. when these series are adjusted for differences in industry definition, the environmental expenditure reports are fairly similar, with the AISI data conforming most closely to the OTA definition of the steel industry.

Industry reported that annual capital investments for required environmental investments during the 1970's averaged 13.1 percent, or $280 million, of total capital spending. pollution control investments have gradually increased, particularly since 1975. In 1978, the steel industry reported that environmental capital spending was about 18 percent, or $450 million, of total capital invest-

NE PA, The Cost *of Clean Air* and *Clean* Water, report to Congress, 1979; D.B. Associates, Economic *Impact of* Coke Oven Standards, vol. 1, report prepared for OSHA, 1975. Federal estimate is not adjusted downward for possible regulatory cost overlap; industry estimate includes a much broader range of regulations than Federal estimate.

ment (table 141). Assuming that half of the environmental investment was financed with IDBs, about $225 million, or 9 percent, of total capital spending must have come from internally generally funds, loans, or stock offerings. * Environmental capital expenditures seem to have been more burdensome for steel than for other major polluting industries. The chemical, petroleum, and electrical utility industries spent no more than about 10 percent of their total capital investment on pollution abatement during the 1970's (table 142). Relatively higher regulatory spending may to some extent have affected steel's profitability and limited its capital spending for modernization and R&D.

EPA and OSHA regulations, along with their impacts on capital requirements, have led to changing employment requirements. When extra workers are needed for the operation of retrofit equipment, labor productivity tends to decline. In other instances, mainly when less polluting substitute technologies such as continuous casting or electric furnaces are involved, labor productivity increases and there is a decline in the total number of employees. A second employment effect is of a distributional nature. If a plant closes down, perhaps in part because of regulatory requirements, employment will decline in the affected area. This decline may be offset by production increases in other steel companies, unless the output of the closed

*Data provided by the EPA Office of Planning and Management suggest that the steel industry has in the past financed close to half of all pollution abatement investments with IDBs,

Table 142.—Pollution' Abatement Investments as a Percentage of Total New Plant and Equipment Expenditures, Four U.S. Basic Industries, 1973=79 (millions of dollars)

	Steelmaking	Chemicals	Petroleum	Electric utilities
Sic.	331			491
1973. . . .	$1,407	$4,324	$ 5,409	$16,250
	16.6%	10.170	10.9%	9.2%
1974. . . .	$2,030	$5,628	$ 7,868	$17,649
	12.170	8.3%.	10.170	8.9%
1975. . . .	$2,926	$6,300	$10,947	$17,030
	13.5%	10.8%	11.8%	9.6%
1976. . . .	$2,954	$6,723	$11,744	$18,942
	15.170	11.3?40	10.8%	10.5%
1977. . . .	$2,815	$6,902	$14,185	$21,743
	16.60/0	10.1 '/0	8.2%	10.4%
1978. . . .	$2,622	$7,205	$15,560	$24,590
	16.8%	7.9%	8.3%	10.O%
1979				
planned	$2,908	$8,106	$17,504	$27,308
	18.4%	7.1 0/0	8.00/0	9.70/0

aAir, water, and solid waste.

SOURCE: U.S. Department of Commerce, Survey of Current Business, June 1978 and June 1979.

Table 141.–Total and Regulatory "Current Capital Costs" for the U.S. Steel Industry, 1969.79

	Total capital investment		Net income	Pollution control capital investment		Pollution control as percentage of capital investment		Pollution control as percent of net income	Occupational health capital investments	
Year	Commerce	AISI	AISI	Commerce	AISI	Commerce	AISI	AISI	(million)	Percent of total
1969	NA	2,046.6	$ 879.4	NA	$138.0	NA	6.7	15.69	—	—
1970	NA	1,736.2	531.6	NA	182.5	NA	10.5	34.33	–	–
1971	NA	1,425.0	562.8	NA	161.5	NA	11.3	28.69	–	–
1972		1,174.3	774.8		201.7	NA	17.1	26.03	193.0	12.3
1973	$1,407	1,399.9	1,272.2	$234	100.1	16.63	7.1	7.86	121.0	6.9
1974	2,030	2,114.7	2,475.2	245	198.8	12.06	9.4	8.03	92.0	3.5
1975	2,926	3,179.4	1,594.9	396	453.0	13.53	14.2	28.4	70.0	1.9
1976	2,954	3,252.9	1,337.4	146	489.2	15.09	15.0	36.57	34.0	0.9
1977	2,815	2,319.3a	377.3a	470	407.6	16.7	1 7.5a	108.0[a]	41.0	1.2
1978	2,622	2,538.3	1,291.9	441	457.9	16.8	18.0	35.44	41.0	1.2
1979	NA	NA	1,297.2	NA	650.9	NA	NA	50.17	NA	NA

aExcluding Bethlehem Steel, which incurred a $355 million loss in 1977 due to plant closings.

NOTE: AISI estimates are for the steel industry proper, Commerce Department estimates are for all environmental expenditures by steel companies, including for occasionally substantial nonsteel expenditures.

SOURCES Commerce—Survey of Current *Business,* June 1978 (survey started in 1973; solid waste for all years); AISI—Armual Statistical *Report,* 1978 (air and water) only; Special *Survey* (air and water only), McGraw Hill, Annual Surveys of Investments in Employee Safety and Health, vols. 1-7, 1973-79

plant is replaced by imports. The increasing use of scrap and electric furnaces, accelerated by regulatory considerations, may also be leading to a loss of jobs, or at least a shift of employment from basic ironworking to the scrap industry.

EPA expects the level of capital investment for regulatory compliance until the mid-1980's to be lower than does AISI, but it expects that annual investments will gradually increase over this period, while AISI assumes roughly similar levels. According to EPA, between 1977 and 1986 the steel industry will invest $41.+1 billion, or about $490 million annually, in pollution abatement equipment to comply with clean air and water requirements.[30] AISI, on the other hand, predicted in 1978 that 1976-85 capital investments for compliance with all environmental regulations would be $4.9 billion, or about $550 million annually .31 In 1980, AISI estimated that environmental plus occupational health investments will amount to $800 million per year until 1988.[32]

Operating and maintenance costs for regulatory equipment are an additional cost burden, and as more pollution abatement systems are installed these costs will increase. Using the **1978** AISI estimate, **1979** annualized air and water pollution abatement costs (capital recovery, operating, and maintenance) were about $2.5 billion.[33] This is about $0.5 billion higher than comparable EPA estimates (table 143). The AISI data are annual averages of cumulative investment projections, while the EPA data attempt to reflect actual capital investments expected to be made each year. Thus, EPA estimates for capital investment and annualized costs increase over time in accordance with anticipated compliance with future regulatory requirements, and AISI projections show higher near-term capital recovery and operating costs than does EPA. The EPA estimates more accurately represent actual industry practices, while the AISI data for annualized pollution abatement costs overestimate current expenditure levels somewhat by including certain investments well before compliance deadlines.

Using industry estimates for annualized environmental costs, one finds that they added **6.4** percent to production costs in **1979.** Using the lower EPA annualized estimates, reflecting in part lower current expenditure levels relative to future requirements, the figure is 5.1 percent (table 143). *

OSHA-stimulated capital costs have on the average been considerably less than those for environmental regulations. Thus far, major occupational regulations have covered a narrower range of steelmaking processes, and implementation of major OSHA regulations is a more recent development. Capital investments for occupational safety and health during the **1970's** averaged **$85** million per year or about 5.8 percent of total capital spending, but there is no clear trend yet in these expenditures. In **1978,** steelmaker reported investing $41 million for industrial safety and health purposes (see table 141).

Steel industry investment levels for occupational safety and health were on average less than half those of other basic industries, such as the chemical and electric utility industries, but they represented a higher proportion of total capital spending (table 144). Steel industry opportunity costs for occupational safety and health have on the average been higher than for other industries. Thus, compared to other basic industries, steel may be under greater pressure to forgo investments in new production equipment because of OSHA-related investments.

[30] EPA, *The Cost* of *Clean Air and Water*, op. cit.

[31] ADL/AISI, *Steel* and the Environment, 1978, p. 1 (1979 dollars).

[32] AISI, *Steelat* the *Crossroads*, 1980, p. 44.

[33] About $1.3 billion of this amount is for operating and maintenance costs only. This is in contrast to the $500 million estimate for O&M in AISI's *Steel* at the Cross Roads (prepublication draft), 1980, p. 11-7.

*EPA estimates that annualized capital and operating costs for environmental requirements have in the past added 4.6 percent to steel production costs and prices. [EPA, Industrial Analysis Branch, letter to OTA, Mar. 18, 1980.)

Table 143.-Effect of Environmental Requirements on Steel Production Costs and Prices, 1979-83 (1979 dollars)

	Annualized P.A. costs[a] (millions)			Annualized P.A. costs per tonne shipped[b]	Production costs per tonne[c]	Total revenue per tonne	P.A. as percentage of production costs per tonne	P.A. as percentage of total revenue per tonne
	Operating and maintenance	Capital recovery	Total					
ADL/AISI								
1979.....	**$1,360.60**	**$1,151.30**	**$2,512.00**	**$27.08**	**$422.40**	**$467.50**	**6.4**	**5.8**
1983.....	**2,261.50**	**1,926.00**	**4,188.50**	**41.88**	**574.20**	**605.00**	**7.3**	**6.9**
EPA								
1979.....	**1,260.30**	**734.64**	**1,995.04**	**21.50**	**422.40**	**467.50**	**5.1**	**4.6**
1983.....	**2,456.65**	**1,411.93**	**3,868.35**	**37.98**	**574.20**	**605.00**	**6.6**	**6.3**

NOTE: P.A. = pollution abatement.
1) Annualized P.A. costs; capital, operating, and maintenance costs for air and water requirements 1983 AISI estimate Includes fugitive emissions, but 1979 estimate does not.
2)8% annual inflation assumed between 1979 and 1983.
3) Shipments: 197992.5 million tonnes.
198399.8 million tonnes,
aArthur D. Little (for AISI). Steel *and the Environment: A Cost Impact Ana;ysis,* 1978, p. 3.
bEnvironmental Protection Agency, "The Cost of Clean Air and Water," report to Congress, 1979
cWorld Steel Dynamics, *Core Report J. Steel Prices, Costs, and Proflts, 1979.*

Table 144.-Reported and Planned Investment in Employee Safety and Health, Four Basic Industries, 1972-82
(in millions of 1978 dollars and as percentage of capital spending)

	1972		1973		1974		1975		1976	
Iron and steel	**$193**	**12.3%**	**$121**	**6.9%**	**$92**	**3.5%**	**$ 70**	**1.90/0**	**$ 34**	**0.9%**
Chemicals.....	**72**	**2.1**	**89**	**2.0**	**119**	**2.1**	**200**	**3.2**	**234**	**3.5**
Petroleum.....	**68**	**1.3**	**196**	**3.6**	**216**	**2.7**	**263**	**2.5**	**128**	**1.1**
Electric utilities	**203**	**1.4**	**144**	**0.9**	**229**	**1.3**	**170**	**1.0**	**150**	**0.8**
All-manufacturing average	**52.1**	**3.0**	**67.0**	**3.2**	**87.6**	**3.4**	**92.2**	**3.1**	**64.6**	**2.2**

	1977		1978		1979 planned		1982 planned		1972-78 annual average	
Iron and steel	$41	1.2%	$41	1.7%	$41	1.4%	$116	3.3%	$84.5	4.O%
Chemicals.....	212	3.1	249	3.5	243	2.9	349	3.6	167.8	2.7
Petroleum.....	250	1.8	490	3.2	600	3.4	222	1.1	230.1	2.3
Electric utilities	194	0.9	448	1.8	413	1.4	577	1.8	219.7	1.1
All-manufacturing average	87.2	2.6	114	3.0	127.5	2.8	111.2	2.3	79.2	2.9

SOURCE McGraw-Hill, 1st through 7th *Annual Surveys of Investrnent* in *Employee Safety and Health, (1973-79).*

There are no comprehensive data on annualized operating and maintenance costs of OSHA regulations or on the impact of these regulations on cost and price competitiveness. It stands to reason that the cost impact will be far less than that of environmental regulations. More importantly, there are no thorough analyses of the cost impact of EPA and OSHA regulations, together. The full costs of regulation will be less than the sum of the costs for meeting EPA and OSHA standards separately, because standards overlap both within and between the two sets of regulations.

Need for Improved Regulatory Cost Projections

Steel industry capital expenditures for pollution abatement during the next few years will be concentrated in investments such as high-performance environmental equipment for the control of fugitive emissions and for the treatment of carcinogenic or hazardous air and water pollutants, OSHA-related cost increases are expected to be associated mainly with required process changes—such as closed systems, improved ventilation, and acoustical redesign—and operational changes leading to reduced coking times.

Both EPA and OSHA conduct economic-impact analyses of major proposed regulations. In addition, EPA periodically prepares comprehensive industry impacts of the cost of regulations. The steel industry also sponsors economic-impact analyses of regulatory requirements. However, economic-impact studies concentrate only on anticipated regulatory costs. There is little or no effort to compare these costs with the benefits resulting from new or extended regulations, nor do the studies compare the cost effectiveness of regulatory control technologies for the steel industry with those for other industries. And finally, these projections generally do not consider the offsetting effects (which can be considerable) of fiscal incentives or public-financing options on capital need estimates for regulatory compliance. Both planning and decisionmaking will be aided if future projections take these factors into consideration.

Future Regulatory Cost Impacts

Available cost studies often show different cost impacts for the same regulations. For instance, EPA annualized environmental cost projections for capital and operating expenditures into the mid-1980's are 8 percent less than those prepared by AISI for the same period (see table 143), while the Agency's capital expenditure projections are approximately 20 percent lower than AISI's (table 145).

Each successive projection has increased the predicted cost of regulatory compliance. A 1970 EPA report to Congress identified particulate as the steel industry's major pollutant and projected 1975 operating and maintenance costs for air pollution compliance to be around $250 million.[34] A 1979 report for EPA estimates that similar expenditures for the 1981-86 period are expected to be $780 million per year.[35] These increases over time and by the same agency are the result of inflation, better forecasting, and the installation of additional equipment needed to control hazardous pollutants.

Even regulatory cost projections developed around the same time and covering approximately similar regulatory areas frequently show rather different estimates of future capital investments and operating costs. Differences between industry and Government projections are largely attributable to different assumptions concerning facility replacement rates, expansion programs, technological choices, interpretations of regulations, and the scheduling of regulatory investments. The more extensive the industry's investment in integrated facilities—as in the High Investment scenario discussed in chap-

[34] Department of Health, Education, and Welfare, The Cost *of Clean* Air, second report to Congress, March 1970, Senate Document 91-65.

[35] EPA, The Cost *of Clean* Air and Water, op. cit.

Table 145.—Annual Steel Industry Investments in Abatement Equipment (air, water, coke ovens): Projected Increases, 1970-85 (millions of 1978 dollars)

	Industry estimates		Federal estimates	
1978	**Pollution** abatement	$450.00	EPA	$441.00
	Industrial health	41.00	OSHA[b]	41.00
		$499.00		$482.00
1985	Pollution abatement	700.00	EPA[c]	490.00
	Industrial health	100.00	OSHA[d]	68.00
		$800.00		$558.00
1978-85 increase		60%		1570

aAll applicable regulatory requreements.
bSteel industry reported data since no Federal estimates are available.
c1977-86.
d1976-85

SOURCES: *Survey of Current Business,* June 1978, McGraw-Hill, Survey of Investment in Employee Satety *and* Health, 1979, American Iron and Steel Institute, *Annual Statistical Report, 1979,* Environmental Protection Agency, The Cost of *Clean Air and C/can Wafer,* Report to Congress, 1979, D.B. Associates, *Inflationary Impact Statement Coke Ovens,* report prepared for OSHA, 1976, American Iron and Steel institute, Steel at the *Crossroads, 1980*

ter 10—the greater regulatory capital costs will be. Technological choices and the facility replacement rate will also significantly influence future regulatory capital costs: for instance, electric furnaces and continuous casters require less regulatory investment than parallel conventional equipment, and a high replacement rate reduces the need for costly retrofit equipment.

In addition to uncertainty about future changes in the economy, Federal policies, and industry investment decisions, the following factors also contribute to differences in regulatory cost projections:

- Different interpretations of regulatory requirements:
  - —AISI cost projections are reported to include compliance costs for some facilities scheduled for shutdown by the early 1980's; only if shutdown took place after 1982 would these facilities be subject to environmental regulations.
  - —AISI assumes a 20-percent coke oven capacity increase will be needed to replace existing capacity expected to be lost under a strict interpretation of the standard; the OSHA-sponsored analysis appears to include only retrofitting of existing capacity .3'
- Unknowns about qualifying regulatory technologies:
  - —Uncertainties about qualifying abatement technologies have produced widely different cost estimates for specific EPA standards such as those concerning fugitive emissions, storm runoff, and BAT requirements for air- and water-quality control .37
  - —Industry-sponsored economic impact studies of the proposed coke oven standard included capital costs for automatic and remote control systems that, according to the United Steelworkers of America, would only be required of new and rehabilitated batteries.[38]
- Differing allocation of joint costs for productive and control equipment.—This is an issue whenever investments are made in new production processes simultaneously aimed at improved productivity and environmental compliance. Examples include capital costs for waste-product recycling systems and perhaps even electric furnaces. Available time series on investments in regulatory equipment attempt to allocate costs on a functional basis. It appears, however, that steel companies tend to allocate joint costs disproportionately to the regulatory function, thereby overestimating compliance costs. For instance, the EPA Enforcement Office argues that AISI charged the cost of facility closures, modernizations, or replacements as environmental costs even though substantial production benefits may be realized. If steel industry modernization programs are stepped up in response to growing demand, the issue of proper allocation of joint costs will grow in importance.
- Lack of access to independent industry data.—In its 1977 report on EPA, the National Academy of Sciences noted that:

  > EPA is inevitably dependent on the industries it regulates for much of the technical and economic information it uses in decision-making (among others with respect to) the assessment of the costs and technical feasibility of pollution processes to achieve pollution control. The impact of many decisions on industry creates a potential conflict of interest that may cause industry either inadvertently or intentionally to distort or withhold necessary information.

  The Academy recommended that:

  > EPA should develop sufficient scientific and technical expertise with the Agency

[36] Federal *Register,* Oct. 22, 1976 p. 4674846749; Temple, Barker, and Sloane, "The Financial Impact of Proposed Coke Oven Standards on the U.S. Steel Industry, " report prepared for AISI n.d., p. 7; Policy Models, Inc. *A* Methodological Approach *for* Use in Assessing *Impact of* Government Regulation *of* the *Steel* Industry, report prepared for the Council on Wage and Price Stability, 1977, p. A-33.

[37] Organization for Economic Cooperation and Development. Emission Control Costs in the *Iron* and *Steel* Industry, Paris, 1977, p, 151.

[38] *Federal Register,* Oct. 22, 1976, p. 46749; Policy Models, Inc., op. cit., p, A-9; Federal Register. Oct. 22, 1976, p. 46748.

> or through independent institutions (and that EPA) should institute procedures to assure the quality, reliability, relevance and completeness of data provided by industry for EPA's use.[39]

Similar observations very likely also apply to OSHA. Both agencies have taken steps to strengthen their economic analysis activities in response to the growing interest in the economic implications of regulatory requirements.

It is important to recognize that projections are essentially best available estimates of predicted industry regulatory investments. Not only do projections differ between sponsoring organizations and over time, they also appear to be higher than actual expenditure reports with they attempt to predict. EPA recently reported that steel producers spent less money meeting antipollution regulations than either the industry or EPA had predicted. The Agency found that for the 1975-77 period, industry investment estimates for water pollution control were three times higher than actual costs incurred. EPA estimates were about 1-1/2 times higher than actual steel industry regulatory expenditures. *

Future steel industry investment in regulatory equipment is, according to Federal estimates, expected to increase by 13 percent to about $550 million annually until the mid-1980's. The industry, on the other hand, expects that future levels will be almost double current investments, averaging $800 million per year (see table 145).

While U.S. regulatory investments are expected to increase over the next several years, Japanese steelmaker are beginning to experience the opposite trend. The financial burden of pollution abatement seems to have been highest in Japan from 1971 through 1976 (table 146). These efforts were closely linked to the installation of new equipment; upon completion of the last expansion projects in 1977, the industry's pollution control expenditures have declined significantly and recently they have been below those of the American industry. Because American steel firms are still in an earlier stage of complying with regulatory requirements, their expenditures for this purpose are likely to remain for some time at a considerably higher level than those of Japanese firms. In Japan, where a large portion of capacity is of relatively recent vintage, antipollution devices could be designed to fit the new equipment. This has led to lower costs per tonne of steel produced than the retrofitting of such devices on old equipment. Moreover, a greater effort was made in Japan than elsewhere to utilize captured waste gases for power generation; this reduces the requirement for purchased energy and thus helps offset to some extent the cost of operating the antipollution equipment .[40]

Using AISI and EPA projections for the distribution of regulatory investments over time, 1983 annualized air and water pollution abatement costs (operation and maintenance) are expected to be around $4.2 billion and

"National Academy of Sciences, Decision Making in the Environmental Protection Agency, 1977, vol. II, p. 12.
*Washington Post, June 19, 1980, p. A7.

[40]Hans Mueller and Kiyoshi Kawakito, The International Steel Market: Present Crisis and Outlook for the 1980's, Middle Temessee State University, conference paper No. 46, 1979, pp. 26-27.

Table 146.—Steel Industry Environmental Control Investment Outlays: United States and Japan, 1970-71 (in millions of dollars and as a percentage of total capital expenditures)

	1977	1976	1975	1974	1973	1972	1971	1970
United States	$407.6	$489.2	$453.0	$198.8	$100.1	$201.7	$161.5	$182.5
	17.5°h	15.0YO	14.2%	9.4%	7.1 %	17.170	11 .30/0	10.5%
Japan	555.3	920.1	685.2	555.6	367.9	284.4	219.2	NA
	15.2	20.6	18.4	18.6	17.3	13.4	8.9	NA

NA = not available

SOURCES American Iron and Steel Institute, *Annual Statistical Report,* 1978, Hans Mueller and Kiyoshi Kawakito, The *International Steel Market Present Crisis and Outlook for the* 1980's, 1979, *p.* 27.

$3.8 billion, respectively. AISI 1983 capital recovery estimates for pollution abatement equipment are a higher proportion of total annualized regulatory costs than is the case for EPA estimates. This difference reflects the higher cumulative capital investments and capital costs assumed by the steel industry (see table 143). The AISI data show a 66-percent increase in annualized pollution abatement costs between 1979 and 1983, while EPA data suggest that annualized costs will not quite double during this period (see table 143). The EPA trend may be the more accurate one because its data are based on gradually increasing costs that anticipate compliance with the more stringent environmental requirements of the mid-1980's.

EPA projections for cumulative 1979-83 capital recovery and operating costs for clean air and water compliance are within 10 percent of the AISI projections, and future steel production cost and price impacts are projected to be rather similar. Using AISI and EPA data, annualized clean air and water compliance costs are expected by 1983 to add 7.3 and 6.6 percent, respectively, to steelmaking costs. If these regulatory costs are fully passed on to consumers, steel prices are expected to increase between 6 and 7 percent (see table 143).*

There are no comprehensive cost projections for all OSHA standards applicable to the steel industry, although individual future cost estimates are prepared during the standard-setting process. A major standard that is presently operational is for the reduction of coke ovens emissions. An OSHA-sponsored estimate suggested in 1975 that this standard would impose annual capital and operating costs of at least $22o million.[41] The benzene standard, now being considered by the Supreme Court, is not expected to impose additional capital requirements on the steel industry because of its compliance overlap with the coke oven standard.[42] If implemented in its present form, the benzene standard could add between $5.5 million and $6 million per year in steelmaking costs. Cumulative annualized capital and operating costs for coke oven and benzene standards are expected to be around $275 million per year (1978 dollars).

Still further into the future are regulatory costs for compliance with final OSHA noise standards, which are still being developed. One source estimates a compliance cost impact of about $100 million annually. *

Financing of Regulatory Equipment

One important option often overlooked when analyzing steel industry regulatory capital requirements is IDB financing.[43] Such financing reduces the need for internally generated capital for investments in regulatory technologies. IDBs make large amounts of outside funds available at low cost and for long periods of time.

All types of permanent facilities, such as piping, pumping, and treatment units, can be financed with such bonds. During the early 1970's, Congress authorized State and local governments to sell IDBs to help companies obtain the financing needed to meet Federal pollution control requirements. The public entity issues tax-exempt revenue bonds, repayment of which is based solely on the credit of the business. The public entity is the nominal owner of the property which is conveyed to the business under a lease, lease purchase,

*Preliminary EPA estimates suggest that air and water control requirements will increase steel prices by no more than 4 percent. (EPA, Industrial Analysis Branch, letter to OTA, Mar. 18, 1980,)

[41] OSHA estimates annual capital and operating costs of $218 million, and AISI estimates $1.28 billion. Expressed as a price increase per tonne of coke produced, OSHA anticipates a $2.75 increase and AISI an increase of $14.62. OSHA attributes its estimated increase largely to a projected 18-percent decrease in the productivit, of the coking process, AISI's estimate, on the other hand, is based on cost increases associated with reduced productivity, external financing costs, and price increases to raise the rate of return on investment to the manufacturing average of 12.4 percent. (Federal Register, Oct. 22, 1976, p. 46749; Temple, Barker, and Sloane, op. cit., p. 6: Policy Models, Inc., op. cit., p. A-33.)

[42] OSHA, *EIS:* Benzene Standard, vol. 1, pp. 5-6.

*The final noise standards are expected to be quite different from the proposed standards, and final cost projections are likely to differ as well.

[43] For instance, OSHA- and industry-sponsored cost impact studies of proposed coke oven regulations differed in their treatment of IDBs. (*Federal* Register, Oct. 22, 1976, pp. 4674846749; Policy Models, Inc., pp. A-9-Io; Temple, Barker, and Sloan, op. cit., p. 7.

installment sale, or similar contract. The business may also obtain tax advantages, such as the 5-percent investment credit and accelerated amortization. The Internal Revenue Service determines whether the interest paid to bond purchasers is subject to income tax.[44] On average, IDBs mature in 23 years and have an average interest rate of 6.8 percent.[45]

All major industries have increasingly relied on low-cost IDB financing to help meet capital requirements for regulatory compliance. Between 1971 and 1977, the steel industry obtained at least $960 million in outside funds through IDB financing. This amounts to 48 percent of past annual pollution abatement investments. IDBs continue to be more attractive to the steel industry than available fiscal alternatives including a recent revision of the tax code which increased the investment tax credit for pollution abatement equipment from 5 to 10 percent. The steel industry's potential tax savings from this source, estimated at $6.5 million for 1978, are not likely to be realized because of the continued industry preference for IDB financing.[46] Continued IDB financing for environmental equipment could reduce future capital requirements from internal sources by the same 48 percent, thereby reducing total internally generated capital needs. *

Future capital shortfalls that may result in part from regulatory compliance are affected by broader industry trends in shipments and profitability. These trends are heavily influenced by industry investment strategy and also by Federal price, tax, and trade policies. Regulatory costs are of concern to the steel industry in part because these expenditures may divert capital from the industry's replacement and expansion plans. Capital diversion, however, is a relative concept. Since the Renewal scenario discussed in chapter 10 projects lower total capital needs than the High Investment scenario for the 1978-88 period, the former would involve a greater proportionate diversion of capital from replacement and expansion to regulatory compliance than the latter. Government and industry regulatory capital need projections of $550 million and $800 million annually would be 18 percent and 26 percent respectively of the total capital needs under the Renewal scenario, but 11 percent and 16 percent respectively under the High Investment scenario. However, since the Renewal scenario emphasizes expansion by means of nonintegrated plants, regulatory capital needs may be less than even the $550 million of $800 million projections.

Conclusion

Federal projections for meeting OSHA and EPA steel industry standards suggest that by 1985 annual investments for regulatory compliance will increase by 13 percent over 1978 levels, to about $550 million, while the steel industry predicts that by 1985 capital spending for a broader range of regulatory requirements will increase by 35 percent over 1978 levels, to about $800 million per year.

Federal and industry regulatory investment projections may be integrated with the Renewal and High Investment scenarios discussed in chapter 10 to determine the magnitude of future capital diversion from steel industry modernization to regulatory compliance. Industry data suggest that in 1988, capital diversion from modernization to compliance would have increased by 2 percent to a total of 16 percent. Federal data, when integrated with the lower Renewal scenario, suggest that capital diversion could increase by as much as 4 percent to a total of 18 percent. However, when integrated with the more costly High Investment scenario, Federal estimates of capital diversion from modernization to compliance could decline by more than 2 percent to slightly below 12 percent.

[44] EPA and the Council on Environmental Quality (CEQ), Federal Assistance *for Pollution* Prevention and Control, 1979, p. 9.
[45] EPA, Office of Planning Management, informal survey, 1980.
[46] To receive a 10-percent investment credit, steel companies must choose between IDB financing and 5-year amortization. (EPA and CEQ. Ibid, p. 9).
*See ch. 10, table 135.

These divergent conclusions arise in part from differences in estimates of total capital need and also from the omission of solid waste and other emerging regulatory costs from available Federal projections. A final reconciliation of these divergent conclusions may have to await the time, just prior to implementation of standards, when requirements will be firm and qualifying control technologies will be known,

Regulatory Requirements and Modernization

Summary

Environmental policies have thus far had a greater impact on steel industry investment decisions than have those administered by OSHA. To the extent that industry has responded to these policies by making investments in retrofit equipment, they have generally increased production costs, and modestly decreased labor productivity. On the other hand, the need for selective facility replacement has made it necessary to enter into environmental agreements earlier than might otherwise have been the case. Industry economics are presently such that it can be cheaper and more productive to replace rather than retrofit in order to comply with environmental standards. In this sense, regulations have accelerated industry modernization. Regulatory requirements have had their most serious impact on integrated companies with a large proportion of aging facilities; they have affected nonintegrated electric furnace producers less than other industry segments.

Three major policies are currently of special concern to the steel industry, all of which pertain to EPA air quality matters. The cost effectiveness of the revised offset policy has become well established, but potential difficulties remain should a steel company wishing to expand have to "buy" emission offsets to compensate for the additional pollution expected from a planned facility, EPA's bubble concept promises cheaper compliance options for existing and replacement facilities, but there is some concern about possible tradeoffs between different types of pollutants within the same plant. And finally, the limited-life facilities policy is of major concern to the industry because there is no alternative phase-out schedule for marginal plants beyond the 1982 statutory compliance date.

Limited Modernization

Regulatory policies, particularly those of EPA, appear to have slightly accelerated the steel industry's modernization process. EPA issues construction permits for new or expanded facilities, while OSHA enforcement activities are limited to inspection of existing production facilities; the latter do not directly affect construction or expansion plans. OSHA does have an indirect impact on industry modernization plans because regulatory requirements become effective as soon as a new facility is operational.

The most apparent effect of environmental regulations on modernization has resulted largely from recent EPA/industry settlements, which included the closing of old, heavily polluting facilities and the construction of modern replacement facilities. For instance, during the fall of 1978 EPA concluded an agreement with Republic Steel committing the company to the construction of a new electric furnace shop and related facilities in one location while phasing out outdated coke batteries, suiterplants, and blast furnaces elsewhere by 1982.

With a high proportion of outdated facilities, for which retrofitting is not cost effective, the industry is poorly equipped to respond to present high demand for steel products and the anticipated greater demand of the 1980's. The need for facility replacement has led the industry to comply by selectively updating or modifying existing plants: most

commonly, outdated integrated facilities such as coke ovens, blast furnaces, and open hearths have been replaced by less polluting electric furnaces requiring comparatively low capital investments.

Both regulatory requirements and industry economics influence industry investment decisions. The industry reports that 1.3 percent of all steelmaking capacity was phased out between 1973 and 1975 because of regulatory requirements; subsequent shutdowns for this reason have been of a much smaller magnitude.[47] A 1978 EPA survey, however, found that market conditions and business considerations were major factors in phaseout and replacement decisions that were in part spurred by environmental requirements. The survey identified 28 facilities, owned by 12 companies, with one or more processes that may close down or be replaced; it was found that contributing business factors included the availability and cost of transportation, changing market conditions, and corporate investment plans for replacing antiquated facilities or rounding out existing facilities. In some instances, plants were found to be either so outdated or in such dire financial straits that shutdown would simply be inevitable regardless of EPA action.[48]

Industry's view is that if compliance has to be achieved, it should be accomplished by making "safe" investments that require comparatively small layouts and fit into a plant's existing infrastructure. Along these lines, electric furnaces have frequently turned out to be an economically more attractive compliance option than extensive rehabilitation of old facilities or replacing them with identical new facilities.[49] Initial capital investment and operating costs for electric furnaces are relatively low, and their return on investment as a replacement for outdated facilities is generally very satisfactory.

[47] McGraw Hill, 1st through 7th annual surveys of *Investment* in Occupational *Safety* and *Health*, 1973-79.

[48] EPA Enforcement Office, *Steel* Documentation *Book*, 1979.

[49] *Steelmaking* Today Supplement, Sept. 24, 1979, pp. 3-4A; "Bethlehem Steel to Add Minimill Capacity," New York *Times*, Aug. 7, 1979.

Industry Differences

EPA and OSHA regulations often affect different steel companies and plants in different ways. OSHA regulations, in particular, have a greater impact on integrated plants than on nonintegrated or alloy/specialty companies. The degree of process integration and the age of the facilities are two of the most significant determinants of regulatory expenditures different companies face.

Degree of Process Integration.—It appears that environmental requirements are a more significant element in the cost of steel for integrated plants than for the smaller nonintegrated plants, which involve a less complex range of steelmaking processes. Furthermore, pollution abatement in these plants is already quite efficient because most of their control equipment was designed for installation at the time of construction.

AISI data show that environmental cost impacts are more severe for nonintegrated than for integrated plants, but independent OTA data indicate there is little difference between segments when considering environmental investments relative to replacement value. However, when considering sales the OTA data show a lower cost impact for nonintegrated plants. AISI data show that current environmental costs are about 7 percent of replacement value for integrated plants and 15 percent for nonintegrated plants. OTA data show that nonintegrated environmental costs would be no more than 7 percent of replacement value, approximating those of integrated mills. This comparison of environmental cost relative to capital cost is clouded, however, by the fact that nonintegrated plants have lower capital costs per tonne of steel produced than integrated producers. Comparing the environmental costs relative to shipments, AISI data suggest that the segments are affected about equally, at about 5 to 8 percent. OTA data, on the other hand, show that environmental costs can be as low as 0.5 percent of shipment costs for nonintegrated plants equipped with wastewater recycling equipment (table 147).

Table 147.—Type-of-Plant Differences in Pollution Control Capital Costs (1979 dollars)

	Number of plants		Capital costs (millions of 1979 dollars)		Percentage of replacement value		Percentage of total shipment cost	
Facility type	AISI	OTA	AISI	OTA	AISI	OTA	AISI	OTA
Integrated	33	—	$4,572.0		6.9%	—	7.6%	—
Nonintegrated [a]	8	5	54.0	$9'16	15.0	6.7%	5.0	0.4%

NOTE Investment levels reflect approximate 1979 practices The AISI data are based on 1975 information, validated in a 1978 study and adjusted for changes in the producer price index for capital goods.

aThese plants are all equipped with wastewater recycling equipment and have zero discharge. Thus, environmental capital and operating costs only pertain to meeting air quality standards.

SOURCES: Arthur D Little, Steel *and the Environment. A Cost Imrpact Analysis,* 1975, revised 1978; OTA data from confidential communication with major nonintegrated steel company

Changes in annual unit costs for emission control will be greatest for finishing facilities because fluctuations in the rate of capacity utilization are greatest for this equipment. As the operating rate goes down, the annual cost of pollution abatement equipment per tonne of steel produced will increase.[50]

Age, Economies of Scale, Location, and Financial Performance.—In some instances, the oldest equipment bears a disproportionate cost burden because of comparatively high retrofitting costs. Frequently, compliance is made easier by replacing outdated equipment with more efficient and less polluting facilities. Unit pollution abatement costs tend to be lower for new facilities in part because they are larger than the old facilities: various engineering estimates indicate that a 100-percent increase in operating capacity can lead to a 20- to 25-percent decrease in unit treatment costs for airborne pollutants. Economies of scale for waterborne effluent control are somewhat higher—25 to 30 percent.[51] The geographic location of a firm's steel-producing capacity also can materially influence regulatory cost impacts. Water pollution control, for example, is often less costly in dry regions, where natural evaporation can inexpensively reduce the volume of discharge. Smaller and older integrated firms are most severely affected by regulatory cost impacts because they frequently have limited, if any, financing options for investments in newer and safer steelmaking technologies. Financially and technologically weak firms may have no choice but to undertake relatively inexpensive stopgap measures, which tend to be counterproductive to the long-range goals of a viable business enterprise.[52] As a result, their relative positions in the industry may slide even further.

Potential Modernization Problems

In response to private-sector concerns that EPA's offset policy for new facility construction would preclude such activity in heavily polluted areas, the Agency revised its policy in 1977. Under the revised offset policy, new construction is allowed if the new facility uses very stringent emission controls and if more than equivalent reductions are made from existing sources owned by the same or different companies in the same or contiguous States. Virtually all recent EPA/industry consent-decree settlements have provided for industry investment in new facilities that follow offset policy principles but attain some net reduction in area emissions.

It is not expected that the revised offset policy will inhibit new facility construction on the basis of regulatory cost considerations alone. There was concern that the requirements for new facilities were too stringent, and thus too costly, compared to requirements for existing plants. Following this reasoning, the more stringent requirements generally applicable to new steelmaking facilities could encourage firms to defer new construction. Thus, firms could continue operat-

[50] OECD, op. cit.

[51] I bid., pp. 88-90.

[52] N. A. Ashford, *Crisis in the Workplace: Occupational Disease and Injury* (a report to the Ford Foundation), Cambridge, MIT Press, 1976, p. 315-316.

ing their older, less efficient plants longer than they might have in the absence of these stringent requirements. This reasoning seems to suggest that environmental requirements alone can shape investment decisions. However, investment decisions are based on overall cost (rather than merely environmental cost) for new or existing plants and on the rate of return on alternate investments. Relative stringency of environmental requirements is only one of several factors influencing such decisions,

A 1979 EPA-sponsored report analyzed investment scenarios for certain steelmaking processes by comparing environmental cost requirements of retrofit with new facility replacement.[53] The authors found that only two investment options were attractive (using typical industry criteria for return on investment), and neither of these options favored retrofitting as a favorable way to meet environmental requirements. The preferred options were: 1) replacement of conventional casting processes with continuous casting and 2) contraction of existing facilities coupled with construction of new electric furnaces. Steelmaker are in fact actively pursuing the latter option, thereby implicitly confirming EPA's conclusion that replacement can provide a more attractive return on investment than the alternative of retrofitting aging equipment—despite the fact that such replacement facilities would have to meet more stringent environmental standards.

The revised offset policy might still create difficulties should a company decide to expand its productive capacity to a point that would create additional pollution. Preliminary EPA findings, however, suggest that most steel plants will be able to find internal offsets for expansion under the revised offset policy, and the few plants unable to develop internal offsets would be able to trade offsets with other plants.[54] The major concern may not be with the availability of tradeoffs but with the cost of trading emission offsets between companies. If unable to efficiently develop internal tradeoffs, a steel company might have to "buy" emission offsets from establishments that are able to control pollution more cheaply and effectively, thus placing an extra economic burden on the industry. Although a "market" in offsets might minimize the total cost of achieving emission reduction in a region, steel producers would probably pay a relatively high price because of the complexity and high cost of pollution abatement in the industry.

Recently EPA also. adopted the "bubble concept" for existing plants and replacement facilities. The bubble concept applies the offset principle at the plant level and enables EPA to regulate entire plants as single sources rather than as a collection of separate emission points. This approach increases regulatory flexibility by enabling the industry to impose stringent controls where it is least costly and to relax controls on emission points with similar pollutants but higher control costs. Because it emphasizes cost effectiveness, EPA expects that the bubble concept will provide industry with increased incentive for innovation in environmental control technology.

The bubble concept is particularly appropriate for steel mills because of the many emission sources in a typical plant. Recent EPA analyses suggest potential cost savings of 5 to 11 percent, or $1.2 million to $1.9 million per year, for moderate controls on average-size integrated plants in industrialized regions of the country. Potential cost savings for nonintegrated minimills are 20 percent, or $20 million per year, for stringent controls.[55] The flexibility inherent in the bubble concept would also apply to equipment replacement: rather than replace old facilities and control the new source of emissions, management could opt to install other new equipment with

[53] Mathtec, Inc., "The Effect of New Source Pollution Control Requirements on Industrial Investment Decisions," report prepared for EPA, 1979, p. 76.

[54] EPA, Industrial Analysis Branch, letter to OTA, Mar. 18, 1980.

[55] "Putnam, Hays, and Bartlett, "An analysis of the cost impact of plant-wide emission controls (the bubble concept) on four domestic steel plants, " prepared for the Economic Analysis Division of EPA, 1979.

tighter and less costly controls elsewhere in the plants.[56]

The steel industry is also concerned about the impact that the limited-life facilities policy will have on modernization. This policy does not provide the special treatment for aging plants that industry has sought; it merely permits the conditional operation of noncomplying facilities for which there are agreements involving replacements or phaseouts no later than December 1982.[57] Implementation of this policy may accelerate the closing of old, inefficient facilities and thereby increase the productivity of the industry. The leadtime is short, however, possibly to short for the timely replacement of aging facilties with major new facilities. There is considerable concern that large replacement expenditures crowded into short periods may overtax the financial capability of the industry and further capacity contraction.

Like EPA, OSHA does not exempt marginal, noncomplying facilities whose planned phaseout is beyond applicable compliance deadlines. OSHA appears to have greater administrative flexibility than EPA, however, because the duration of variances for individual facilities is not specified in the authorizing legislation. An executive task force reviewing OSHA regulations has recommended that:

> OSHA begin to identify standards for which compliance could be mandated in tandem with normal equipment replacement cycles instead of by retrofitting.[58]

OSHA may issue variances aimed at innovative compliance approaches on a case-by-case basis or perhaps, industrywide by considering modernization rates. Informal OSHA comments suggest that, until recently, variances may have been under utilized.

Current enforcement and compliance activities may also have a serious impact on future coke and scrap problems if they fail to give sufficient consideration to new substitute steelmaking technologies. A number of steel companies have found it profitable to construct additional cokemaking capacity, because the use of company-owned coal and the sale of coke byproducts generate fiscal benefits and additional revenues that can far outweigh the regulatory costs associated with cokemaking. However, a more prevalent response to regulatory and market forces has been to install electric furnaces to replace outdated integrated equipment like coke batteries, sinter plants, and blast furnaces—industry economics are presently such that it is often cheaper to build electric furnaces than to retrofit or make replacements in kind. As a result, U.S. coking capacity declined from 61 million to 49 million tonnes between 1975 and 1978. Domestic coke supplies are now being supplemented with imported coke, some of which is processed abroad from American metallurgical coal. Growing use of scrap will help offset some of the anticipated coke shortage while undoubtedly also contributing to increases in the price of scrap. Industry and EPA alike have underassessed the long-term raw material pressures and the technological alternatives that could reduce the likelihood of future shortages or price increases. One of these alternatives, continuous casting, reduces the need for coke and other process materials by increasing yield. Improved coke rates in newer blast furnaces will also help reduce the need for coke. Still another option, domestic or imported direct reduced iron, could be used as a superior complement to limited scrap supplies. Although major integrated companies have made only minimal efforts in these areas, smaller firms are actively pursuing continuous casting and considering the merits of direct reduction.

[56] *33 Metal* Producing, January 1980, p. 23.

[57] Industry sources suggest that large-scale retrofitting of old facilities is less often required abroad than in the United States. Old plants, particularly in Japan, have to be retrofitted only to meet the most serious violations. (AISI, *Steel* at the Crossroads, prepublication draft, 1979, p, II-7.)

[58] Interagency Task Force on Workplace Safety and Health, "Making Prevention Pay, " 1978, p. I-3.

Conclusion

Regulatory requirements have been and will continue to be a major cost burden on the domestic steel industry. As additional pollution control equipment is installed during the next few years, the industry's capital, operating, and maintenance costs will increase accordingly. Future industry decisions regarding facility replacement, capacity expansion, and selection of steelmaking technologies, as well as trends in productivity and shipments, will all have some influence on future capital investments for regulatory compliance. Federal agencies expect that regulatory investments for air, water and coke oven pollution abatement will increase modestly to around $550 million per year by the mid-1980's. These estimates do not include anticipated capital investments for emerging requirements, including those for noise abatement and hazardous solid waste disposal. Industry projections suggest that regulatory capital investment will increase by almost 60 percent to $800 million annually to meet all present and future requirements. IDB financing, heavily used by the industry as a source of regulatory capital, will help offset potential financing problems. Once compliance has been achieved by the mid-1980's, pollution abatement equipment investments could well level off, while operating costs—depending on the replacement rate—could either level off or increase.

Had these requirements emerged during a period of vigorous industry renewal and expansion, their costs would have been considerably less burdensome. Retrofitting, the prevailing compliance approach, is not a very economical way of responding to Federal mandates. Additional RD&D is needed to find and encourage the use of more cost-effective, high-performance regulatory technologies. The potential private gains from regulatory research are limited, however, and the industry prefers to use already available control systems. Future industry decisions regarding replacement and expansion, its selection of steelmaking technologies, and trends in its productivity and shipments will heavily influence future capital investment for regulatory compliance.

Federal regulations, particularly those administered by the EPA, have in effect forced companies that wish to modernize or expand to enter into compliance agreements with the Agency. This has accelerated industry phaseout and replacement of marginal facilities, so that environmental and occupational policies have had beneficial, as well as detrimental, effects on the industry. Economic considerations have recently been receiving greater weight in the identification of qualifying control technologies, and the industry hopes that the feasibility of future regulatory technologies will also be fully considered.