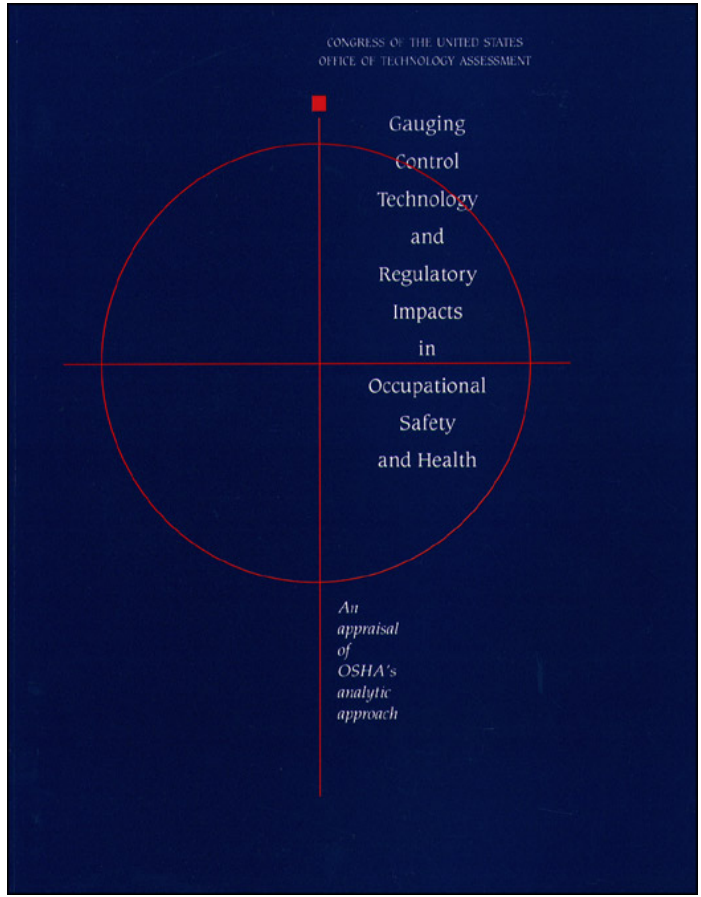
Gauging Control Technology and Regulatory Impacts in Occupational Safety and Health: An Appraisal of OSHA's Analytic Approach

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Foreword

Gauging Control Technology and Regulatory Impacts in Occupational Safety and Health responds to requests from the Senate Committee on Labor and Human Resources and the former House Committee on Education and Labor to evaluate the methods the Occupational Safety and Health Administration (OSHA) uses to examine hazard control options and estimate regulatory impacts. Setting workplace health and safety compliance standards continues to be one of the more contentious arenas of government regulatory policy. Debates among labor, industry, outside experts, and various government bodies over the availability of appropriate technological controls and the economic consequences of their adoption are often at the heart of these matters.

This report reviews the roles that analyses of control technology and regulatory impacts play in OSHA's standard setting process, and evaluates the various methods and resources on which the agency draws in conducting these efforts. In addition, based on findings from close examinations of a number of OSHA's past rulemakings, the report provides a critical appraisal of how well these analyses seem to be helping the agency achieve its basic occupational safety and health mission.

It is apparent that OSHA takes its responsibilities to prepare these analyses seriously. The agency has established analytical steps that are responsive to its procedural mandates and rely generally on methods that provide a credible basis for the determinations essential to rulemakings. The agency's analytical findings and estimates are frequently the subject of vigorous review and challenge. But, for the most part, this reflects the wide disagreements that inevitably arise when the interested parties and experts involved in rulemakings have differing visions of the need for hazard reduction, draw different conclusions about the efficacy of new compliance measures, and rely on differing data sets and assumptions in estimating the benefits and costs likely to arise.

The principal shortcomings that the Office of Technology Assessment (OTA) perceives in OSHA's analytical procedures relate to gauging the potential of leading-edge technologies and targeted innovations to address workplace hazards in technologically and economically superior ways, and to generating systematic information about the actual outcomes and effects of the agency's regulatory actions. For various reasons, including procedural priorities, rulemaking politics, and budget constraints, neither of these important analytical objectives now receives the attention warranted. In OTA's estimation, both of these deficits merit attention, with an eye toward relevant enhancements of the agency's capabilities and scope of analytical activities.

In preparing this report, OTA gratefully acknowledges the assistance of the project's advisory panel, chaired by John Froines of UCLA. The several contractors involved made essential contributions in conducting original research on rulemaking outcomes. OSHA staff were helpful on a number of occasions in facilitating OTA's understanding of the elements of the agency's regulatory analysis work. Nonetheless, as with all OTA reports, responsibility for the final content rests with OTA.



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Note: OTA appreciates and is grateful for the valuable assistance and thoughtful critiques provided by the advisory panel members. The panel does not, however, necessarily approve, disapprove, or endorse this report. OTA assumes full responsibility for the report and the accuracy of its contents.

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Study Overview and Major Conclusions 1

This study is broadly concerned with the processes and methods that the Occupational Safety and Health Administration (OSHA) employs to examine control technology options and to estimate compliance costs and other regulatory impacts in support of its major regulatory actions.[1] This report responds to Congress's interest in better understanding the nature and soundness of the analytical procedures OSHA conducts in these substantive areas.

In general, the findings and estimates the agency produces on these matters can significantly influence the course of the policy debate and the specifics of the health and safety standards ultimately promulgated. In addition, the process of soliciting comments on drafts of these analyses from stakeholders and other interested parties represents one of the principal channels through which competing interests are engaged in rulemakings. Thus, the drafting and completion of these analyses in an adequate and credible way are essential in OSHA's performance of its regulatory mission.

In brief, this study reviewed the analytical methods (related to technology options and regulatory impacts) employed by OSHA in a substantial number of past rulemakings; compared actual industry outcomes with the prior rulemaking estimates in a selected number of cases; examined the organization and resources supporting the agency's analytical efforts; and compared the agency's practices with those of other regulatory organizations. OTA's broad appraisal of OSHA's capabilities and procedures arises from findings in each of these areas.

THE CONTEXT FOR THIS STUDY

The Occupational Safety and Health Act of 1970 (29 *USC* section 651–678) signaled Congress's intent that occupational injuries and illnesses should, as much as possible, be eliminated from American workplaces. This legislative action was taken in view of the existing incidence of

[1] Health and safety risk assessments are also of central importance in OSHA's rulemakings. Nonetheless, the agency's analytical procedures in this respect are not a chief focus of this project, and little comment is provided on them here. OSHA is also required to prepare an Environmental Impact Statement to accompany rulemakings, in accordance with the Environmental Policy Act of 1969. However, in the vast majority of rulemakings this is a relatively minor aspect of the regulatory analysis effort, and this report makes no comment on the preparation of these statements.

occupational fatalities, injuries, and illnesses that was widely regarded as unacceptable. (Box 1-1 provides some background on the magnitude of workplace fatalities, injuries, and illnesses.) At the same time, Congress also recognized that workplace injuries and illnesses imposed a

BOX 1-1: The Trends In Workplace Fatalities, Injuries, and Illnesses

The principal motivation for enactment of the OSH Act and subsequent establishment of OSHA stemmed from unacceptably high incidence rates of workplace fatalities, injuries, and illnesses. The discussion below briefly reviews some of the estimates of these rates over the now more than 20 years since the OSH Act became law.

It should be recognized at the outset, however, that the task of measurement is more difficult than might first be imagined. In 1985, the Office of Technology Assessment (OTA) discussed the shortcomings of the data that go into workplace fatality, injury and illness rates. Two years later, the National Research Council drew attention to the deficiencies in data gathering and reporting and suggested a number of changes in procedures. Improvements have been made since, but varying sources still produce rate estimates that differ widely.

Workplace Fatalities

Year	Fatality rate (per 100,000 workers)	Injury and Illness rate (per 100 workers)	Injury rate (per 100 workers)
1972	17.2	10.9	—
1973	17.0	11.0	10.6
1974	15.7	10.4	10.0
1975	15.3	9.1	8.8
1976	14.2	9.2	8.9
1977	14.1	9.3	9.0
1978	13.7	9.4	9.2
1979	13.2	9.5	9.2
1980	13.4	8.7	8.5
1981	12.5	8.3	8.1
1982	12.0	7.7	7.6
1983	11.7	7.6	7.5
1984	11.0	8.0	7.8
1985	10.8	7.9	7.7
1986	10.2	7.9	7.7
1987	10.1	8.3	8.0
1988	9.6	8.6	8.3
1989	9.2	8.6	8.2
1990	8.7	8.8	8.3
1991	8.4	8.4	7.9
1992	7.9	8.9	8.3
1993	7.7	8.5	7.9

SOURCES: Fatality rates—National Safety Council, 1994. *Accident Facts: 1994 Edition.* National Safety Council: Chicago, p. 37. Injury and illness rates—U.S. Department of Labor, Bureau of Labor Statistics, 1994. *Workplace Injuries and Illnesses in 1993,* USDL-94-600, Table 3.

(continued)

BOX 1-1: The Trends In Workplace Fatalities, Injuries, and Illnesses (Cont'd.)

The National Safety Council (NSC) publishes the most comprehensive estimates of occupational fatalities that cover the entire period of OSHA's existence. These figures are based on information from death certificates and from workers' compensation data from state programs. They are intended to reflect all unintentional injury-related deaths in the civilian workforce, 14 years and older, with the exception of private household workers. (NSC's figures exclude workplace deaths from homicides and suicides.)

A 1994 NSC report indicates that the estimated workplace fatality rate dropped from about 17 per 100,000 workers in 1972 to a little less than 8 per 100,000 workers in 1993—a decrease of about 57 percent since establishment of OSHA. Generally speaking, workplace dangers are greatest in the construction and heavy-industry sectors. Overall, however, motor vehicle accidents continue to be the single largest component of the fatalities identified by NSC, accounting for 35 percent of all occupational mortality in 1993, up from 31 percent in 1972. (Other major causes include falls, being struck by various objects, electrocutions, fires and explosions.)

The National Institute of Occupational Safety and Health (NIOSH) and the Department of Labor's Bureau of Labor Statistics (BLS) also have prepared surveys of occupational fatalities. Both of these also indicate a long-run decrease in workplace fatality rates.

NIOSH's figures show the death rate as falling from around 9 per 100,000 workers in 1980 to about 5.8 per 100,000 in 1989—a decrease of about 35 percent, similar to the 31 percent decrease in the NSC estimates over the same period. Nonetheless, NSC's year-to-year figures are consistently a good deal higher. In part, NIOSH's figures are based on reviews of death certificates, not all of which contain sufficient information to identify work associations, especially motor vehicle accidents.

BLS changed its method for collecting information on workplace fatalities in 1992, and it now characterizes its prior estimates as too low. Nonetheless, its existing figures for 1970 through 1991 show a generally downward trend. The present BLS system estimated there were 6,083 workplace deaths in 1992, as compared with NSC's estimate of 9,200. Unlike the NSC's figures, however, BLS includes workplace homicides (associated with robberies, for the most part), which account for 16 percent of the total (now second only to motor vehicles as a source of fatalities in BLS's data).

Generally, measurement problems are endemic to all of these estimates. It is important to note that deaths from workplace illnesses (e.g., health effects like cancer) are not included in either the NSC, NIOSH, or BLS data. Sorting out whether a particular death was the result of a workplace exposure or incident that may have occurred years or decades earlier is often very difficult. Thus, in all probability, the cited workplace fatality rates are underestimates of the actual incidences—and perhaps so to a considerable degree.

Workplace Injuries and Illnesses

The table also lists BLS's reported rates of workplace injury and illnesses from 1972 through 1993 (injuries are also listed as a subset). As is apparent, the general trend was one of declining rates over the 1972-1983 period—from an average of around 10.8 per 100 workers in the 1972-74 period down to an average of 7.7 in 1982-83, a cumulative decrease of about 21 percent. However, the annual rate rose somewhat (to the mid 8's per 100 workers) thereafter, although remaining well below the much higher levels that prevailed in the early 1970s.

Factors other than increased attention to health and safety, no doubt, contributed to some of these movements in the rate levels. For example, in the early 1970s, some employers entered "first aid cases"—minor injuries that involved essentially no lost time—into the records. BLS did not in fact require that such cases be recorded, and as employers quit entering them, the observed rates fell. For another, the recession of the early 1980s resulted in some workforce layoffs, and, as a rule, younger, less experienced workers (who tend to have higher accident rates) are laid off first. The modest increase in rates in the second half of the 1980s was a departure from the previous prevailing trend. However, this increase in rates also coincides with OSHA's increased emphasis on the accuracy of recordkeeping, and some of the upward movement is no doubt reflective of this development.

(continued)

BOX 1-1: The Trends In Workplace Fatalities, Injuries, and Illnesses (Cont'd.)

Undercounting is a problem in workplace-related illnesses, just as it is with fatalities. There are various reasons, including the difficulty of distinguishing workplace- and non-workplace-related illnesses, lengthy latency periods (including long after exposures have ceased), or diagnoses made without investigations of possible workplace associations. But the magnitude of the undercounting is simply unclear. (However, in 1992, BLS reported 2.3 million injuries and illnesses that caused workers to miss work beyond the day of injury or illness onset. Only 105,000 of those lost-day cases related to illnesses. The vast majority were directly attributable to the workplace, for example, contact dermatitis and repetitive motion task injuries.)

Identifying OSHA's Impact

Measuring the direct effect of OSHA regulations is a difficult analytical task, given the numerous confounding factors that need to be considered in identifying cause and effect. In part, the share of workers in higher-risk occupations has been shifting, as manufacturing jobs have ebbed and the services sector has ascended. Business cycles are also part of the story, in that economic downturns tend to remove less experienced, and typically higher-risk, workers from the workplace. Employer actions to improve health and safety conditions taken independent of OSHA's requirements need to be distinguished. The effect of worker's compensation payments on employee behaviors needs to be examined. Changes in record-keeping practices generally complicate the examination of time series trends. And the undercounting thought to be endemic in the available incidence data simply leaves a basic gap.

The generally falling workplace fatality rate reported by NCS, NIOSH, and BLS alike since the early 1970s at least provides room for finding an OSHA effect. And in some industries where reasonable data are available, there is strongly suggestive evidence of an OSHA impact (e.g., nearly 60 percent fewer deaths from dust-related fires and explosions in the grain-handling sector since OSHA's 1987 standard addressing these hazards, around 35 percent fewer deaths from trench cave-ins since the agency's 1989 standard addressing excavation practices in the construction industry).

Various non-OSHA factors have been suggested to explain the apparent long-run decline in injury and illness rates—including changes in record collection practices, employer actions taken independent of OSHA, and business cycle effects. Nonetheless, one well-regarded analyst of the agency's policies (Viscusi, 1992) has drawn a preliminary conclusion from examination of a number of specific industry sectors that OSHA regulations during the 1972–83 period have indeed contributed to reduced injury rates. (However, he also cautions that these conclusions "must necessarily be guarded," with further research needed to verify and separate the effects of OSHA from other factors.) One graphic example is the textile manufacturing sector, where reductions of dust levels in compliance with OSHA's 1978 cotton dust standard cut the incidence of crippling respiratory diseases from 20 percent of the workforce to about 1 percent.

SOURCES: M.J. Moore and W.K. Viscusi, *Compensation Mechanisms for Job Risks.* (Princeton, NJ: Princeton University Press, 1990). W.K. Viscusi, *Fatal Tradeoffs: Public and Private Responsibilities for Risk.* (New York: Oxford University Press, 1992). National Research Council, *Counting Injuries and Illnesses in the Workplace: Proposals for a Better System.* (Washington DC: National Academy Press, 1987). National Safety Council, *Accident Facts: 1994 Edition.* (Chicago: National Safety Council, 1994). U.S. Congress, Office of Technology Assessment. *Preventing Illness and Injury in the Workplace.* (Washington DC: U.S. Government Printing Office, 1985). U.S. Department of Labor, Bureau of Labor Statistics, *News: Workplace Injuries and Illnesses in 1992,* Washington, DC, December 15, 1993. U.S. Department of Labor, Bureau of Labor Statistics, *Fatal Workplace Injuries in 1992: A Collection of Data and Analysis,* Washington, DC, 1994. U.S. Department of Labor, National Institute for Occupational Safety and Health, *Fatal Injuries to Workers in the United States, 1980–1989: A Decade of Surveillance,* Department of Health and Human Services, Washington DC, 1993.

sizable, systemic burden on the national economy in the form of lost production, lost wages, added medical expenses, and compensation for disabilities.

The OSH Act created OSHA, placed it within the Department of Labor, and charged the Secretary with the responsibility for setting and enforcing safety and health standards mandatory for all businesses in order to secure and maintain workplaces free from preventable accidents and occupational diseases. Since 1970, OSHA has promulgated some two dozen major standards dealing with health hazards, and nearly five dozen in the safety arena (see box 1-2). At the time of this report's completion (late summer 1995), another three dozen new rulemakings are at varying stages of development (see box 1-3).

OSHA's mission principally involves identifying health and safety hazards that exist at unacceptable levels in the workplace and promoting their removal. Nonetheless, in promulgating rules, the agency is obliged to consider and present reasoned evidence concerning the economic consequences of the standards it issues, the regulatory benefits it anticipates, and, where compliance involves a technological element (many, but not all, provisions do), the technical feasibility of the required actions by the affected industries. In the course of a rulemaking, OSHA normally conducts various analyses addressing these issues: such as, assessments of prospective control technologies and the steps necessary to meet other requirements, estimates of the incremental costs to be incurred to achieve compliance, examinations of the cost burdens imposed on the directly affected industries and the economy at large, estimates of expected benefits, and the justification for agency intervention into the workings of the marketplace.

OSHA's conclusions on these matters are subject to considerable review and oversight. The public—including workers, employers, their representatives, the professional health and safety communities, and others with interest in the public policy outcome—has input via established hearing and comment procedures. Executive orders have provided the executive branch—particularly the Office of Management and Budget (OMB)—with the means to oversee and influence the form and content of intended regulatory actions. In many cases, promulgated standards are subsequently contested (in whole or part) in the courts, giving judges the opportunity to examine the agency's rulemaking rationale and corroborating evidence in some detail.

OSHA has long been one of the most criticized regulatory agencies in the federal bureaucracy. This unenviable position is, no doubt, an inevitable consequence of the agency's fundamental mission. Establishing, and enforcing, occupational safety and health regulations invariably pits individuals and groups with strongly held beliefs and vital interests against one another in what is often perceived as a zero-sum game, where as two analysts put it "any decision that significantly affects workers interests will just as significantly affect employers interests in the opposite direction."[2] Furthermore, the frictions that have long been attendant to labor and management relations in the United States—which certainly predate OSHA by well over a century—are often a palpable undercurrent.

The principal criticisms of the agency today span a wide range of issues. Many in the labor and the professional safety and health communities complain about the slow pace and low productivity of the agency's rulemaking effort—asserting that although important hazards have been addressed over the last two decades, many still remain. Concern is also expressed about the extent of protection the agency has been targeting in its rulemakings, particularly since the early 1980s. Businesses and those specialists concerned with the impacts of government intervention on the workings of the nation's economy often question whether the agency pays enough attention to the balance between the benefits and the new cost burdens expected to result from its regulatory actions. Stakeholders on both sides of issues and the courts alike often question

[2] S.A. Shapiro and T.O. McGarity, "Reorienting OSHA: Regulatory Alternatives and Legislative Reform," *Yale Journal on Regulation* 6 (1): 1-63, 1989.

BOX 1-2: Permanent Standards Promulgated By OSHA

HEALTH

Permanent rule	Promulgation date	Federal Register citation
Asbestos	June 7, 1972	37 FR 3155
Fourteen carcinogens	Jan. 29, 1974	39 FR 3755
Vinyl chloride	Oct. 4, 1974	39 FR 35890
Coke oven emissions	Oct. 22, 1976	41 FR 46741
1,2-Dibromo-3-chloropropane	Mar. 17, 1978	43 FR 11530
Inorganic arsenic	May 5, 1978	43 FR 19584
Cotton dust	June 23, 1978	43 FR 27350
Acrylonitrile	Oct. 3, 1978	43 FR 45762
Occupational exposures to lead	Nov. 14, 1978	43 FR 52952
Medical records	May 23, 1980	45 FR 35212
Noise exposure	Mar. 8, 1983	48 FR 9738
Hazard communications	Nov. 25, 1983	48 FR 53280
Ethylene oxide	June 22, 1984	49 FR 25734
Asbestos (NOTE: this action substantially amended the 1972 standard)	June 20, 1986	51 FR 22612
Benzene (NOTE: the benzene standard the agency promulgated in 1978 was set aside by the courts in 1980)	Sept. 11, 1987	52 FR 34460
Formaldehyde	Dec. 4, 1987	52 FR 46168
Air contaminants	Jan. 19, 1989	54 FR 2332
Lead, non-ferrous foundries	Jan. 30, 1990	55 FR 3146
Toxic substances in laboratories	Jan. 31, 1990	55 FR 3300
Bloodborne pathogens	Dec. 6, 1991	56 FR 64004
Cadmium	Sept. 14, 1992	57 FR 42102
Hazard communications (NOTE: this action extended the 1983 standard)	Feb. 9, 1994	59 FR 6126

SAFETY

Permanent rule	Promulgation date	Federal Register citation
Construction safety and health regulations	Apr. 17, 1971	36 FR 7340
General industry standards	May 29, 1971	36 FR 10466
Construction—roll-over protective structures	Apr. 5, 1972	37 FR 6837
Power transmission and distribution	Nov. 23, 1972	37 FR 24880
Scaffolds	Dec. 2, 1972	37 FR 25712
Lab accreditation	Sept. 11, 1973	38 FR 25149
Temporary flooring—steel	July 2, 1974	39 FR 24360
Mechanical power presses	Dec. 3, 1974	39 FR 41841
Agricultural tractors—roll-over protective structures	Apr. 25, 1975	40 FR 18253
Industrial slings	June 27, 1975	40 FR 27367
Guarding of farm field equipment, farmstead equipment, and cotton gins	Mar. 9, 1976	41 FR 10189

(continued)

BOX 1-2: Permanent Standards Promulgated By OSHA (Cont'd.)

SAFETY

Permanent rule	Promulgation date	Federal Register citation
Ground fault circuit interrupters	Dec. 21, 1976	41 FR 55695
Commercial diving operations	July 22, 1977	42 FR 37649
Fire prevention	Sept. 12, 1980	45 FR 60656
Guarding of low-pitched roof perimeters during performance of built-up roofing work	Nov. 14, 1980	45 FR 75618
Electrical safety requirements	Jan. 16, 1981	46 FR 4034
Shipyard consolidation	Apr. 20, 1982	47 FR 16984
Gasoline dispensing nozzles, removal of ban on latch open devices	Sept. 7, 1982	47 FR 39161
Marine terminals	July 5, 1983	48 FR 30886
Servicing multi- and single-piece rim wheels	Feb. 3, 1984	49 FR 4338
Power lawnmowers	Feb. 1, 1985	50 FR 4648
Electrical standards for construction	July 11, 1986	51 FR 25294
Accident prevention tags	Sept. 19, 1986	51 FR 33251
Recordkeeping requirements for tests, inspections, and maintenance checks	Sept. 29, 1986	51 FR 34552
Field sanitation	May 1, 1987	52 FR 16050
Grain handling facilities	Dec. 31, 1987	52 FR 49592
Presence sensing device initiation of mechanical power presses	Mar. 14, 1988	53 FR 8322
Safety testing/certification of workplace equipment and materials	Apr. 12, 1988	53 FR 12102
Concrete masonry construction safety	June 16, 1988	53 FR 22612
Crane or derrick suspended personnel platforms	Aug. 2, 1988	53 FR 29116
Hazardous waste operations and emergency response training	Mar. 6, 1989	54 FR 9294
Underground construction	June 2, 1989	54 FR 23824
Powered platforms for building maintenance	July 28, 1989	54 FR 31408
Control of hazardous energy (lockout/tagout)	Sept. 1, 1989	54 FR 36644
Excavations, trenching	Oct. 31, 1989	54 FR 45894
Welding, cutting, and brazing	Apr. 11, 1990	55 FR 13694
Electrical work practices	Aug. 6, 1990	55 FR 31984
Lift slab construction	Oct. 18, 1990	55 FR 42306
Stairways and ladders in construction	Nov. 14, 1990	55 FR 47660
Process safety management	Feb. 24, 1992	57 FR 6356
Confined spaces	Jan. 14, 1993	58 FR 4462
Electric power generation, transmission, and distribution	Jan. 31, 1994	59 FR 4320
Face, head, eye, and foot protection	Apr. 6, 1994	59 FR 16334
Reporting of fatality or multiple hospitalizations	May 2, 1994	59 FR 15594
Logging operations	Oct. 12, 1994	59 FR 19745

SOURCE: Compiled by Office of Technology Assessment from *Federal Register* citations and other sources.

BOX 1-3: OSHA Rulemakings in Progress

Title	Status
HEALTH	
Respiratory protection	Proposed rule stage
Occupational exposure to hexavalent chromium	Proposed rule stage
Occupational exposure to tuberculosis	Proposed rule stage
1,3-Butadiene	Final rule stage
Glycol ethers: 2-methoxyethanol, 2-ethoxyethanol, and their acetates	Final rule stage
Methylene chloride	Final rule stage
Air contaminants rule for construction, agriculture, and maritime	Final rule stage
Indoor air quality in the workplace	Final rule stage
SAFETY	
Steel erection	Proposed rule stage
Control of hazardous energy (lockout/tagout)—construction	Proposed rule stage
Powered industrial truck operator training	Proposed rule stage
Ergonomic protection	Proposed rule stage[1]
Comprehensive occupational safety and health programs	Proposed rule stage
Confined spaces—construction	Proposed rule stage
Miscellaneous amendments to the safety standards for the construction industry	Proposed rule stage
General working conditions in shipyards	Proposed rule stage
Fire protection in shipyard employment	Proposed rule stage
Permit required confined spaces (amendment to existing standard)	Proposed rule stage
Scaffolds—construction	Final rule stage
Safety and health regulations for longshoring and marine terminals	Final rule stage
Scaffolds in shipyards	Final rule stage
Access and egress in shipyards	Final rule stage
Personal protective equipment in shipyards	Final rule stage
Walking working surfaces and personal fall protection systems	Final rule stage
Accreditation of training programs for hazardous waste operations	Final rule stage
OTHER	
Recording and reporting occupational injuries and illnesses	Proposed rule stage
Abatement verification	Final rule stage

[1] In June 1995 the OSHA director placed the ongoing Ergonomics rulemaking on hold.

SOURCE: Department of Labor, Occupational Safety and Health Administration, "Unified Agenda of Regulations," *Federal Register* 60: 23571–23583, May 8, 1995.

whether the agency adequately understands the extent of hazards at hand and the pertinent facts and considerations essential to forming sound policy. Some believe the agency spends too little time probing the potential of new technology for removing constraints in the way of workplace

hazard reductions. Many of these complaints are widely shared, but interested parties differ—often radically—in the specifics of their fault finding and prescriptions for remedies.

STUDY REQUEST AND QUESTIONS ADDRESSED

This study stems from a May 1992 request from members of the House Committee on Education and Labor[3] and the Senate Committee on Labor and Human Resources that the Office of Technology Assessment (OTA) prepare a report "evaluating OSHA's methods for selecting and examining the feasibility of engineering and other process changes to limit worker exposures to occupational hazards."[4] The request went on to express interest in also knowing how well the agency's rulemaking estimates of the methods of control, associated costs, and other economic effects typically matched the outcomes actually experienced as affected industries adjusted to the new compliance requirements.

To satisfy this request, OTA established a research effort that addressed a number of questions:

- What is the basic nature—tasks, procedures, methods—of the technology assessment, cost, and regulatory impact analyses OSHA normally conducts? Does the agency execute these efforts soundly?
- What are the principal criticisms of the agency's current analyses in these arenas? What has the agency done to address these concerns? What remains to be done?
- How reliable are the agency's rulemaking estimates of actual outcomes? What are the apparent major sources of disparities?
- What organizational capabilities and resources does the agency bring to its analytical tasks, and are these adequate?
- How do the agency's analytical approach and methods compare with those of other organizations with safety and health regulatory responsibilities?

The nature of the research and of the resources drawn upon is discussed further in chapter 3 of this report, which also contains the major evaluative findings. In brief, however, the effort encompassed four main areas. First, more than a dozen of OSHA's major health and safety standards were examined—a few of the major rules issued in the 1970s, but most from the early 1980s up through the early 1990s. This effort was intended to appraise the characteristic methods, data foundations, and uses of the feasibility and regulatory impact analyses prepared for the agency's rulemakings. Second, for eight of the standards, OTA assembled data on the nature of affected industries' actual adjustment to the compliance provisions and examined the accuracy of the rulemaking estimates (vis-à-vis predominant control measures adopted, compliance costs, and other economic impacts) against these post-promulgation outcomes. Third, to gain a better appreciation of the agency's internal procedures and capabilities for conducting technology and regulatory impact analyses, the operation and budgetary resources of the parts of the agency principally involved in these efforts were reviewed. Finally, to judge how OSHA's practices compared with those of other government organizations, the health and safety decisionmaking approaches of other federal agencies and those of some of the major trading partners of the United States were examined.

[3] In the 104th Congress, the responsibilities of this committee have been assumed by the House Committee on Economic and Educational Opportunities.

[4] William D. Ford, Chairman, House Committee on Education and Labor, and Edward M. Kennedy, Chairman, Senate Committee on Labor and Human Resources, letter to the Director, Office of Technology Assessment, U.S. Congress, Washington, DC, May 27, 1992.

MAJOR CONCLUSIONS

As a preview of the lengthier discussion in chapter 3, the principal findings from OTA's evaluative research are tabulated in box 1-4. The overall conclusions that OTA draws from these are as follows:

1. The 1970 OSH Act, particularly as the courts have subsequently interpreted its procedural requirements, executive orders (mandating the conduct of "regulatory analyses"), and other legislation (in particular, the 1980 Regulatory Flexibility Act) combine to impose an extensive set of analysis and evidentiary stipulations concerning hazard control options and regulatory impacts that OSHA must satisfy in promulgating its health and safety standards. By and large, the agency has developed a coherent and credible set of procedures and methods that are responsive to these various requirements—and which generally provide a reasonable channel for engagement of the views of direct stakeholders and other interested parties.
2. The agency's findings and estimates on hazard control options and regulatory impacts are often the subject of vigorous review and challenge by stakeholders and various experts on all sides of rulemaking issues. But this reaction does not generally indicate underlying agency analytical neglect. The agency's rulemakings are often lightning rods for controversy and are conducted in a politically polarized setting. The stakeholders, industrial health and safety professionals, and various government bodies involved in rulemakings often diverge widely when it comes to such basic issues as the intrinsic need for enhanced protection, the likely efficacy of new compliance measures, and the benefits and costs to arise. Furthermore, the analytical questions with greatest bearing on these matters are often not amenable to fully conclusive determination for various reasons: the complexity of the technical considerations involved (e.g., to what extent will risk be reduced as a result of the installation of particular control measures on an existing production process); the inevitable shortages of data on important parameters (which arise because, as a practical matter, the agency often does not have the budget, work calendar, or access to industry needed to collect all relevant data on the many technical factors involved); and attendant imponderables (such as what pertinent operating conditions will prevail over time in affected or otherwise involved industries).
3. OSHA's examinations of prospective control measures and the possible economic effects of their adoption occur principally in the course of procedurally obliged demonstrations that the compliance provisions of an intended standard are generally feasible in technical and economic terms for affected industries. It appears from the sample of existing standards OTA examined for this report, that the agency has generally performed this task with workable accuracy—that is, standards determined by OSHA to be "feasible" in the course of its analytical deliberations have usually proved to be so when industries took the necessary steps to comply. (However, a few failures in this respect were evident in the cases, and point to some analytical deficiencies the agency should consider in future work.)

   Nonetheless, the agency's demonstrations of feasibility are often based on conservative assumptions about what compliance responses will predominate across affected industries. As a result, there are often sizable disparities between OSHA's rulemaking projections of control technology adoption patterns, compliance spending, and other economic impacts, and what actually happens when affected industries respond to an enacted standard. In a good number of the cases that OTA examined, the actual compliance response that was observed included advanced or innovative control measures that had not been emphasized in the rulemaking analyses, and the actual cost burden proved to be considerably less than what OSHA had estimated.
4. Benefit-cost comparisons are not at present a formal basis on which OSHA sets its stan-

dards—the result of Congress's original crafting of the 1970 OSH Act and the various interpretations and guidelines provided by the courts in the years since. Nonetheless, as a practical matter of policymaking, such comparisons are often an informal medium through which the debate among OSHA, stakeholders, oversight bodies (such as OMB), and other interested parties proceeds. In light of this (and the executive order mandate for conduct of regulatory impact analyses), the agency normally assembles considerable analytical information on both estimated costs and benefits for an intended standard—and has done so largely irrespective of the expected magnitude of the overall economic impact on the economy.

Nonetheless, the figures the agency typically provides are, at best, an imperfect estimate of what is likely to actually transpire. The agency's quantification of benefits in rulemakings tends to focus on only the most important sources, rather than on the full spectrum of effects expected. Costs are usually comprehensively quantified, but the estimates are captive (as discussed earlier and immediately below) of the typically conservative assumptions about the control measures adopted.

5. The rulemaking cases OTA examined largely confirmed one of the stronger criticisms of OSHA's analytical priorities and practice: that the agency devotes relatively little attention to examining the potential of advanced technologies or the prospect of regulation-induced innovation to provide technologically and economically superior options for hazard control. Most attention does appear to be placed on "conventional" control measures (e.g., increased ventilation and production equipment enclosure), rather than on "new technology" (ranging from sophisticated emissions control devices to technologies capable of supporting basic shifts in production processes, including process redesigns, product reformulations, and material substitutions).

   Such a bias is not surprising, given the "feasibility demonstration" orientation of the agency's rulemaking logic and the need for control technology assumptions capable of standing up well under "substantial evidence" scrutiny by the courts later. But this narrowed focus leaves a significant gap in the vision of the potentially available control options that OSHA can bring to the policymaking debate. Furthermore, in a few of the rulemakings OTA examined, it appears that greater attention to the potential of new technology during the rulemaking might have supported more stringent hazard reduction provisions than were actually promulgated.

   Arguably, OSHA ought to be a progressive supporter of innovations and the adoption of better technology, when such measures may provide for the cost-effective application of superior hazard removal measures, work to the benefit of both industry and workers, and enhance the agency's ability to secure additional health and safety protections in the workplace. However, the agency's present approach and priorities in examining control options do not appear to be providing an effective means to this end.

   In OTA's opinion, this is a substantive deficit that particularly deserves OSHA's consideration. Moreover, it is an area to which Congress may wish to consider encouraging and facilitating the agency's more substantial attention.

6. Finally, it is surprising, given the long-standing and contentious public debate about the benefits and costs of OSHA's regulatory interventions, how little systematic knowledge exists about the actual effects of the agency's standards. OSHA would, no doubt, significantly benefit from a more routine effort to collect and interpret information pertaining to actual regulatory outcomes and impacts—to aid the agency in identifying possible needs for mid-course policy adjustments, to better inform the public on the balance between new

BOX 1-4: Summary of Principal Evaluative Findings

Appraisal of Methods and Process

- OSHA's examination of control measures and the impacts of new compliance requirements arises chiefly in preparing the procedurally mandated feasibility determinations and regulatory analyses. Within the confines of these tasks, the broad elements of what the agency prepares are generally coherent and credible. However, there is a "narrowness" in the questions addressed and findings provided that needs to be recognized.
- Typically, the considerations most influential in shaping feasibility and impact findings require substantial factual information about the characteristics of affected industries. Data collection to meet these needs is generally among the most challenging aspects of the agency's analytic effort for a rulemaking.
- A closely related point is that OSHA's feasibility and regulatory impact findings are often criticized as lacking empirical depth. This is a matter not easily dismissed, given the procedural importance of these findings and the threat of subsequent judicial remand, but it reflects an analytical challenge with few simple solutions.
- Explicit benefit-cost comparisons are not at present a formal basis for OSHA's rulemaking actions. Nonetheless, the agency normally prepares substantial information on the benefits and costs of intended standards—and, as a practical matter, stakeholders' competing perceptions about the benefit-cost balance likely to result are often a major focus of debate in the course of a rulemaking.
- For the most part, OSHA's current feasibility analyses devote little attention to the potential of advanced or emerging technologies to yield technically and economically superior methods for achieving reductions in workplace hazards. Much of this circumstance reflects the procedural priorities of the rulemaking process, as well as the nature of the hazard reductions the agency has targeted since the early 1980s. But a good case can be made that a lack of continuing insights on the potential of leading-edge technology hinders the agency in performing its mission.

Lessons from the Retrospective Case Studies

- Straightforward comparisons of the industry response and regulatory impact circumstances that have actually occurred with those projected by OSHA in promulgating standards exhibit both "hits" and "misses." But most all of the cases contain at least some significant disparities.
- Nonetheless, if the cases examined are judged on the basis of the accuracy with which feasibility was determined, OSHA's rulemaking estimates appear in a more favorable light.
- A number of larger lessons are suggested by these comparative findings:
  - — Based on the cases examined for this report, OSHA's rulemakings are not generally imposing an unworkable compliance burden on industry.
  - — OSHA's present procedures for estimating compliance responses and the associated economic consequences provide considerable room for actual adjustment outcomes to differ.
  - — Too narrow a concept of the feasible technology can hinder the agency in establishing justifiable health and safety protections.
  - — Feasibility analysis can be short of influence in driving consideration of competing policy options.
- One additional lesson from OTA's case research for this project is that it is surprising how little systematic information on the actual outcomes and impacts of the agency's standards is available.

(continued)

BOX 1-4: Summary of Principal Evaluative Findings (Cont'd.)

Organizational and Resource Considerations

- The level of resources supporting the agency's technology and regulatory analysis efforts is hard to pin down precisely, but it is apparent that demand has long been substantial and the resources thin.
- The existing resource constraints notwithstanding, developments on the horizon portend the need for an even larger regulatory analysis effort:
  - — increased pace of rulemaking;
  - — new analytic support for priority setting;
  - — increasing rulemaking controversy;
  - — an enlarged scope for judicial review;
  - — expanded analysis of control options and impacts.
- A number of ways to improve the agency's existing procedures for conducting and using regulatory analyses appear to merit consideration:
  - — improved interoffice integration within OSHA;
  - — expanded interaction with NIOSH;
  - — links with new-technology research at EPA;
  - — renewal of Department of Labor Policy Office inputs;
  - — increased interdisciplinarity at OSHA's Office of Regulatory Analysis.

Observations from Benchmarking

- OSHA's regulatory analysis tasks are, in some respects, more complicated than those of its counterparts elsewhere in the U.S. federal bureaucracy. Nonetheless, the agency's work is generally comparable to the best practices of other health and safety regulatory agencies.
- OSHA's regulatory analysis tasks are far more demanding than its foreign counterparts because the United States requires far more detailed economic and technological analysis to promulgate occupational safety and health regulations.
- Occupational safety and health regulators in other nations seem to be able to promulgate standards more quickly than OSHA and without the discord and rancor that often arises in OSHA proceedings. However, applying the means used elsewhere to limit conflict in U.S. rulemakings is problematic.
- Some of the initiatives related to safety and health standard setting now underway at EPA, an agency with similar regulatory analysis requirements, may merit OSHA's attention and consideration.

SOURCE: Office of Technology Assessment. See chapter 3 for a fuller discussion of each of these findings.

costs and new benefits being realized, and to provide insights that might help OSHA shape the content of future rulemakings.

To be sure, complete answers to these questions imply data collection and analysis efforts that are probably beyond practical reach (and beyond beneficial return for the agency's primary responsibilities). But the experience of the few existing evaluative studies on past rulemakings suggest that informative and useful findings (on industry compliance responses, incurred costs, and extent of hazard reductions) can be derived from something less than exhaustive studies. What is needed is

a more systematic effort on the agency's part to develop this kind of information.

Nonetheless, the tight constraints of the agency's present budget appear to make initiation of such a new evaluative research program difficult without undesirably diverting resources from other high-priority activities. Congress may wish to consider how it could best encourage and facilitate OSHA's greater attention to this task.

THE REST OF THIS REPORT

Chapter 2 provides some essential background on the features of OSHA's rulemaking procedures, the roles for control technology and regulatory impact analyses, and basic nature of the data collection and analytic steps taken. *Chapter 3* summarizes the major findings from OTA's evaluative research, along the four lines of inquiry just outlined above. *Chapter 4* discusses the policy implications of these findings, with particular attention to a number of issues of current Congressional attention regarding OSHA. *Appendices A and B* at the end contain further findings on the eight standards examined retrospectively and citations to the principal working papers and research reports prepared over the course of the project.

This entire report is principally a *summary* of a larger body of documented material prepared in the course of the research for the project. Readers interested in more details on the findings should consult the aforementioned working papers and research reports. OTA is making all these documents available through the National Technical Information Service (NTIS) in Springfield, VA.

OSHA's Current Analytic Procedures 2

Before the project's principal findings are discussed (in chapter 3), it is essential to review OSHA's principal procedures for setting standards. The associated steps and requirements are extensive. As rulemakings now work, the agency's examinations of control technologies and regulatory impacts are prepared chiefly in response to the particular tasks delegated by these regulatory procedures.

ELEMENTS OF OSHA'S PERMANENT STANDARDS

Health Standards

OSHA's health standards address exposures to hazardous materials and agents, such as chemicals capable of causing cancer (or other chronic health effects), poisons, severe noises, or vibrations. In the language of section 6(b)(5) of the OSH Act, such "toxic materials or harmful physical agents" are specially treated, and the Secretary of Labor is directed to promulgate standards "which most adequately assure, to the extent feasible, on the basis of the best available evidence, that no employee will suffer material impairment of health or functional capacity even if such employee has regular exposure to the hazard ... for the period of his working life."

Standards that the agency promulgates under this authority typically involve several kinds of compliance provisions. A requirement for employers to limit worksite exposures to a specified level or below is usually central—a "permissible exposure limit" (PEL) usually reflecting a time-weighted average exposure over a full workshift of 8 hours (TWA8) or a "short term exposure limit" (STEL) spanning a far shorter period (often 10 to 15 minutes). Such a requirement may require an employer to install new or improved engineering controls or to use substitute materials, to modify existing work practices (to remove workers from contaminated areas or limit the length of time they are exposed), to implement new administrative procedures (such as job rotation)—or often to use some mix of these various avenues for control.

Other kinds of compliance provisions can include establishing ongoing programs to monitor workplace exposure levels and to provide exposed employees with periodic medical surveillance examinations, establishing plans to be used in emergency exposure circumstances, and providing employees with up-to-date informa-

tion about the extent of workplace risks and training in hazard-reducing work practices.

Typically, the most extensive changes an affected establishment will have to undertake for compliance will relate to lowering worksite exposure levels. Here, modifications to existing production equipment, processes, and procedures may need to be made. Nonetheless, PEL or STEL provisions are intrinsically performance objectives, where employers are free to achieve the specified limits through whatever means they deem most economical. However, in keeping with industrial hygiene practice and the agency's long-standing policy, OSHA's health standards have continued to insist on the primacy of feasible engineering controls to lower exposure levels, rather than, say, fitting employees with personal respirators and protective clothing on a full-time basis.[1]

Safety Standards

OSHA's safety standards address workplace hazards "capable of causing immediately visible physical harm." Examples include ordinary industrial equipment that may, through sudden movement, cut, crush, or otherwise injure a worker, or industrial processes whose normal operation, when combined with other worksite circumstances, could yield catastrophic incidents such as explosions or electrocutions. OSHA's setting of safety standards comes under the general guidance of the OSH Act's section 3(8) for all permanent standards, to require "conditions, or the adoption or use of one of more practices, means, methods, operations, or processes, reasonably necessary or appropriate to provide safe or healthful employment and places of employment."

The specific features of safety rulemakings vary with the nature of the hazard. Generally, however, the kinds of provisions incorporated include those such as engineering specifications for equipment; work practices that seek to minimize the prospect for serious accidents; inspection and maintenance programs; advance planning for emergency situations; employee training and hazard communications; and, on occasion, formal certifications by external parties of the designs, installation, and operational adequacy of the equipment and work practices involved.

OSHA's past safety standards have often included quite specific requirements for equipment and procedures. In recent years, however, the agency has sought whenever possible to establish provisions on a performance basis, leaving employers with flexibility in choosing the means to comply.

RULEMAKING REQUIREMENTS AND INFLUENCES

As a matter of principle, OSHA has substantial policymaking discretion, with the latitude to defer to its own technical expertise in setting standards. Nonetheless, the agency's promulgation of rules is subject to considerable review and influence by various actors outside the agency. Indeed, as a general rule, OSHA's rulemakings need to be supported by an extensive presentation of evidence and rationale, and, along the way to promulgation, must be responsive to significant comments and submissions to the record by stakeholders and other interested parties. Arguably, OSHA faces rulemaking requirements among the most demanding of all federal agen-

[1] Industrial hygiene's "hierarchy of controls" places engineering controls at the top of the priority ladder, reflecting a conclusion (on good professional practice and risk reduction grounds) that workplace hazards should be removed at the source when at all possible. In parallel, OSHA's "methods of compliance" policy, first adopted by the agency from national consensus standards in 1971, has required that employers primarily use feasible engineering controls to achieve PELs. Nevertheless, this priority has been a matter of significant debate over the years with some segments of industry, wherein the flexibility to substitute respirators and/or personal protective equipment providing equivalent protection to engineering or work practice controls has been sought—and argued (by these proponents) to often provide a more cost-effective method of control.

cies with health, safety, and environmental regulatory responsibilities.[2]

Some of this circumstance stems from the various legal requirements incumbent on the agency. As the proponent of a rule or an order, OSHA must provide a demonstration in advance of promulgation that an intended rule is reasonably necessary, and refer to a documented record in doing so. As specified by the OSH Act, the agency is required to conduct rulemakings through a more demanding, hybrid version of the "informal" procedure specified by the Administrative Procedures Act.[3] Furthermore, should a challenge be mounted to a standard after promulgation, the agency's determinations must be capable of withstanding a "substantial evidence" review[4] by the courts—rather than the less demanding "arbitrary and capricious" level of review normally specified for "informal" agency rulemaking procedures by the Administrative Procedures Act.[5]

In addition, since the mid-1970s, the OSH Act has been the subject of numerous judicial interpretations—arising, for the most part, in the course of challenges mounted by stakeholders dissatisfied with newly promulgated standards. These decisions have generally been far-reaching for the agency's rulemaking procedures. Among other effects, this evolving body of case law has mandated or refined various substantive determinations the agency is obliged to make in support of rulemakings, notably, confirmation of the significance of the hazard being addressed and the technological and economic feasibility of the compliance provisions specified. Box 2-1 provides a further discussion of the essential features of these decisions as they affect OSHA's analytical activities.

[2] For a useful discussion of this point with citations, see Sidney A. Shapiro and Thomas O. McGarity, "Reorienting OSHA: Regulatory Alternatives and Legislative Reform," *Yale Journal on Regulation*, 6 (1989), pp. 4–12. Also, an OTA working paper prepared for this project compares OSHA's procedures to decisionmaking by other federal regulatory agencies with health and safety responsibilities and by OSHA-equivalent organizations abroad: David Butler, "OSHA's Brethren—Safety and Health Decisionmaking in the U.S. and Abroad," Office of Technology Assessment, U.S. Congress, Washington, DC, September 1995.

[3] As specified by the Administrative Procedures Act, "informal" rulemakings are conducted through informal notice and comment procedures, akin to a legislative process. By contrast, "formal" rulemaking operates chiefly through judicial procedures, such as swearing of witnesses, taking of depositions, and cross-examination. Congress specified essentially an "informal" procedure for OSHA with a legislative-type public hearing. But to assure the effective participation of concerned stakeholders and a just rulemaking, OSHA's procedures allow for cross-examination and specify keeping a verbatim transcript of the proceedings.

[4] The U.S. Supreme Court has interpreted substantial evidence to consist of "such relevant evidence as a reasonable mind might accept as adequate to support a conclusion" (*Consolo* v. *Federal Maritime Commission*, 383 U.S. 607, 619-20, (1965)). Nonetheless, the courts have repeatedly recognized that OSHA's standard setting involves legislative-type decisions, which are by nature not entirely reducible to determinable facts and often must engage imperfect and contradictory information. Under these circumstances, the courts have generally been deferential to agency actions, construing "substantial evidence" to involve the presentation of pertinent factual evidence, capable of supporting the rationale used by the agency in reaching its conclusions. Such evidence must be the best available, but it does not have to approach scientific certainty. See Kent D. Strader, "OSHA's Air Contaminants Standard Revision Succumbs to Substantial Evidence Test," *University of Cincinnati Law Review*, 92 (1993): 358–365.

[5] Some analysts argue that contemporary reviewing courts applying "hard look" scrutiny to agency actions have, as a practical matter, removed much of the intended difference between the "arbitrary and capricious" and "substantial evidence" levels of review (see Shapiro and McGarity, 1989, p. 9 and footnote 50). Nonetheless, the circumstance remains that OSHA is subject to a high standard of review and, because of the considerable threat of post-promulgation challenge, must generally go the extra mile to assemble an exceptionally strong rationale and supporting record for its regulatory actions.

BOX 2-1: Court Decisions Affecting OSHA's Conduct of Rulemakings

Health Standards

Significant Risk. In a 1980 decision, the U.S. Supreme Court (in *Industrial Union Dept.* v. *American Petroleum Institute*, 448 U.S. 607) concluded that OSHA could regulate a substance only after making a threshold finding (capable of meeting a "substantial evidence" test) that a significant risk of harm existed and that the standard would eliminate or reduce that risk. Several subsequent U.S. Court of Appeals decisions refined the evidentiary basis for such determinations. In light of these directions, OSHA's normal initial step in a health rulemaking is to verify that a significant risk exists and that a new/revised standard will reduce it. Scientific evidence from quantitative risk assessments is the usual foundation for this finding—although, the courts have made it clear that a positive determination can be made, if necessary, on less conclusive evidence (e.g., the weight of expert testimony or opinion), as long as it is applicable to the situation that causes the risk. Furthermore, once the agency makes a significance determination, it must then act to eliminate the hazard—or at least reduce it to the extent feasible.

Technological Feasibility. Reviewing courts have generally interpreted the "to the extent feasible" stipulation of the OSH Act's section 6(b)(5) to contain separate technological and economic components. On the technology side, OSHA must establish a general presumption (within the limits of best available evidence, capable of satisfying a substantial evidence level of review) that the typical firm in an affected industry will reasonably be able to develop and install the necessary engineering and work practice controls in most of its operations. This can be done by pointing to technology already in use. Nevertheless, the agency is not restricted to presently available technology. It can set a standard at a level achievable only by the most advanced plants in an industry or one that forces the development and diffusion of new technology. Here, certainty is not necessary, but the agency must provide a substantial evidence finding that the necessary technology has been conceived and is reasonably capable of experimental refinement and distribution within the standard's deadlines by companies acting vigorously and in good faith. (Decisions by both the U.S. Supreme Court and U.S. Court of Appeals were instrumental in defining these principles. See particularly *Society of the Plastics Industry* v. *OSHA*, 509 F.2d, 1301, 1309 (1975); *USWA* v. *Marshall*, 647 F.2d, 1189 (1980); *American Textile Manufacturers* v. *Donovan*, 452 U.S. 490 (1981); *Building and Construction Trades Dept., AFL-CIO* v. *Brock*, 838 F.2d 1258 (1988)).

Economic Feasibility. Similarly, the courts have concluded that OSHA must demonstrate (again, on a best available evidence basis, capable of substantial evidence review) that a standard is generally economically feasible for each regulated industry (or, potentially, for specific segments therein, if such segments are particularly vulnerable to the ramifications of the standard). In this, the agency must prepare a sound estimate of compliance costs and show that the standard will not cause massive economic dislocations within, or imperil the existence of, affected industries. Nevertheless, an economically feasible standard can be financially burdensome, can affect profit margins adversely, and need not guarantee the continued viability of individual firms that historically have lagged other regulated firms in providing safe places of employment. (See particularly *Industrial Union Dept.* v. *Hodgson*, 499 F.2d 467 (1974); *USWA* v. *Marshall*, 647 F.2d, 1189 (1980); *American Textile Manufacturers* v. *Donovan*, 452 U.S. 490 (1981)).

(continued)

BOX 2-1: Court Decisions Affecting OSHA's Conduct of Rulemakings (Cont'd.)

Benefit-Cost Balancing. In 1980, the U.S. Supreme Court, in *American Textile Manufacturers* v. *Donovan* (452 U.S. 490), directly addressed the use of benefit-cost analysis in establishing OSHA's health standards. The court concluded with the agency that section 6(b)(5) of the OSH Act precluded benefit-cost analysis as a direct basis—because Congress had placed the benefit of worker health above all other considerations save those making attainment unachievable, had considered health and safety protections as a reasonable cost of business, and had required feasibility analysis (to limit the prospect of regulatory overstretch). The Court's guidance in this area supersedes the executive order requirements that intended standards necessarily reflect a reasonable benefit-cost relationship. Nevertheless, as a practical matter, OSHA prepares estimates of regulatory costs and benefits—and often discusses their relationship in reviewing its economic feasibility findings.

Safety Standards

Significant Risk. OSHA has drawn much the same conclusions about the courts' guidance on this matter for safety standards as it has for health standards, that is, section 3(8) of the OSH Act requires, prior to promulgation, a threshold finding that significant risks are present in the workplace and can be eliminated or reduced by a change in practices. Thus, in this regard, the agency generally approaches a safety standard much the same as a health standard, and makes a significance determination as an initial rulemaking step.

Technological and Economic Feasibility. OSHA must make threshold determinations in both of these areas, just as for a health standard. The same burdens of proof prevail: general presumptions of feasibility for each affected industry (or relevant segments thereof), best available evidence, capable of withstanding a substantial evidence level of review by the courts.

Benefit-Cost Balancing. The U.S. Supreme Court's 1980 decision in *American Textile Manufacturers* v. *Donovan* (cited earlier) addressed the use of benefit-cost analysis only in health standards and left open the relevance of this method in safety rulemakings. More recently, though, in *International Union, UAW* v. *OSHA*, 938 F.2d 1310 (1991), the District of Columbia Circuit court (addressing various challenges to OSHA's 1989 Hazardous Energy Sources ["lockout-tagout"] safety standard) indicated concern that OSHA's interpretation of the OSH Act vis-à-vis the procedures for safety rulemakings could lead to very costly and minimally protective standards. The court expressed the view that safety standards restricted only by "feasibility" provided unreasonably broad discretion to OSHA. The court remanded the agency's interpretation of its procedural requirements for further consideration and suggested that benefit-cost analysis (though not the only acceptable approach) was consistent with the language of section 3(8) (the portion of the OSH Act that governs setting safety standards). OSHA's response to this matter to date (see 59 *Federal Register* 4427-4429) has been to argue that a technologically and economically infeasible standard would *a fortiori* not meet the "reasonably necessary or appropriate" threshold of section 3(8) and to strongly affirm the adequacy of its existing process for safety standards. (These procedures include a significant risk finding, technological and economic feasibility determinations, evidence and rationale capable of withstanding a substantial evidence review by the courts, the need to consider all serious comments on the record and specify cost-effective measures, but not a benefit-cost test.) Nonetheless, this is a matter that may not yet be resolved, and could well further gravitate toward a need for more systematic consideration of the balance of benefits and costs in future safety standard rulemakings.

SOURCE: Summarized by OTA from various OSHA rulemaking preamble materials in the *Federal Register*; Kent D. Strader, "OSHA's Air Contaminants Standard Revision Succumbs to Substantial Evidence Test," *University of Cincinnati Law Review* 92 (1993): 358-365; and other sources.

Presidential orders have added to the analytical requirements for a rulemaking. Nearly every administration since President Ford's in 1974 has issued an executive order mandating that federal regulatory agencies prepare comprehensive regulatory impact analyses to support rulemakings. The broad purpose of these orders has been to assure due consideration of the expected costs and benefits of new regulations and, since the early 1980s, to expand the role of White House and Executive Office of the President oversight in federal agency rulemaking.[6]

Additional requirements for analysis derive from congressional legislation subsequent to the OSH Act. The 1980 Regulatory Flexibility Act (5 U.S.C. 60 *et seq.*) requires that OSHA examine the economic impacts of its standards on "small entities" (i.e., small businesses, organizations, governmental jurisdictions) and demonstrate that a significant or unnecessary burden will not result.

Finally, beyond these formal requirements, there is also the day-to-day reality that the agency's regulatory mission is often exceedingly controversial and involves stakeholders with widely diverging interests. There are often substantial differences among affected parties' assessments of the need to enhance a level of protection, the likely efficacy of new compliance measures in reducing existing risks, and the attendant economic benefits and costs. The threat that those dissatisfied with an action will seek post-promulgation redress and a reshaping of the outcome through the courts is considerable and is a circumstance that has arisen frequently in OSHA rulemakings (particularly with respect to health standards). Beyond the statutory and technical considerations, the agency's policymaking invariably faces the challenging task of accomplishing the health and safety mission delegated to it by Congress and striking a workable balance among competing stakeholder interests.

[6] In general, these orders have reflected the desire that agencies clearly consider economic costs and alternative policies in their rulemakings and that adequate opportunity be provided for public comment on agency assumptions and findings. President Ford's E.O. 11821 in 1974 required an "inflation impact statement" to assure consideration of the possible inflationary effects of a regulation, where significant impacts on costs, productivity, competition, or the supply of important products and services were expected. (E.O. 11949 in 1976 extended the period of applicability of this mandate, and also renamed the required analyses "economic impact statements.") In 1978, President Carter replaced the Ford executive orders with his own E.O. 12044, requiring preparation of a "regulatory analysis" for all "major" rules (i.e., those expected to impose an annual effect of $100 million or more on the economy or give rise to a major increase in costs or prices for individual industries, levels of government, or geographic areas), showing that alternative policy approaches had been considered, and explaining the agency's policy choice. In 1981, President Reagan replaced the Carter order with E.O. 12291, which similarly mandated preparation of a "regulatory impact analysis" for all "major" rules (defined in most respects along the lines of the Carter order) but required more elaborate attention to expected costs and benefits, the consideration of policy alternatives (including nonregulatory means of achieving policy goals), and the net benefit and cost-effectiveness of potential new regulations. The Reagan order also substantially enlarged OMB's role in overseeing the regulatory impact assessment process and monitoring the preparation of potential regulatory actions. (A second order, E.O. 12498, issued four years later, authorized OMB's involvement at an earlier stage in the rulemaking process.) President Clinton's E.O. 12866 in 1993 replaced both of the Reagan orders, introduced a number of significant changes in the procedures for regulatory planning and executive oversight of rulemakings, but retained a requirement for the preparation of a formal "assessment" for any "significant regulatory action" (defined similarly to "major" in the Carter and Reagan orders) that considered the potential costs and benefits of the intended action and the policy alternatives available (including non-regulatory means).

ANALYTICAL CONTENT AND METHODS

In light of these various guidelines and requirements, OSHA normally conducts a rulemaking along a well-defined logical path. In the case of health standards, the principal steps are to (as OSHA describes them): 1) demonstrate that the substance/hazard to be regulated poses a significant risk to workers; 2) identify which if any of the regulatory policy alternatives being considered will substantially reduce the risk; 3) identify the most protective control requirements that are both technologically and economically feasible for the affected industries; and 4) identify the most cost-effective way to achieve this risk reduction objective.[7]

The agency articulates something quite similar for safety standards: 1) demonstrate that the proposed standard will substantially reduce a significant risk of material harm; 2) confirm that the required compliance actions are technologically feasible for the affected industries (in the sense that the protective measures required already exist, can be brought into existence with available technology, or can be created with technology that can reasonably be developed); 3) show that the new costs arising from these actions are economically feasible for the affected industries to bear (in the sense that industry can absorb or pass on the costs without major dislocation or threat of instability); and 4) demonstrate that the standard is cost-effective (in the sense that it employs the least expensive protective measures capable of reducing or eliminating significant risk).[8]

As the rulemaking process is (and has for some time been) organized to work, OSHA defines a target exposure level (e.g., a PEL) that provides an appropriate degree of protection, on health/safety grounds and with reference to "significant risk" considerations.[9] Such determinations are generally based on findings and risk modeling methods from the various scientific fields that comprise the discipline of Quantitative Risk Assessment (QRA).[10] The agency's conclusions on this matter are normally discussed in detail in the "preamble" sections published (in the *Federal Register*) along with the proposed and final versions of permanent standards.

Assessments of technological and economic feasibility are conducted in light of this target exposure level (or range of levels, if a single point has not been specified). These determinations, along with the additional analyses needed to satisfy the executive order-mandated regulatory impact analysis and Regulatory Flexibility Act requirements, are documented in "Regulatory Impact and Regulatory Flexibility Analysis"

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[7] See, for example, Department of Labor, Occupational Safety and Health Administration, "Occupational Exposure to Bloodborne Pathogens—Final Rule," *Federal Register* 56: 64034, Dec. 6, 1991.

[8] See, for example, Department of Labor, Occupational Safety and Health Administration, "Electric Power Generation, Transmission, and Distribution; Electrical Protective Equipment—Final Rule," *Federal Register* 59:4427, Jan. 31, 1994.

[9] As discussed earlier in Box 2-1, in setting permanent standards, OSHA is obligated to make a threshold determination (through substantial evidence) that a "significant risk" of harm exists and that new/revised compliance requirements can eliminate or reduce the risk. The U.S. Supreme Court's decision in *Industrial Union Dept. v. American Petroleum Institute* established the "significant risk" test in 1980. (For a further discussion, see Strader, 1993, pp. 365–373.) The Court did not, though, specify the "bright line" dividing significant from non-significant levels of risk. In rulemakings since the early 1980s, and based on an interpretation of Justice Steven's opinion in the case, OSHA has placed this "line" at a marginal risk of about one in a thousand over a full working lifetime. Some critics argue, however, that this level is not sufficiently protective, noting that other agencies such as EPA have been regulating to risk levels as stringent as one in a million. (See, for example, AFL-CIO, Department of Occupational Safety and Health, "The Workplace: America's Forgotten Environment—A Comparison of Protections Under U.S. Workplace Safety and Environmental Laws," Washington, DC, April 1993.) In fact, the Court only gave rough guidance in this matter, by recognizing that one in a thousand risk was "certainly significant" and that one in a billion was certainly not. Some critics view OSHA's choice of the least stringent level in this range as evidence of a policy objective to set comparatively relaxed standards that limit the economic burdens imposed on employers.

[10] For background on the issues and methods involved, see U.S. Congress, Office of Technology Assessment, *Researching Health Risks*, OTA-BBS-570 (Washington, DC: U.S. Government Printing Office, November 1993), pp. 45–66, or National Research Council, *Science and Judgment in Risk Assessment* (Washington, DC: National Academy of Science Press, 1994). A useful example of the current application (and complexities) of these methods to OSHA rulemakings is the recent health standard for cadmium, 57 *Federal Register* 42108-42210, Sept. 14, 1992.

reports, published in preliminary and final forms (also summarized in the *Federal Register*) to accompany proposed and final rules.

The agency's regulatory impact/regulatory flexibility assessments are multifaceted analyses, which, since the early 1980s, have normally focused on the following matters:

- *Identification and characterization of affected industries*. Here, the incidence of the hazard is mapped across industry, identifying those sectors and occupational groups with existing conditions and material uses that create exposures relevant to the intended rulemaking. The resulting profiles are typically quite detailed—usually distinguishing industries at a 3- or 4-digit Standard Industrial Classification (SIC) level and according to relevant occupational subgroups.[11]

The key results include estimates of the number of affected establishments and workers in each industry, existing exposure levels, and the frequency of health/safety effects. Background information on the basic business and process features of each affected industry is also normally assembled at this time. (OSHA's typical findings on these topics are illustrated in box 2-2, drawing on material from the 1992 health standard for cadmium.)

- *Technological feasibility of compliance*. On this matter, the principal task is demonstrating, for each affected industry, a general presumption that the compliance steps required by the various provisions of the intended standard involve control measures that are reasonably available, that is, they are either in the marketplace currently or can be developed/implemented consistent with the court's guidelines on "feasibility" (as outlined in box 2-1).

Normally this exercise involves detailed consideration of the existing production processes and work practices, along with the controls and programs for hazard prevention already in place. Depending on the specifics of the compliance provision examined, this analysis may focus on controls already successfully applied by establishments in the industry, or look more widely—to approaches in other industries, to experiences in industries/establishments outside the United States, or to emerging technologies not yet commercially available. (A further description of the agency's approach to this task is in box 2-3.)

By the time of the final rule, the discussion of technological feasibility is usually tightly focused on the specific provisions being promulgated. Earlier in the rulemaking, however, the examination of varying policy options is often wider (say, to examine the means and feasibility of achieving exposure ceilings at differing levels of stringency).

- *Anticipated benefits from regulation*. As part of the rationale for a rulemaking and to comply with executive order-mandated "regulatory impact analysis" requirements, OSHA normally provides quantified estimates of the principal health and safety benefits (on an annualized basis) that it expects to result from compliance (e.g., avoided cancer deaths, avoided cases of chronic illnesses, avoided permanent disabilities, avoided injuries involving lost work days).

Typically, these estimates are built up from detailed, industry-by-industry analyses, using the

[11] The information used for these tasks varies by the standard and the industries involved. However, recurring sources include data from OSHA's Integrated Management Information System (IMIS—which chiefly contains the field data collected during the agency's inspection and enforcement efforts) and from the record of prior rulemakings (some of which may have involved large-scale survey efforts collecting data on exposures, in place production processes, and control measures already used); data from other federal agencies, including the National Institute of Occupational Safety and Health (particularly from the Institute's Health Hazard Evaluations), Environmental Protection Agency (such as information from the Toxic Release Inventory), and the Department of Commerce (particularly from the various periodic surveys of manufacturers); original research conducted for the rulemaking, such as site visits to establishments in affected industries or large-scale industry surveys; and information submitted to the rulemaking docket, such as self-reports provided by individual establishments, surveys prepared by industry representatives, or research findings provided by various experts. OSHA normally assembles a substantial record of data on these matters. But often the best available information is incomplete, and working estimates must be prepared from what is available.

risk assessment findings and estimates of pre- and post-promulgation compliance levels. For the most part, the estimates are presented in physical terms (i.e., deaths, diseases, injuries avoided), as the agency has historically been reluctant to specify a particular monetary value for a statistical life saved or injury avoided. On occasion, however, the physical units are infor- really monetized in the course of discussing the findings.

BOX 2-2: An Illustration of OSHA's Industry Baseline and Control Option Characterizations—1992 Cadmium Standard

Industry sector [a,b]	Existing circumstances	Additional controls for compliance
Nickel-cadmium batteries *6* plants. 1,500 potentially exposed workers, Average exposure level is 73 μ g/m³ in "high" group, 14 μ g/m³ in "low" group, SECALs	Local exhaust ventilation (LEV), automation, enclosure, housekeeping practices in place—but used to varying extent. Respirators standard practice in high-exposure areas. All processes pose challenges for compliance through engineering and work practice controls alone—but difficulties are greatest in plate making and plate preparation,	Further exposure reduction through expanded use of current practices. Additional steps include modifications in materials procedures, upgrade of hygiene practices, improved information and training. But continued respirator use is likely to be necessary in some high exposure process areas.
Zinc/cadmium refining *5* plants. 1,350 potentially exposed workers. Average exposure level is 91 μ g/m³ in "high" group, 6 μ g/m³ in "low" group. SECAL	Hoods and baghouses exist in many process operations. Challenges for compliance through engineering and work practice controls alone in some areas: cadmium refining, casting, melting, oxide production, and sintering.	Added/improved LEV, mechanization of material transfer, added enclosures, centralized vacuum cleaning, clean air islands, revised work practices, improved housekeeping (vacuuming, damp mopping, added cleanup prior to maintenance). But continued respirator use is likely to be necessary in some high exposure process areas.
Cadmium pigments *4* plants. 100 potentially exposed workers. Average exposure level is 130 μ g/m³ in "high" group, 23 μ g/m³ "low" group, SECALs	Some controls in place, but use of ventilation systems generally limited. Large extent of batch production limits dedicated production lines. All processes pose challenges for compliance through engineering and work practice controls alone-but difficulties are greatest in calcining, crushing, milling, and blending.	Extensive expansion of ventilation systems, enclosure of process equipment, added central vacuuming equipment, adjusted work practices, improved housekeeping. Continued respirator use is likely to be necessary in some high-exposure process areas.
Dry color formulators *700* plants. 7,000 potentially exposed workers. Average exposure level is 10 μ g/m³	LEV, general ventilation, good housekeeping practices (vacuuming, damp mopping) are already in place. But batch nature of operations yields intermittent, variable exposure levels and frequent cleaning is required.	Added/improved general ventilation and LEV, dust collection systems, central vacuuming. But continued/ expanded respirator use—particularly during cleaning and maintenance, and other intermittent activities such as weighing out pigments.

(continued)

BOX 2-2: An Illustration of OSHA's Industry Baseline and Control Option Characterizations—1992 Cadmium Standard (Cont'd.)

Industry sector[a,b]	Existing circumstances[c]	Additional controls for compliance
Cadmium stabilizers 5 plants. 200 potentially exposed workers. Average exposure level is 116 µg/m^3 in "high" group, 3 µg/m^3 in "low" group. SECAL	Some LEV/baghouse control exists in dry process operations; little control present in wet process operations. Challenges for compliance through engineering and work practice controls alone in some areas: cadmium oxide charging, crushing, drying, and blending.	Added/improved LEV, installation of centralized vacuum systems, containment and enclosure improvements, automated material handling systems. Continued respirator use is likely to be necessary in some high-exposure process areas.
Lead smelting/refining 4 plants. 400 potentially exposed workers. Average exposure level is 43 µg/m^3 in "high" group, 3 µg/m^3 in "low" group. SECAL	Industry is already employing engineering controls to the extent feasible—because of the OSHA lead standard. Respirators used substantially in high-exposure areas. But particular challenges for compliance based on engineering and work practice controls alone in sinter, blast furnace, baghouse, and yard areas.	Some incremental improvements in ventilation and enclosure equipment. Marginal expansion of employee protection programs (hygiene, medical removal, etc.) Many of the requirements of the revised cadmium standard overlap existing requirements. Existing respirator use is expected to continue.
Cadmium plating 400 plants. 1,200 potentially exposed workers. Average exposure level is 35 µg/m^3 in "high" group, 2 µg/m^3 in "low" group. SECAL	Electroplaters make up 90 percent of this industry—adequate ventilation systems (LEV, hoods over material handling areas) are generally in place, and exposure levels for most are already below the PEL. Mechanical platers make up the rest of industry—ventilation systems are fairly widely in place, but exposure levels are well above the PEL, and apparent challenges are posed for full compliance based on engineering and work practice controls alone.	For mechanical platers: improved ventilation equipment, partial enclosures, better work practices and housekeeping procedures, increased respirator use during some operations.
Electric utilities 4,000 plants. 37,000 potentially exposed workers. Average exposure level is 1 µg/m^3.	Employee exposures generally arise during intermittent inspection or maintenance activities associated with electrostatic precipitators, fly ash conveyance, and boiler outages—and not during ordinary operations. Respirators are already standard practice.	Some additional engineering and work practice controls may be useful, e.g., wash downs of fly ash prior to boiler maintenance, fans or ventilation systems during maintenance operations. But respirators are likely to remain the mainstay of protection, due to intermittent and unpredictable nature of exposures.
Iron & steel 120 plants. 40,000 potentially exposed workers. Average exposure level is 2 µg/m^3.	"Best adequately demonstrated" technological systems for continuous emission reductions are generally in place in the industry—largely because of extensive EPA regulations. Respirator use is common in high-exposure areas. Job/process classifications with greatest risk for above PEL exposures include leaded steelmaking, work on air pollution control systems, maintenance activities.	Modest expansion of respirator use.

(continued)

BOX 2-2: An Illustration of OSHA's Industry Baseline and Control Option Characterizations—1992 Cadmium Standard (Cont'd.)

Industry sector[a,b]	Existing circumstances[c]	Additional controls for compliance
Other general industry 50,000 plants. 365,570 potentially exposed workers. Average exposure levels for the 10 occupational classes range from 0.4 to 6.0 µg/m^3.	Extent of existing controls varies widely across the many industries in this analysis group.	Generally applicable steps are improved general dilution ventilation, LEV for close capture of dusts and fumes, process enclosure (e.g., sealed panels, equipment covers, enclosed conveyors, glove boxes), separation/isolation of processes, improved work practices (to reduce generation of airborne cadmium and risks of exposures to high levels), additional cleanup prior to maintenance activities. In some cases it may be possible to shift to other materials or processes. Respirators are likely to be necessary in some situations.
Construction 10,000 plants. 70,000 potentially exposed workers. Average exposure level is 0.5 µg/m^3.	Construction activities are often intermittent and of short duration with unpredictable exposures. Activities may not involve fixed workplace and frequently occur in circumstances where engineering controls are not feasible. Respirators are widely used.	In some applications, shifts to products without cadmium. Feasible engineering and work practice controls include: portable hoods, exhaust ventilation, fans, enclosures, tools and work practices capable of minimizing exposures. Some further increase in the already substantial level of respirator use.

[a]The rulemaking identified nearly 100 industries as subject to compliance requirements under the new standard. However, for purposes of the analysis, these were grouped into the 11 sectors identified below in the table.

[b]The exposure levels listed are all TWA8.

[c]The descriptions above are summaries of the more detailed industry characterizations on which OSHA based its control and impact analyses.

[d]The final rule specified a uniform TWA8 PEL of 5 µg/m^3. However, in six industries, where feasibility limits were judged to exist, one or more so-called separate engineering control air limits (SECALs) were established (addressing specific production areas), allowing employers to achieve the PEL through application of a wider number of control measures (e.g., personal respirators along with engineering and work practice controls).

SOURCE: Summarized by OTA from U.S. Dept. of Labor/OSHA, Office of Regulatory Analysis, Final Cadmium Rule, 57 *Federal Register* 42224-42330, Sept. 14, 1992.

BOX 2-3: OSHA's Approach To Demonstrating Technological Feasibility

OSHA's consideration of applicable technological measures for hazard control arises chiefly in the course of providing adequate evidence of the general feasibility of an intended standard's compliance requirements across the industries identified as affected. In light of the procedural guidelines from the courts, such an analysis is normally conducted industry by industry (i.e., at a 3- or 4-digit SIC level of detail).

In the case of *health standards*, most of the effort is usually directed toward showing that suitable control measures are available (or can reasonably be developed within the compliance timeframe of the standard) so that an intended PEL can generally be achieved across an affected industry. Other provisions (medical surveillance, emergency planning, workforce training, and the like) may involve a technological component, but achievability is usually not a matter of debate.

As OSHA's rulemaking process is now organized to work, "significant risk" considerations define the target level for hazard reduction. Feasibility analysis proceeds in a "serial" way based on this determination, that is, engineering controls or substitution options are considered first (in keeping with industrial health's "hierarchy of controls" and OSHA's policy priority). If added control measures or substitutes that reduce exposures to (or below) the target level can be identified, then the analysis moves on to the economic feasibility test. Should some residual significant risk remain beyond the full application of such controls, however, work practice and administrative measures are considered. As a last resort, respirators and other personal protection equipment are factored in, if necessary.

Safety standards vary widely in the technological content of their provisions. (For example, the 1992 Process Safety Management standard primarily involved safety audit and other procedural requirements. But the 1987 Grain Handling Facilities standard involved various process equipment improvements and a major expansion in some housekeeping activities.) Nonetheless, the major issues and demonstration tasks are essentially the same as those for health standards.

The analyses for both kinds of standards have a number of common features:

- The consideration of potential means of control normally begins from a fairly detailed description of the industry baseline—the mix of production processes and equipment running in a typical plant, the work practices used, level of hazards experienced, and control measures already in place. Also, where scale effects and/or functional differences among the various subgroups of establishments in an industry are relevant considerations, the industry is often disaggregated into a number of stylized "model" plants for separate treatment.
- The primary focus of the analysis is demonstrating feasibility. As a general rule, the agency does not seek to identify and evaluate all possible control measures available to address the hazard or to define the frontier of maximally feasible hazard control.
- The agency's analyses tend to emphasize those measures whose engineering applicability, effectiveness of control, and cost characteristics can be well documented in the rulemaking record, that is, already commercially evident technologies with a clear track record are the preferred basis for feasibility determinations (because they can less easily be contested later in court). Where such obviously feasible measures cannot be identified or where a standard is deliberately technology forcing, OSHA must look more widely to analogous measures in other industries or to measures yet to be developed. Such measures can provide an adequate basis for a standard, as long as the agency can make a substantial evidence case that the necessary technology can be sufficiently refined and distributed within the standard's deadlines (see discussion in box 2-1, presented earlier).

(continued)

BOX 2-3: OSHA's Approach To Demonstrating Technological Feasibility (Cont'd.)

- Finally, the analysis process does *not* generally seek to forecast expected behaviors. The establishments that make up an affected industry are not, for the most, examined from the standpoint of the control options perceived to be available or the nature of the incentives at play that influence the selection of one kind of compliance strategy over another.

To comply, some (perhaps, even many) of an affected industry's establishments will adopt the control measures on which the agency's feasibility determination is based. (These measures are, after all, identified by OSHA because of their workability and usually are, by the ranking procedures employed, low-cost options among the set of feasible measures identified.) However, other establishments may well decide that it is more advantageous from a business standpoint to accelerate the turnover of plant equipment in order to adopt a new generation of production technologies (deriving, perhaps, productivity and product quality improvements at the same time as providing enhanced health/safety risk protections). Alternatively, some establishments may also choose to pursue opportunities for innovation with the prospect of yielding new technologies with a superior combination of production and hazard control characteristics. However, a reasonable estimate of the mix of behaviors among these various responses that one could expect to see post-promulgation is not something that can readily be discerned from OSHA's present analysis process—and actually involves a more complex and extensive analytical effort than what OSHA routinely performs in the context of feasibility demonstration.

SOURCE: Office of Technology Assessment, based on discussions with OSHA staff and review of various rulemaking docket materials.

OSHA's analyses also often identify one or more kinds of direct expenses that are anticipated to be avoided as a consequence of the hazard-reducing effects of the standard (e.g., reduced insurance premiums or lower costs for company-provided medical treatments). While these are tangible benefits of the regulation, OSHA's normal practice with such effects is to categorize them as avoided costs and net them against the estimated compliance spending. (Boxes 2-4 and 2-5, based on material from the 1992 Process Safety Management standard, illustrate the agency's benefits estimation process.)

- *Costs of compliance*. Often a considerable proportion of the overall analytical effort is devoted to identifying where compliance entails new costs for establishments in affected industries and preparing quantified estimates of this incremental spending. The agency now usually reports these figures on a pre-tax and annualized basis, spanning a time horizon dictated by the compliance terms of the standard and the depreciable life of the equipment and control actions involved.[12]

[12] The components of incremental compliance costs can include capital investments in new production equipment or controls, one time "sunk costs" required to establish required programs, and periodically recurring expenses such as for operations and maintenance. OSHA's normal procedure is to amortize capital investments and one-time costs over some appropriate recovery period (dictated by the specifics of the equipment and actions involved) and then add these as annualized figures to the estimated recurring costs. Where avoided costs (e.g., reduced insurance premiums because of reduced risk) are identified, they are quantified and netted out.

Typically, this is a detailed computational exercise, conducted provision by provision, and industry by industry.[13] In most cases, the calculations assume industry-wide adoption of the predominant technologies and control steps identified in the "feasible technology" analysis described earlier.[14] The calculations are also usually prepared to reflect the extent of pre-existing compliance with the new provisions prevailing across the industry—although, this aspect of the estimation process is often hampered by the absence of adequate field data pertaining to the existing baseline. (As an illustration, box 2-6 summarizes the compliance cost calculations for one of the industries regulated under OSHA's 1992 cadmium standard.)

Like the examination of feasible technologies, the version of compliance cost estimates published with the final rule is generally tightly focused on the provisions actually promulgated. But at earlier stages in the rulemaking, figures on several competing policy alternatives are often presented for review and comment.

- *Economic impacts*. The main objective of this portion of the rulemaking analysis is to demonstrate a general presumption of the financial feasibility of the compliance-related spending for each affected industry. Generally, this task is addressed by considering the ability of the typical establishment in the industry to either pass through or absorb these added costs. Analytically, the estimates of annualized compliance costs are compared with current figures on the industry's annual sales and annual profitability; these findings are supplemented by a discussion of the fundamental competitive and other economic forces driving the industry. (Box 2-7 provides a more detailed discussion of the agency's approach to these determinations. Box 2-8 illustrates the analytic results, drawing on the 1992 cadmium standard.)

[13] To put this task in perspective, OSHA's 1992 health standard for cadmium (57 *Federal Register* 42104) had 13 major compliance provisions and spanned almost 100 affected industries, with about 65,000 establishments and 525,000 potentially exposed workers. The 1991 standard for process safety management (57 *Federal Register* 6356) included 14 major provisions and affected 127 industries, with around 153,000 plants and around 3 million affected workers.

[14] See box 2-3. As reviewed there, OSHA generally assumes (for any given industry) the adoption of the low-cost, feasible measures relevant to the control needs at hand. The emphasis of attention is usually placed on those measures whose applicability, effectiveness of control, and cost characteristics can be well documented in the rulemaking record (i.e., already commercially evident technologies with a clear track record).

BOX 2-4: An Illustration of the Scope of OSHA's Consideration of Expected Compliance Benefits—1992 Process Safety Management Standard

Source identified	Treatment in rulemaking analysis
Incident reduction	
Fatalities avoided/major incidents	Quantified (annual estimates, years 1–5 and 6–10)
Injuries & illnesses avoided/major incidents	Quantified (annual estimates, years 1–5 and 6–10)
Injuries & illnesses avoided/less severe incidents	Mentioned, but not quantified
Health risk reductions	
Lowered risks for long-term health effects—reduced chronic exposures to airborne toxics from improved process designs	Mentioned, but not quantified
Cost savings	
Improved employee productivity	Quantified (annual estimates, years 1–5 and 6–10)
Reduced property damage	Quantified (annual estimates, years 1–5 and 6–10)
Reduced lost production	Quantified (annual estimates, years 1–5 and 6–10)
Reduced employee turnover	Quantified (annual estimates, years 1–5 and 6–10)
Lower insurance premiums	Mentioned, but not quantified
Reduced administration	Mentioned, but not quantified
Other accident prevention costs	Mentioned, but not quantified
Other economic benefits	
Improved use of space, labor, equipment	Mentioned, but not quantified
Efficiency gains from integration of process design, construction, operation, and safety	Mentioned, but not quantified
Reduced loss of raw materials; reduced inadvertent generation of waste	Mentioned, but not quantified
Reduced minor process/equipment breakdowns	Mentioned, but not quantified
Improved product quality	Mentioned, but not quantified

NOTE: OSHA addressed a 10-year post-promulgation time horizon in preparing the regulatory impact calculations for this rulemaking. Separate calculations were prepared (across all measures) for years 1–5 and years 6–10, because some of the major compliance provisions involved a gradual phase-in and the expectations for regulation-induced reductions in fatalities and injuries/illnesses were accordingly different.

SOURCE: Summarized by Office of Technology Assessment from the preamble to the final rule, 57 *Federal Register* 6400, 6402, Feb. 24, 1992.

BOX 2-5: An Illustration of OSHA's Estimation of Cost Savings from Compliance—1992 Process Safety Management Standard

OSHA's examination of the economics of compliance by the affected industries with the PSM standard quantified four sources of associated cost savings: improvements in productivity, reductions in worker turnover, reductions in lost production, and reductions in property damage. Examples of the estimates for several selected industries (for the standard as a whole, 127 industries were so identified) appear here, followed by some descriptive comment on how the calculations were performed.

	SIC industry	Productivity improvements	Reduced worker turnover	Reduced lost production	Reduced property damage	Total cost savings	Total compliance cost[1]
		$ thousands, annually					
Years 1– 5							
1321	Natural gas liquids	1,285	344	162	674	2,465	2,900
20	Food and kindred products	12,009	3,219	7,736	25,513	48,477	35,800
22	Textile mill products	2,160	579	125	1,926	4,790	3,200
2431	Millwork	1,105	296	133	3,562	5,097	5,900
25	Furniture and fixtures	9,273	2,486	653	8,472	20,884	44,100
Years 6–10							
1321	Natural gas liquids	2,570	689	323	1,348	4,930	1,100
20	Food and kindred products	24,018	6,438	15,472	51,026	96,955	13,500
22	Textile mill products	4,320	1,158	250	3,851	9,579	1,300
2431	Millwork	2,211	593	266	7,124	10,193	2,400
25	Furniture and fixtures	18,547	4,972	1,305	16,945	41,768	18,100

[1]Reported here to provide a basis for gauging the magnitude of the estimated cost savings.

Productivity Improvements

Substantial opportunities for improvements in operational efficiencies were expected to result as a by-product of the standard's required conduct of process hazard analyses. Some of these improvements related to streamlined equipment and technology (reducing waste and inefficiency), some to enhanced standardization of operating procedures (improving worker effort per unit of production).

The rulemaking docket contained a number of instances where efficiency gains could be associated quantitatively with the implementation of process safety management procedures. OSHA concluded that 0.5 percent annual productivity gains in years 1–5 and 1.0 percent annually in years 6–10 were roughly in line with this information. This gain, in effect, reduced the number of production labor hours required for the same level of output, which yielded an economic benefit in the form of reduced payroll costs.

(continued)

BOX 2-5: An Illustration of OSHA's Estimation of Cost Savings from Compliance—1992 Process Safety Management Standard (Cont'd.)

Reduced Worker Turnover

The level of workplace health and safety risks is generally regarded as an important contributing factor in the rate of employee turnover that is experienced. Thus the reduction of risk resulting from a program such as PSM was expected to slow the pace of such turnover. And such an improvement would reduce costs, because expenses are incurred in hiring and training new employees, and some decrease or interruption in production may be experienced while new workers are screened, hired, and trained to achieve the same efficiency as the previous personnel.

For the PSM rulemaking, OSHA approximated these costs according to the wages of the departed workers. Industry by industry, the gross payroll cost of production workers (assumed to average 60 percent of all employees) was multiplied by the overall turnover rate for manufacturing (26.4 percent) and by the fraction of turnover accounted for by the existence of hazards (33 percent) to establish a worker turnover baseline. The 40 and 80 percent effectiveness rates (Years 1-5 and Years 6-10, respectively) expected for the standard were then applied to estimate the cost savings.

Reduced Lost Production

Major/catastrophic incidents will often physically damage an affected plant's final products. Raw materials used to fashion a final product may be damaged or lost, and have to be purchased anew when production ultimately resumes. Furthermore, interruptions in production can give rise to unintended physical waste, some of which may be hazardous and require costly special treatment. Also, beyond the industrial sector that is immediately affected, sudden production bottlenecks can impose higher prices (OSHA noted that a major explosion at a Phillips Corporation plant in 1989 reduced the supply of high density polyethylene by 18 percent, which, in turn, drove a sharp price increase for this product.)

OSHA examined lost value added as an indicator of the economic value forgone in the aftermath of an incident—a measure it recognized as useful but conservative, because labor and overhead expenses were recognized, but raw materials (which may also be lost) were not. Estimates of the lost value added for the average incident (two weeks' shutdown time, on average, at minimum, based on an examination of historical incidents by an OSHA consultant) were developed industry by industry, using data from the *Annual Survey of Manufactures*, other government censuses, and private sources. A baseline level (i.e., pre-compliance) for value added lost annually was assembled by combining these figures with industry-level estimates of the number of incidents. Compliance with the standard was assumed to lower the number of incidents (in line with the aforementioned 40 and 80 percent effectiveness levels), from which a corresponding savings in value added was estimated.

OSHA went on to note that the PSM rule was also expected to prevent a large number of minor breakdowns. OSHA placed the annual economic savings of this reduction in the "tens of million" dollars. It did not, however, include this component in the savings figures reported.

Reduced Property Damage

Here, the main concern was that major/catastrophic incidents could yield significant damage to facilities and the in-place equipment.

Using analyses of historical incidents by outside consultants, OSHA estimated that average value of property damage from major/catastrophic incidents was $904,000. (OSHA characterized this as a lower bound, however, because history clearly indicated that damage ranging up to 10's of million dollars or more could arise.) This value for the average incident was then used to prepare savings estimates, industry by industry, in line with the baseline rate of incidents and the expected effectiveness of the PSM standard.

SOURCE: Summarized by Office of Technology Assessment from U.S. Department of Labor, Occupational Safety and Health Administration, Office of Regulatory Analysis, "Final Regulatory Impact and Regulatory Flexibility Analysis of the Final Standard for Process Safety Management of Highly Hazardous Chemicals," Washington, DC, 1992, pp. IV.17-IV.29.

BOX 2-6: An Illustration of OSHA's Estimation of an Affected Industry's Compliance Costs—1992 Cadmium Standard

Compliance cost estimates are often numerically extensive, but usually straightforward in concept. The figures and text here illustrate the details of these calculations for one of the industries identified as affected in the 1992 revision of the cadmium standard. (Across the entire standard, almost 100 industries were identified as affected. Similar calculations were prepared for these other industries.)

Nickel-Cadmium Batteries

The industry consists of 6 plants and has 1,500 potentially exposed workers. The average exposure for the "high" group of workers is 73 $\mu g/m^3$; that of the "low" group, 14 $\mu g/m^3$. The final rule established a uniform TWA8 PEL of 5 $\mu g/m^3$ across all affected industries. However, in the case of this sector, the usual requirement for PEL compliance principally through engineering and work practice controls was modified by a pair of "separate engineering control air limits" (SECALs)—which called for engineering/work practice controls to achieve 50 $\mu g/m^3$ in plate making and plate preparation, 15 $\mu g/m^3$ for all other processes, with respirators sanctioned to cover the excess of exposure between the SECAL and PEL (5 $\mu g/m^3$) levels.

■ **The cost of engineering controls**

	Controls per plant by size of plant				Cost per control (thousand $)			Industry costs (thousand $)				
Type of control	Small	Med	Large	Total industry-controls[1]	Capital	Ann. power & main.	Ann. labor	Total capital	Ann. capital charge[2]	Ann. power & main.	Ann. labor	Total annual industry cost (thou.$)
Local exhaust ventilation	1	5	8	29	80	8	0	2,320	377	232	0	609
Clean air islands	1	5	10	31	18	2	0	558	91	62	0	153
Central vacuum systems	1	1	2	7	15	1	7	105	17	7	49	73
Enclosure	0	3	5	17	9	0	0	153	25	0	0	25
TOTAL				84				3,136	511	301	49	861

[1]The industry consisted of 1 small plant; 4 medium plants; 1 large plant. [2]Assumes a 10% interest rate (the OMB "standardized" figure) and an amortization period of 10 years (in line with the depreciable life of the equipment involved, as defined by the tax code and standard accounting treatment).

The assumptions about the adoption of engineering controls reflected OSHA's "feasible technology" determination (described earlier), along with what available knowledge (or the most reasonable interpretation thereof) indicated about specific plant circumstances (i.e., existing exposure levels and controls, and process requirements). The unit cost figures used were the most credible values that OSHA could identify—whether from its own data, the initial estimates prepared by its contractor, figures submitted to the docket (e.g., those prepared by industry representatives or industry firms), or a reasonable synthesis of all of these. There was some controversy, however, about the assumptions used for these calculations, because several industry representatives submitted detailed analyses with findings on the options available, the likely effectiveness of controls, and costs that differed in significant ways from OSHA's preliminary estimates.

(continued)

BOX 2-6: An Illustration of OSHA's Estimation of an Affected Industry's Compliance Costs—1992 Cadmium Standard (Cont'd.)

■ **The cost of other provisions**

Provision	Annualized cost (thousand $)	Basis for calculations
Respirator use	180.0	An estimated 80 percent of production and maintenance employees would need to wear respirators full time after the implementation of feasible engineering controls. Accounting for existing use (which was substantial), the revised standard would require respirators for an additional 600 workers (i.e., 40 percent of the 1,500 potentially exposed employees). OSHA estimated the unit cost for appropriate respiratory protection at about $300 per worker. Thus the added annual cost is $300 times 600.
Exposure monitoring	16.2	The revised standard requires semi-annual exposure monitoring of "each shift for each job classification in each work area," but also allows representative samples to be taken for workers with similar exposures. Such a sampling regime is already prepared at the typical plant, but only annually. About 180 jobs would need to be monitored: an average of 10 job categories per plant, times 6 plants, times 3 shifts. OSHA estimated the unit costs at $40 per lab analysis and $1,500 per plant for the services of an industrial hygienist (or other qualified professional). Thus the incremental annual cost is $40 times 180 plus $1,500 times 6.
Medical surveillance (including operation of the "medical removal" program)	387.5	The revised standard's medical surveillance requirements involve a complex combination of various employee categories, action triggers, and types of exams. The base requirements call for annual biological monitoring, including tests for cadmium in urine, cadmium in blood, and β_2-microglobulin in urine, and for a full medical examination every two years. More frequent biological monitoring and medical exams are required if tests indicate elevated levels. Although medical surveillance was already widely done in the industry, the final rule would require most establishments to expand their programs. OSHA estimated that 300 additional medical exams would be needed (for those not currently covered plus those needing to be examined more frequently), at about $250 each (professional services plus employee wages). Tests for β_2-microglobulin were generally not currently provided; about 30 percent of the exposed workforce may be subject to more frequent biological monitoring, with 20 percent receiving semi-annual monitoring and 10 percent, quarterly monitoring. This entails an estimated 2,000 β_2-microglobulin tests annually (at $85 each including collection), 750 additional tests for cadmium in the urine (at $65 each, including collection), and 750 tests for cadmium in the blood (also $65 each). Based on these figures, the total estimated cost for incremental medical exams and biological monitoring is $342,500 annually. Regarding medical removal, OSHA estimated that on average about 3 percent of the workforce (i.e., 45 employees) may need to be removed every 5 years, at a cost of $5,000 per employee—or $45,000 on average annually for the industry as a whole.

(continued)

BOX 2-6: An Illustration of OSHA's Estimation of an Affected Industry's Compliance Costs—1992 Cadmium Standard (Cont'd.)

Hygiene facilities and protection	495.0	Most plants in this industry already comply with the work clothing and regulated areas requirements. But some modifications or expansions of lunch and shower rooms would be needed. The wages of the additional employees required to shower and change (about 300 workers) would also have to be taken into account. OSHA concluded that $200,000 in capital costs and $5,000 in annual operating costs would be a reasonable working average for the physical plant improvements. At about $900 per employee for showering on work time, i.e., 15 minutes per day, 240 days a year, at an hourly rate of $15, the cost works out to $1.2 million in capital spending (or $195,000 appropriately annualized) plus $300,000 in annual expenses.
Record-keeping and information	7.5	OSHA estimated an annual cost of $5 per employee—to cover the equipment needed and staff time. Thus, the incremental annual cost is $5 times 1,500.
Subtotal	1,086.2	Summing all the "other provisions" components above.

NOTE: OSHA drew the various figures and characterizations for these calculations from its own analyses and those of its contractor's initial assessment. The assumptions, however, were generally in line with the testimony and evidence in the rulemaking record and, for the most part, were not controversial.

■ **Total annual cost of compliance**

	thousand $	
Engineering controls	861.0	From above
Other provisions	1,086.2	From above
TOTAL	1,947.2	

SOURCE: Summarized by Office of Technology Assessment from the preamble materials to the final rule prepared by OSHA's Office of Regulatory Analysis, 57 *Federal Register* 42235-42239, Sept. 14, 1992.

BOX 2-7: Economic Feasibility—OSHA's Approach To Determining It

Concept

New regulations ordinarily shift resources toward compliance goods and services and away from production activities. As part of its burden to demonstrate feasibility, OSHA must show that the costs and other economic consequences of such a redistribution will not threaten the existence or competitive structure of the affected industries.

Establishments may pass the costs of a new regulation through to their customers as increased product prices or absorb them in the form of reduced profits, or some combination of these two. In markets where customers have choices (say, for a substitute product or for the equivalent product of a competitor that may not face the same regulatory requirements), a noticeable increase in price can usually to be expected to result in a loss of product sales. Alternatively, lower profits may reduce the value of the industry's capital, firms operating at the margin may choose to exit the industry, and the desirability of new investment in the industry may be diminished.

Typically, the most important determinant of a regulated industry's pricing flexibility is demand elasticity, that is, the extent of change in demand for a product changes with increases (or decreases) in its price. Where demand is relatively inelastic, producers can increase prices without losing sales. But where demand is elastic, the opposite circumstance is true. Numerous factors influence demand elasticity, including the availability of a substitute product, the importance of the product in customers' budgets, the degree of customers' technological or contractual dependence on the product, and the relative importance of price and nonprice attributes of the product.

Analysis and Data

OSHA's examination concerns the financial and economic impacts of compliance, with particular attention to changes in prices and profits. But consideration is also given to the effects on industry output, competition, employment, and international trade.

A first look at feasibility is gleaned by examining the maximum potential impacts on prices and profits. This is quantified by calculating both the ratio of estimated compliance costs to the industry's current revenues, and the ratio of compliance costs to the industry's current (pre-tax) profits. The former ratio reflects the situation that would arise if demand is price inelastic and compliance costs are fully passed on to customers as increased product prices. The latter ratio reflects the situation where demand is price elastic and compliance costs are absorbed by the industry as reduced profits. In most cases, these ratios reflect extreme circumstances, with the likely reality lying somewhere between. But they provide a useful perspective on how large the price and profit effects might be if the worst impacts prevail.

The figures used for these comparisons are straightforward. The compliance cost estimates are the annualized figures discussed earlier. Data on the industry's annual revenue and profits (usually for the most recent year available) are drawn from a variety of sources, including from the U.S. Department of Commerce's *Annual Census of Manufactures* and the financial press (Dun & Bradstreet, DIALOGUE, Dow Jones, etc.). Financial data on individual companies, which may have been submitted to the rulemaking docket, are used also, but OSHA indicates its normal practice is to first verify such figures through comparison with published sources.

OSHA then combines these ratios with other, and often more qualitative, information on the dynamics of the industry—demand growth rates, apparent demand elasticity, competitive considerations (both domestic and international), etc.—to draw its overall conclusions about feasibility. Obviously, where the ratios alone suggest that compliance costs are a small share of both revenues and profits, there is little evidence of a threat to the industry's existence.

SOURCE: Summarized by Office of Technology Assessment from OSHA discussion materials; see also the preamble to the Cadmium Final Rule, 57 *Federal Register* 42265, 42326, Sept. 14, 1992.

BOX 2-8: An Illustration of OSHA's Economic Feasibility Determinations—1992 Cadmium Standard

Industry sector[a]	Estimated average annual cost, per affected establishment	Expected economic impacts and feasibility rationale[b]
Nickel-cadmium batteries 6 plants. 1,500 potentially exposed workers. Average exposure level is 73 µg/m^3 in "high" group, 14 µg/m^3 in "low" group. SECALs[c]	$324,500	The final version of the standard may impose palpable costs for this industry (including reduced profitability). But these effects should not be substantial, compared with the other forces already operating in the market. Demand for Ni-cad batteries is strong and growing, and a 1 percent increase in revenues would completely offset the compliance costs, without reduction in profits. But the prospects for recouping compliance costs by raising prices are limited—as foreign competition is strong and there appears already to be enough production capacity outside the United States to satisfy current global demand. The standard is not expected to yield overall changes in production or result in plant closures. But the consequences for new investment or job creation is unclear.
Zinc/cadmium refining 5 plants. 1,350 potentially exposed workers. Average exposure level is 91 µg/m^3 in "high" group, 6 µg/m^3 in "low" group. SECAL	$344,600	By 1989, the U.S. had gone from near self-sufficiency to a net import reliance of 62 percent—as the result of environmental regulation, labor costs, and other factors. Nonetheless, the effects of the revised cadmium standard would be completely overshadowed by the basic forces in this industry. Cadmium is a necessary by-product of zinc refining, and decisions about its production are not made independent of conditions in the zinc market—indeed, cadmium revenues are usually considered a credit (or negative cost) by zinc refiners. The incremental costs of the standard are only a small fraction of present revenues and return on equity. Cadmium refining operations are currently conducted with extensive use of respirators and would have to continue to do so with or without the revised standard. The incremental compliance costs would be a very minor factor in investment decisions and are unlikely to greatly influence the survival of the industry in the United States.
Cadmium pigments 4 plants. 100 potentially exposed workers. Average exposure level is 130 µg/m^3 in "high" group. 23 µg/m^3 "low" group. SECALs	$118,400	Cadmium pigments are more expensive than other types of pigments. But overall demand is relatively inelastic, because of superior coloring features and chemical properties. (However, U.S. and foreign environmental regulations currently provide incentives to substitute away from cadmium pigments. And where their unique properties are not essential, the use of cadmium pigments has been declining.) Imported pigments reportedly sell for 15 to 30 percent less than comparable domestic products, but U.S. producers have maintained their share (70 to 80 percent) of the market. Compliance with the new standard would increase production costs for U.S. producers, but the associated changes in prices and profits would be relatively small. These changes would be overshadowed by more fundamental industry forces—price changes in raw materials and labor, tighter environmental restrictions at home and abroad, changes in the basic pattern of demand.

(continued)

BOX 2-8: An Illustration of OSHA's Economic Feasibility Determinations—1992 Cadmium Standard (Cont'd.)

Industry sector[a]	Estimated average annual cost, per affected establishment	Expected economic impacts and feasibility rationale[b]
Dry color formulators 700 plants. 7,000 potentially exposed workers. Average exposure level is 10 µg/m^3.	$10,500	Cadmium pigments are essential in many applications, and thus demand is inelastic. Only a slight increase in prices is needed to recoup compliance costs, and these should not result in plant closures, generally threaten the viability of the formulator industry, or produce adverse impacts in other industries. However, compliance costs can be expected to vary among establishments, depending on the type of technology used and the extent of existing exposure controls. And competition may limit the ability of some producers to raise prices to fully offset these new costs.
Cadmium stabilizers 5 plants. 200 potentially exposed workers. Average exposure level is 116 µg/m^3 in "high" group, 3 µg/m^3 in "low" group. SECAL	$187,100	Demand is inelastic. The dominant, almost exclusive market for cadmium stabilizers is for the production of flexible PVC compounds—and the stabilizers themselves account for only a small share of the cost of the compound. No good substitutes currently exist for cadmium stabilizers, imports currently make up an insignificant fraction of domestic supply, and domestic suppliers have generally similar cost profiles. Manufacturers should be able to raise prices sufficiently to recover compliance costs without major reductions in profits or sales volumes. The new standard poses no apparent threats to the industry's viability or competitive stability, should not result in plant closures, and would have only negligible influence on new investment decisions.
Lead smelting/refining 4 plants. 400 potentially exposed workers. Average exposure level is 43 µg/m^3 in "high" group, 3 µg/m^3 in "low" group. SECAL	$70,700	Many of the requirements of the revised standard overlap existing requirements (e.g., for control of lead and arsenic exposures) and do not create new burdens. The compliance costs imposed represent only a modest increase in exposure control costs and a marginal expansion of employee protection programs already instituted. Lead smelters and refiners should be able to absorb these new compliance costs—about equivalent to one new employee—into operating expenses.
Cadmium plating 400 plants. 1,200 potentially exposed workers. Average exposure level is 35 µg/m^3 in "high" group, 2 µg/m^3 in "low" group. SECAL	$2,000	Over 90 percent of establishments in this industry are electroplaters, generally with low exposures that will require minimal or no additional expense to comply with the new standard. The costs of compliance are primarily concentrated in mechanical plating—the other 10 percent of establishments. But demand for this more expensive and specialized service is relatively inelastic and should not be significantly affected. A price increase of about 10 percent would be needed to offset the estimated compliance costs for these establishments. Nevertheless, the cost of plating components generally is only a small fraction of the cost of final products (such as automobiles), and an increase in the cost of plating would translate into only a small increase in final product cost. Most of the affected establishments are small businesses that may need technical assistance in complying.

(continued)

BOX 2-8: An Illustration of OSHA's Economic Feasibility Determinations—1992 Cadmium Standard (Cont'd.)

Industry sector[a]	Estimated average annual cost, per affected establishment	Expected economic impacts and feasibility rationale[b]
Electric utilities 4,000 plants. 37,000 potentially exposed workers. Average exposure level is 1 µg/m^3.	$600	Implementation of the new standard would not involve new programs or large changes in procedures. The employees affected are already covered by the existing standards for lead and arsenic. The expected compliance costs are vanishingly small in comparison with the industry's revenues and operating income. There will be no significant impact on electricity demand, prices, production, or installed generation capacity.
Iron & steel 120 plants. 40,000 potentially exposed workers. Average exposure level is 2 µg/m^3.	$13,700	The value of blast furnace and basic steel industry shipments in 1989 exceeded $64 billion; new capital expenditures exceeded over $3 billion. The prospects for continuing future profitability are strong. The industry is subject to environmental and other regulations that impose costs far greater than the costs of meeting the new cadmium standard. The new standard represents a minimal increase in total regulatory burden and involves provisions consistent with requirements imposed by existing regulations. The standard will not threaten the industry's existence, reduce its competitiveness, or cause its contraction.
Other general industry 50,000 plants. 365,570 potentially exposed workers. Average exposure levels for the 10 occupational classes range from 0.4 to 6.0 µg/m^3.	$3,200	The new standard affects only a small part of the workforce in these industries and a limited number of activities. The standard's probable effect will be mixed—a combination of increased prices and reduced profits in the affected industries. But the estimated compliance costs are quite small by comparison to overall revenues and profits and are unlikely to affect the viability of existing establishments. The overall effect—on prices, output, etc.—would be largely undetectable.
Construction 10,000 plants. 70,000 potentially exposed workers. Average exposure level is 0.5 µg/m^3.	$1,100	Compliance costs would be incurred on a per-project basis, varying according to the size of the project, but would generally not require large capital expenditures. These cost increases, estimated to be only about 2 percent of the industry's current revenues, would in most cases be passed through to customers.

SOURCE: Summarized by Office of Technology Assessment from U.S. Dept. of Labor/OSHA, Office of Regulatory Analysis, Final Cadmium Rule, 57 *Federal Register 42224-42330*, Sept. 14, 1992.

NOTES: [a]The rulemaking identified nearly 100 industries as subject to compliance requirements under the new standard. However, for purposes of this analysis these were grouped into the 11 sectors identified in the table. [b]Not shown here, but an essential consideration in the findings, are the ratios of estimated annual compliance costs to, first, annual revenues and, then, annual (before tax) profits that OSHA calculated for each industry. [c]The final rule specified a uniform TWA8 PEL of 5 µg/m^3. However, in 6 industries, where feasibility limits were judged to exist, so-called separate engineering control air limits (SECALs) were established, allowing employers to achieve the PEL through application of a wider number of control measures (e.g., personal respirators along with engineering and work practice controls).

To satisfy Regulatory Flexibility Act requirements, a similar analysis—one that distinguishes small establishments from the larger organizational entities in the industry—is performed. And, in keeping with the executive order mandate, there is generally some discussion of the

potential magnitude of the economic impacts expected to ripple through to the larger economy—for example, on the general level of prices, levels of employment in affected sectors, effects on trade and competitiveness, and so on.[15]

- *Assessment of "nonregulatory alternatives."* Finally, the agency's regulatory impact documents now routinely include a section discussing why the market itself or other non-governmental interventions have not provided, and are unlikely to provide, the level of workplace health and safety protections envisaged by the standard. This discussion responds to a stipulation of the executive order-mandated regulatory analysis process and a practical need to address the "Why regulate?" question.

IMPLEMENTATION

Principal responsibility for the conduct of the agency's control technology and regulatory analyses is vested in OSHA's Office of Regulatory Analysis (ORA), located in the agency's Directorate of Policy (see figure 2-1). Nonetheless, other agency offices also contribute; these include the Health Directorate and Safety Directorate, which often provide some analytic support to ORA on matters related to workplace exposures and control technologies; the Department of Labor's Office of Regulatory Economics and Economic Policy Analysis, which in the past has reviewed OSHA's regulatory analysis documents and provided technical advice on economic regulatory issues; and the Department of Labor's Office of the Solicitor, which extensively reviews OSHA's regulatory analyses, vis-à-vis compatibility with statutory requirements.

OSHA continues to rely substantially on outside contractors (usually, expert consultants or consulting firms with expertise variously in fields related to engineering, economics, and industrial health) to conduct the necessary regulatory analysis research.[16] OSHA has also sought to draw, where possible and relevant, on the expertise and research of other federal agencies, particularly that of the National Institute of Occupational Safety and Health (NIOSH).[17]

The physical production of the analyses of control technology and regulatory impacts varies by the specifics of rulemaking and the affected industries. Nonetheless, most draw on a wide variety of information sources[18] and are produced and completed through a process that evolves over the course of a rulemaking and is open to substantial external review and comment.

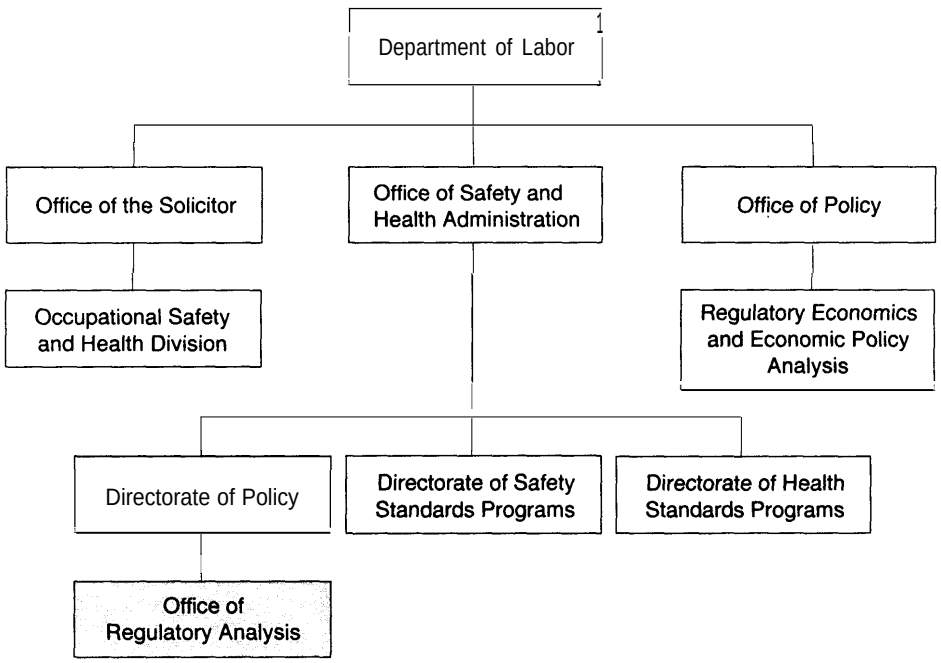
[15] Much of this kind of analysis has been performed by the agency on a more-or-less qualitative (though, nonetheless, informed) basis. However, the economic impact analysis for the 1978 cotton dust standard—which was anticipated, at least in the early stages of the rulemaking, to entail comparatively large compliance costs—did rely on simulations from a large-scale input/output model of the U.S. economy.

[16] Nonetheless, final responsibility for the content of a feasibility/regulatory impact analysis resides with OSHA. The preliminary version of the analysis report may well closely reflect the contractor's findings and conclusions. But the final version is usually substantially revised by OSHA—to reflect the opinions and data received from the hearings and comment period, any new analytical studies completed, and attendant changes in findings and conclusions.

[17] NIOSH is the principal federal agency with responsibility to conduct and disseminate research on occupational safety and health. NIOSH is formally a part of the Department of Health and Human Services. The staff is predominated by professionals with expertise in the areas of epidemiology, industrial hygiene, other health sciences, and engineering. NIOSH often makes recommendations to OSHA (in the form of "Criteria Documents" or other formal statements) concerning safety and health standards.

[18] As is perhaps apparent from the few illustrative examples provided in the chapter, the typical feasibility/impact assessment relies on and is documented through an extensive array of calculations, data points, and expert analytical judgments—documentation that in most cases defies brief summary. Generally, the kinds of information sources that play key roles include materials on health, safety, control engineering, and various economic matters published by the government, industry, and independent experts; field data from visits to selected establishments in affected industries and industry survey data (where available in the literature or from previous studies, or prepared specifically for the rulemaking by OSHA or interested parties); and expert judgments from various knowledgeable analysts.

FIGURE 2-1: Where OSHA's Regulatory Analysis Work is Conducted within the Department of Labor



SOURCE: Office of Technology Assessment, 1995.

Normally, a rulemaking is begun when OSHA issues an Advance Notice of Proposed Rulemaking (ANPR), inviting the submission of data, opinions, and other information (including that related to potential control options, compliance costs, and other regulatory impacts) from stakeholders and knowledgeable commentators.[19] In parallel with or soon thereafter, OSHA usually commissions one or more outside contractors (typically, consulting firms with expertise in the areas of economics, engineering, and industrial health or specialized knowledge about the affected industries) to prepare initial studies covering the full spectrum of the feasibility and regulatory impact issues just outlined. The agency then prepares a proposed standard and a preliminary regulatory impact/regulatory flexibility assessment reflecting these studies and the comments and other material available in the rulemaking record. Prior to publication, the agency is required to submit the proposed standard and the supporting regulatory impact analysis to OMB for review.

Subsequently, public hearings are held (usually announced in a Notice of Proposed Rulemaking, NOPR), wherein stakeholders, those with relevant expert knowledge, and other interested parties can comment and/or submit additional information related to the proposed content of the standard and the preliminary feasibility and regulatory impact findings. OSHA then uses these comments and other materials, along with any further studies/analyses that it may deem necessary, to resolve the final content

19 While an ANPR is the normative first step, **OSHA** does not always issue one. For example, the rulemaking leading **to** the 1992 cadmium health standard formally began in 1989, under a court-ordered deadline to quickly issue a proposed standard and move expeditiously to a final rule. Nonetheless, an ANPR is not the only way that preliminary opinions and information pertaining to a potential rulemaking can be gathered. In the cadmium case, the need for a standard had been a matter of consideration and debate by OSHA and the industrial health community since the early 1970s and much documented material already existed at the time the rulemaking commenced (see 57 ***Federal Register 42106,*** Sept. 14, 1992).

of the permanent standard and complete its regulatory impact/regulatory flexibility findings. The flow of these outside comments, recommendations, and new information (which can include new industry survey data or substantial technical analyses) is frequently quite heavy[20] and can lead to significant refinements and revisions in the OSHA's preliminary findings and policy decisions. Prior to publication, OSHA must again submit the final rule and the supporting regulatory impact analysis to OMB for review.

[20] Substantial comments and submissions from stakeholders, experts, and other interested parties in the many hundreds, if not the thousands (yielding many testimony transcript and other written pages) are typical for the agency's rulemakings. Some of these may be elaborate and detailed arguments—reflecting significant independent data collection and analysis—which take issue with OSHA's findings and determinations.

Discussion of Evaluation Findings 3

As outlined earlier, the research for this project pursued several avenues of inquiry: review of the methods and procedures OSHA normally employs in examining control technologies and regulatory impacts; conduct of a number of retrospective case studies on existing standards (comparing actual post-promulgation outcomes with the rulemaking estimates); examination of OSHA's current resources and organization for its control technology and regulatory analysis work; and comparisons of OSHA's analytic practices with those of other comparable regulatory organizations (in both the United States and abroad). This chapter discusses the major findings in each of these areas.

APPRAISAL OF METHODS AND PROCESS

OSHA's rulemakings vary widely with respect to the specific questions addressed, analytic methods employed, and information bases drawn upon—and, in most respects, the "real action" lies in the details. Nonetheless, the agency's typical examinations of control options and regulatory impacts contain similar elements. The observations in this section are intended to comment on the broad features of the data-gathering and analytic processes the agency routinely employs.

The findings reflect OTA's review of more than a dozen past OSHA rulemakings,[1] discussions with agency staff involved in the preparation and use of the analytic material, review of the scholarly literature on OSHA processes, and comments from other knowledgeable observers.

- ***OSHA's examination of control measures and the impacts of new compliance requirements arises chiefly in preparing the procedurally mandated feasibility determinations and regulatory analyses. Within the confines***

[1] Over the course of this study, OTA and its contractors examined the preamble and docket materials (focusing chiefly on the feasibility and regulatory impact analysis aspects) of more than a dozen OSHA health and safety standards promulgated since the mid-1970s: Vinyl Chloride (1974), Cotton Dust (1978), Occupational Lead (1978), Ethylene Oxide (1984), Formaldehyde (1987), Grain Handling Facilities (1987), Presence Sensing Device Initiation of Mechanical Power Presses (1988), Powered Platforms for Building Maintenance (1989), Air Contaminants (1989), Hazardous Energy Sources ["lockout/tagout"] (1989), Bloodborne Pathogens (1991), Process Safety Management (1992), Cadmium (1992), and Confined Spaces (1993).

of these tasks, the broad elements of what the agency prepares are generally coherent and credible. However, there is a "narrowness" in the questions addressed and findings provided that needs to be recognized.

The agency's various analytical findings and estimates are often vigorously disputed in the course of rulemakings by stakeholders and expert advisers on all sides of issues. Nonetheless, the broad evidence of the more than a dozen past rulemakings OTA has examined for this study indicates that OSHA routinely brings analytic processes to bear that are considerably detailed, in line with the established practices of the technical fields involved (whether related to risk factors, engineering considerations, economic impacts, or other relevant dimensions of assessment), and generally credible for the intended purposes.

Control measures and other compliance steps are normally examined in some depth with respect to their operational characteristics and adoption considerations. Estimates of costs and other economic impacts are developed in a serious way—in extensive detail for compliance expenditures, usually with substantial attention to potential effects on productivity and company viability, although more qualitatively with regard to impacts on the structure of affected industries and effects externalized to the larger economy. Estimates of the major benefits associated with hazard reduction also are normally prepared in some detail. Furthermore, the "full cycle" of events implemented for an analysis—commissioned studies, other expert contributions, OSHA staff analyses, findings published in preliminary and final versions, the often extensive comments and technical submissions during the public hearings and comment period (from stakeholders, their representatives, and other experts), and review by external bodies such as OMB—generally provides for an extended and deliberate examination of the major issues affecting a rulemaking.

Nonetheless, there is some narrowness (that is, incompleteness) in the content of the agency's typical analyses that needs to be recognized in judging the findings that result. This circumstance variously reflects the agency's decision-making framework, the practical realities of the rulemaking context, and the specific features of the information needed to promulgate standards.

Perhaps most important, the agency's current estimation process is, by and large, *not* targeted on providing a "most likely" forecast of the mix of control actions, costs, and other economic impacts to arise as the various establishments making up an affected industry act to comply with a hazard reduction requirement established by the agency. Rather, the analytical effort is chiefly aimed (in keeping with the agency's procedural requirements) at providing a defensible demonstration that the compliance provisions specified by the preliminary or final version of a standard are generally achievable across an affected industry. In this way, the majority of attention is usually placed on those control measures deemed essential to the feasibility demonstration at hand, rather than to the full scope of control options that may be available to establishments to comply (which could include significant shifts in production processes or the adoption of advantageous innovations, in addition to the conventional control measures OSHA's analyses tend to emphasize). And, unless binding technological or economic limits are encountered in removing what the agency determines to be an existing "significant risk," the analytic process generally does not take on the task of identifying the most stringent extent of hazard control that is achievable.

In addition, the agency's analyses are usually more comprehensive in charting the cost side of the regulatory equation than the anticipated benefits.[2] Estimates of the reductions of adverse health effects or accidents as a result of affected industry compliance are usually prepared in some detail.[3] But explicit quantification tends to be limited to the most significant endpoints, rather than to the more complete set of health and safety improvements expected.[4] Benefits in the form of directly avoided costs (e.g., reduced insurance premiums—because the risk levels experienced are lower) also are often quantified and included. But here again, the agency has not generally sought to be exhaustive.[5]

- ***Typically, the considerations most influential in shaping feasibility and impact findings require substantial factual information about the characteristics of affected industries. Data collection to meet these needs is generally among the most challenging aspects of the agency's analytic effort for a rulemaking.***

OSHA usually draws on a sizable array of information from diverse sources to prepare the necessary feasibility and impact analyses for rulemakings—although the specifics vary widely according to the nature of the standard and the industries involved.

Published materials from government and private sources are often used—materials such as Department of Commerce data characterizing the establishments and employees in particular industries, the industry financial indicators available from various on-line sources (e.g., Dun & Bradstreet), and various scientific/engineering studies (e.g., on production process issues or control options) in the scholarly or industrial trade literature. Technical studies prepared by other agencies, when relevant, are often drawn upon, for example, the Health Hazard Evaluations (HHEs)[6] prepared by NIOSH or industry-specific analyses from agencies such as EPA prepared in support of their own regulatory activities. Databases routinely maintained by OSHA often provide relevant information for rulemakings, notably, from the Integrated Management Information System (IMIS), Fatalities/Catastro-

[2] Nevertheless, OSHA's "imbalance" in this regard is not unlike the circumstances for other agencies with regulatory analysis requirements. Directly incurred costs are usually reasonably identifiable, amenable to estimation, and readily valued in a common economic metric (i.e., dollars). On the benefit side, the chief sources can usually be reasonably identified. However, credible quantitative estimation is often quite difficult—because, for example, of limits in the scientific foundation for relating causes to effects or because benefits with the character of an amenity are involved. And translation into a common economic metric poses a quagmire of conceptual issues of proper valuation.

[3] On occasion, OSHA does report a monetization of its benefit estimates. For the most part, however, the agency has sought to avoid the controversy of identifying a specific value for a statistical life saved or injury avoided. As a result, the benefit projections are generally presented in their native physical terms.

[4] OSHA often identifies a substantial list of acute and chronic health effects and hazard factors it expects will be removed or reduced by a new regulation. But quantification is usually limited to the most predominant effects (e.g., excess deaths from cancer over a working lifetime) and to situations in which there is a reasonable scientific and evidentiary basis for preparing estimates.

[5] For example, for health standards, OSHA has generally not quantified the economic benefits expected to accrue to industry from improved worker health. Furthermore, the agency has not yet sought for any standard to estimate the benefits from reduced workers' compensation premiums or reduced payouts (for companies that self-insure) for medical expenses and forgone earnings or reduced risk premiums paid to workers to accept hazardous workplace conditions (to the extent workers currently receive such premiums).

[6] NIOSH conducts industrial hygiene monitoring studies at specific industrial sites (when requested by the Secretary of Health and Human Services, by an employer, or an authorized worker representative) through a technical assistance program called Health Hazard Evaluations (HHEs). Normally, an HHE assembles detailed information on exposures, existing control measures by job classification, and related matters. For a further discussion, see J. Froines, D. Wegman, E. Eisen, "Hazard Surveillance in Occupational Disease," *American Journal of Public Health* 79 (Supplement): 26-31, Dec. 1989.

phes database (FATCAT), and, on occasion, the record of prior rulemakings.[7]

Data, analyses, and other materials submitted by stakeholders and other interested parties during the hearings and public comment period also often represent a sizable source of information. The agency is obligated to consider all serious submissions of this nature, and often a large fraction of a rulemaking's preamble section is taken up in acknowledging and responding to this material. While the potential for self-serving representation is clearly a consideration, it is apparent that OSHA has often been able to use this information to advantage.

Nonetheless, the considerations typically most central in making feasibility and impact determinations involve fairly detailed information about the features of affected industries. The most notable factors include: the existing distribution of exposures (or injuries or fatalities) among the workforce; the production processes and work practices in place, and the protective controls already being used; the likely efficacy of potential new compliance measures in reducing principal risk factors; and the various unit costs to be incurred in taking particular compliance actions. These factual and technical matters usually cannot be adequately resolved by consulting "off the shelf" or otherwise readily available information. Rather some form of primary data collection and original analysis of engineering, economic, and risk factors must be mounted for most rulemakings.[8]

OSHA and its research contractors have approached these data needs in various ways. Site visits (to willing establishments) in affected industries have been a typical feature of the empirical foundation for most rulemakings. Also, in recent years, the agency has conducted a number of large-scale surveys of affected industries (using statistical sampling methods and telephone interviews or written questionnaires or some combination).[9] (And, as noted earlier, in some cases, the information generated from such surveys has served to substitute in part for extensive original data collection in later rulemakings.[10]) On occasion, the agency has relied on a working panel of experts, with participants contributing information and judgments on affected industries about which they are particularly knowledgeable.[11]

OSHA appears to have used all of these approaches to advantage in the past. However, each has strengths and weaknesses. Site visits have provided substantial useful data on such matters as existing plant processes and control

[7] The Integrated Management Information System is OSHA's principal database characterizing workers' exposures to hazardous substances or conditions (see also Froines, Wegman, and Eisen, December 1989). IMIS maintains the monitoring results from both programmed and complaint inspections performed by the agency's field compliance officers—although, to date, around three-quarters of IMIS data relates to only a dozen or so chemicals. OSHA's Fatalities/Catastrophes database is a part of IMIS and records data from the mandated reports on workplace incidents involving fatalities or hospitalized injuries. A discussion of the major surveys of industrial establishments OSHA has conducted to support some past rulemakings follows in footnote 9 below.

[8] Some commentators knowledgeable about OSHA's rulemaking tasks observe that much of the functional content of a standard can be shaped without exhaustive evidence about the features of affected industries—and that even extensive research efforts will be unlikely to remove all pertinent uncertainties in key parameters such as those just outlined above. Nonetheless, it is essential to recognize (as a subsequent finding emphasizes) that the agency's feasibility and impact analyses are performed at least as much to satisfy the evidentiary guidelines specified by the courts and other government actors and to provide a record capable of withstanding future challenges, as to support the agency's internal policy design effort. However, information on the nature of impacts is also obviously essential to the agency's engagement of stakeholders in rulemakings.

[9] For example, to support the 1989 Air Contaminant rulemaking, OSHA collected data (regarding chemicals and processes used, existing engineering controls and work practices) from 6,500 establishments (sampled at a 4-digit SIC level of detail, but statistically representative only at 2- and 3-digit levels). In 1990, a survey with similar characteristics was conducted to support the Personal Protective Equipment Rulemaking; it involved a sample of 5,500 establishments. Survey data from around 3,000 establishments was collected across nearly 20 industries for the 1991 Bloodborne Pathogens standard.

[10] In the 1992 Process Safety Management standard, for example, OSHA relied extensively on the information available in the previously completed (and aforementioned) Air Contaminants and Personal Protective Equipment surveys.

[11] In the 1993 Confined Spaces rulemaking, for example, OSHA relied heavily on inputs from a 57-member panel of experts, each with specific expertise on one or several of over 100 industries determined to be affected.

measures, possible avenues for enhanced hazard control, insights on the feasibility issues likely to arise, and the chief considerations affecting compliance expenditures. But given the constraints of available budget, available work calendar, and the external review and approval specified by the Paperwork Reduction Act,[12] usually only a small fraction of the establishments potentially subject to an intended standard can be visited in the course of any given rulemaking. This fact and the potential unrepresentativeness of those facilities willing to be surveyed make it difficult to construe the data derived through this means as an adequately representative sample.

Large-scale surveys can address the statistical representativeness issue but usually cannot collect the detailed data on relevant plant features that site visits provide. In addition, such surveys are expensive and time-consuming to implement, and at present face the need for external review and sign-off by government personnel outside OSHA. These surveys have also been subject to the criticism that they provide essentially unverified data. Expert panels, when competent and balanced, can be an efficient mechanism to consider complex issues (particularly when standards are expected to require a technology-forcing component).[13] Nevertheless, the often judgmental character of the findings of such advisory bodies (in contrast to more conventional "hard" numerical analyses) can be a source of later vulnerability, should a challenge be mounted.

As a practical matter, OSHA must balance the needs of a particular rulemaking with the strengths and weaknesses of the methods available and the operating constraints of tight budget, constrained work calendar, and external oversight. In most rulemakings, therefore, OSHA has had to piece together as much relevant published information as is accessible, supplemented with original empirical work to the extent allowed by the prevailing constraints. As is evident in existing rulemaking records, the data and other information assembled by the agency are usually quite extensive. Nonetheless, as a matter of practice, an exhaustive assembly of all relevant evidence, such as would satisfy normal scientific research canons, is a difficult, if not impossible, objective in most cases.[14]

- ***A closely related point is that OSHA's feasibility and regulatory impact findings are often criticized as lacking empirical depth. This matter is not easily dismissed, given the procedural importance of the findings and the threat of subsequent judicial remand, but it is an analytical challenge with few simple solutions.***

[12] Under the OSH Act's existing requirements, where more than nine industrial sites are to be visited for data collection purposes in a rulemaking, OSHA must receive OMB's advance approval of the data collection and sampling plan. OSHA has successfully completed these steps with its past large-scale industry surveys, but OSHA staff indicate that the problem can be more troublesome when smaller-scale industry data collection efforts are involved.

[13] For example, OSHA has the option to appoint special advisory committees to assist with standard setting—which it has used in the past. In addition, the statutorily established National Advisory Committee on Occupational Safety and Health (NACOSH) could be used as a forum to discuss compliance options. However, OSHA has not made use of either of these information gathering tools for some time.

[14] With even the largest of the industry field surveys the agency has mounted in the past, the sampling of establishments has been too limited to yield statistically reliable projections at an industry-by-industry level, that is, at a 4-digit SIC level of disaggregation.

Criticisms about "data limitations" in OSHA's findings and estimates have come from several quarters. The courts have periodically reminded the agency of the importance of an adequate record and due treatment of relevant distinctions among industries in developing feasibility determinations. The U.S. Court of Appeals (11th Circuit) did this most recently in a 1994 remand of a portion of the 1992 Cadmium standard, which arose from a perceived deficiency in the field data supporting a feasibility determination for one of the affected industries.[15] A few years earlier in 1992, the same court rejected portions of the rationale of OSHA's 1989 Air Contaminants rulemaking, affirming (among other considerations) the need for substantial industrial detail in technological and economic feasibility determinations.[16]

In addition, stakeholders comment with some frequency that the agency makes decisions without a detailed understanding of the relevant existing features of establishments (exposures, in-place controls, practical constraints on control measures, etc.).[17] Whether or not such assertions are self-serving or fair in recognizing the practical constraints the agency routinely faces in collecting data, they represent a vulnerability for OSHA in completing and ultimately sustaining a rulemaking.

The problem would be substantially diminished if OSHA could routinely mount primary data collection (of a site visit nature) from a statistically representative sample of establishments in most all affected industries. However, such an effort would entail a budget, a work calendar, and access to affected industries that are generally beyond the agency's practical reach. Agency policymakers and research managers are left to resolve the tensions between analytic needs and incumbent constraints as best they can, case by case.

- ***Explicit benefit-cost comparisons are not at present a formal basis for OSHA's rulemaking actions. Nonetheless, the agency normally assembles substantial information on the benefits and costs of an intended standard—and, as a practical matter, stakeholders' competing perceptions about the benefit-cost balance likely to result are often a major focus of debate in the course of a rulemaking.***

One of the enduring critiques of OSHA's rulemaking procedures (typically coming most vigorously from economists, industry representatives, and others concerned about the effects of government interventions in the workings of the economy) has been that standards are set without due consideration of whether the benefits to be

[15] In 1994, in *Color Pigments Manufacturers Association, Inc.* v. *OSHA* (CA 11, No. 92-3057), the appeals court remanded the Cadmium standard (promulgated in 1992) for a specific inquiry into the feasibility of the standard for the dry color formulator industry (one of the nearly 100 industries affected). Here, despite the considerable analytical detail of the rulemaking as a whole, the agency's feasibility finding was deemed insufficient, because the companies and operations used to make the determination were not adequately representative of the dry color formulators industry as a whole.

[16] In 1992, in *AFL-CIO* v. *OSHA* (965 F.2d 962), the appeals court (again the 11th Circuit), reviewing the Air Contaminants standard (which had been promulgated in 1989, and sought to revise *en masse* the existing PELs for some 425 hazardous chemicals and substances in line with the latest American Conference of Governmental Industrial Hygienists recommendations), declared OSHA's technological and economic feasibility findings insufficient, on the ground that the agency had not demonstrated a general presumption of feasibility for each affected industry. OSHA's final analysis had presented feasibility findings classified at a 2-digit SIC level of detail (i.e., in considerably aggregated "major groups"). The court concluded that such a demonstration of feasibility was wholly inappropriate when disparate industries were involved whose production technologies or compliance costs were unrepresented by gross sectoral averages. What was needed instead was industry-specific information, i.e., at a 3-digit or 4-digit SIC level, as relevant differences among industries dictated.

[17] See, for example, L.P. Halprin, Keller & Heckman, Washington, DC, "Re: Proposed OSHA Survey on Ergonomic Hazards and Prevention Programs" (and supporting appendix material), unpublished letter to Secretary Lynn Martin (U.S. Department of Labor) and Acting Assistant Secretary Dorothy Strunk (Occupational Safety and Health Administration), Washington, DC, Dec. 28, 1992.

achieved are justified by the new costs incurred.[18] Indeed, in being subjected to this criticism, OSHA is not unlike most other regulatory agencies with responsibilities in the health, safety, and environmental risk arenas.

Nonetheless, as discussed earlier, OSHA routinely assembles substantial information related to both costs and benefits for its rulemakings, and does so largely irrespective of the anticipated magnitude of the cumulative impact on the national economy.[19] Some of this effort reflects compliance with the executive order mandate for conduct of "regulatory analyses." But it also reflects the practical reality that perceptions (if not competing figures) pertaining to the balance of benefits and costs to result from an intended regulation are often a focus for vigorous policy debate among principal stakeholders and in the agency's interaction with oversight bodies such as OMB.

It is true that the agency does not now set and justify its standards (of either a health or a safety nature) directly in accordance with the benefit-cost marginal analyses and net comparisons normally recommended by those advocating the "benefit-cost approach" to public policymaking. This circumstance is not, however, an unconsidered oversight. The roles of benefit and cost estimates in the agency's policy decisions have been the subject of substantial past attention by both Congress and the courts in defining the legal basis for the agency's regulatory actions.

In rulemakings on health standards, the agency has understood its procedural mandate to involve removing "significant risk" subject to technological and economic feasibility. In addition, the courts, interpreting Congress's legislative intention in the 1970 OSH Act, have directly precluded benefit-cost comparisons as a basis for setting health standards—particularly in the U.S. Supreme Court's 1980 decision in *American Textile Manufacturers* v. *Donovan* (see chapter 2, box 2-1). For setting safety standards, the agency has concluded (at least, to date) that much the same significant risk and feasibility analysis procedures provide an adequate procedural basis.

Nevertheless, there is room in the foreseeable future for these features to change in important ways—the result of actions by either the courts or Congress—and with potentially substantial implications for the agency's analytical procedures.

First, the role of benefit-cost considerations in safety-related rulemakings has become less clear in the wake of a 1991 U.S. Court of Appeals (DC Circuit) opinion, related to challenges to OSHA's 1989 Hazardous Energy Sources ("lock out/tag out") rulemaking, where questions about the breadth of OSHA's discretion in safety rulemakings were raised and the agency was asked to consider more explicitly incorporating benefit-cost balancing procedure in this type of regulatory action. The court expressed concern that the agency's existing basis for setting safety standards (chiefly, findings of "significant risk" and feasibility demonstrations—just as for health standards) provided unreasonably broad discretion, which, in the absence of systematic benefit-cost balancing, could yield very costly but minimally protective compliance requirements.[20] On this basis, OSHA's prevailing interpretation of

[18] A useful primer on the benefit-cost concept and associated analytical methods is E. Stokey and R. Zeckhauser, *A Primer on Policy Analysis*, New York: W.W. Norton, 1978, pp. 134–158. For a more specific discussion of the approach with regard to OSHA see M. Connerton and M. McCarthy, *Cost-Benefit Analysis and Regulation: Expressway to Reform or Blind Alley?* (Washington, DC: National Policy Exchange, October 1982); P.W. Kolp and W.K. Viscusi, "Uncertainty in Risk Analysis: A Retrospective Assessment of the OSHA Cotton Dust Standard," *Advances in Applied Micro-Economics*, 4: 105–130, 1986; and C.R. Sunstein, "Valuing Life," *The New Republic*, Feb. 15, 1993, especially pp. 38–40.

[19] Since the late 1970s, executive orders have generally mandated preparation of regulatory impact analyses where a cumulative national impact of $100 million or more annually is expected. Some bills in the present "regulatory reform" debate have proposed substantially tightening this threshold—to as low as a $25 million annual effect. However, OSHA has for some time been preparing the regulatory impact analyses as a routine element of the record, regardless of the expected level of economic impact.

[20] See U.S. Court of Appeals (DC Circuit) 1991 decision in *International Union, UAW* v. *OSHA*, 938 F.2d 1310 (particularly pp. 1318–1321).

its section 3(8) procedural requirements (the portion of the OSH Act governing safety standards) was remanded for further consideration—with the suggestion that benefit-cost analysis (although not the only possible approach to "balancing" benefits and costs) provided a means to resolve the problem.

In its subsequent safety rulemakings to date, OSHA has basically affirmed the adequacy of its existing procedures (i.e., significant risk findings, feasibility analysis, documentation capable of withstanding "substantial evidence" review, consideration of all serious comments in the record, and the need to identify cost-effective measures) for meeting the court's concerns and has *not* acted to incorporate more explicit benefit-cost balancing procedures in its rulemaking steps.[21] But it is unclear whether this issue has reached a point of policy stability—and is a matter to which the DC Circuit (or other court, for that matter) could return at some future point.

A second and more encompassing command to revise the role of benefit-cost considerations in OSHA's rulemakings—affecting health and safety standards alike—could come from the "regulatory reform" debate now underway in Congress.[22] Elevating the influence of explicit benefit-cost analyses in safety, health, and environmental regulatory rulemaking generally is a primary consideration in many of the present House and Senate proposals that have been submitted.

The specifics of any such new guidance from the courts or Congress are, of course, speculative at present. Nonetheless, it seems apparent that a mandate for more explicit benefit-cost consideration would press OSHA to deepen its control technology and regulatory analysis procedures in a number of significant respects. First, there would be a strong incentive to seek to quantify a fuller scope of estimated regulatory benefits, including those that are usually itemized now in more qualitative terms (particularly those in the health benefits arena, and the economic benefits accruing to industry as a result of hazard reductions). Second, the logic of the balancing comparison—whatever it proves to be—would no doubt press the agency to seek to more nearly prepare *expected* outcome forecasts of the costs from an intended regulation. This is a substantially more demanding analytical task than that necessary for the prevailing feasibility demonstration test, because the diversity of possible responses among the various establishments in affected industries and the prospect for significant shifts in production technologies (e.g., adoption of regulation-induced product/process innovations, accelerated replacement of plant equipment to use leading-edge technology, substitutions to alternate materials and products) would need to be more carefully considered.

- ***For the most part, OSHA's current feasibility analyses devote little attention to the potential of advanced or emerging technologies to yield technically and economically superior methods for achieving reductions in workplace hazards. Much of this circumstance reflects the procedural priorities of the existing rulemaking process, as well as the nature of the hazard reductions the agency has targeted since the early 1980s. But a good case can be made that a lack of continuing insights on the potential of leading-edge technology hinders the agency in performing its mission.***

[21] See OSHA's statement on this matter in the preamble to the 1994 Electric Power Generation, Transmission, and Distribution safety standard, 59 *Federal Register* 4427–4429, Jan. 31, 1994.

[22] A number of bills affecting almost all health and safety regulatory agencies were introduced in both chambers in the present (104th) Congress. At the time this report is being completed (late summer, 1995), the House has passed a comprehensive regulatory reform measure as part of H.R. 9 (the Job Creation and Wage Enhancement Act of 1995). Among other provisions, this bill mandates that all major rules must demonstrate that the benefits resulting from implementation "justify and [are] reasonably related to" their costs. Extensively documented risk assessments and detailed consideration of regulatory alternatives are also required. In the Senate, several bills, with widely varying provisions, are now under consideration, notably, S. 343 (the "Comprehensive Regulatory Reform Act of 1995). Competing bills include S. 291, S. 333, and S. 1001.

Another substantial criticism of the agency's rulemaking analyses (coming most vigorously from those advocating the aggressive adoption of stringent workplace health and safety protections) is that ordinarily there is too narrow a focus on conventional, well-established control measures—such as increased ventilation, added enclosure of existing machines, and improved housekeeping based on existing technologies and work practices. According to this view, opportunities are missed to harness leading-edge or innovative production technologies (including input substitutions, process redesigns, or product reformulations) to society's collective advantage, and to achieve greater worker protection with technologically and economically superior means.[23] Moreover, a narrow emphasis on only the clearly apparent means of control at the time of a rulemaking can fail to provide a sound basis for estimating the actual burden an affected industry may bear in accommodating compliance provisions at any given level of stringency—because industries (or some of the establishments therein) may be able (and have an incentive) to exploit accessible opportunities for substantial product or process changes to achieve compliance.[24]

OSHA's preoccupation in the course of rulemakings with a "static state" characterization of affected industries and clearly available control measures is widely apparent in the existing standards OTA has reviewed (which consisted, for the most part, of rulemakings in the 1980s and early 1990s). In fairness, OSHA's examinations of "feasible technologies" do sometimes comment on control methods potentially available but not yet adequately demonstrated, and on the implications of potentially emerging technological capabilities. Nevertheless, the vast majority of attention in demonstrating feasibility and estimating the costs and other impacts of compliance is placed on conventional control measures (most often involving retrofits of in-place production equipment) with reasonably well established records of performance.

A good deal of this narrowing of the analytic inquiry reflects the formal procedures and operational pressures of the existing rulemaking process. As discussed in the previous chapter, the agency's considerations of control options and economic impacts enter chiefly as matters of confirming a presumption that the compliance actions necessary to achieve the targeted hazard reduction goal are generally feasible for the affected industries. Given the contentiousness that often marks OSHA's rulemakings, there is obvious strategic value in providing such a demonstration based on actions (engineering controls, work practice modifications, etc.) that are already evident in the affected industry (or in other industries with reasonably analogous processes). This is because concrete documentation of applicability, cost, and hazard reduction efficacy is reasonably likely, and the capacity of the record to withstand later judicial scrutiny is at its strongest.

Of course, a need to examine other possible steps, e.g., measures which do not yet have an established track record or may require further experimental development, arises in the circumstance that these existing, established means are not sufficient to enable attaining the extent of hazard reduction targeted by the agency's

[23] There clearly have been occasions in the past when businesses facing OSHA requirements (with or without "technology forcing" objectives) for more stringent controls responded in ways that relied substantially on process innovations. See, for example, the 1974 Vinyl Chloride standard discussed in the next section. For a broader discussion, see Nicholas A. Ashford, Christine Ayers, and Robert F. Stone, "Using Regulation to Change the Market for Innovation," *Harvard Environmental Law Review*, 9 (2), 419-466, Summer 1985. See also Ruth Ruttenberg, *The Incorporation of Prospective Technological Change into Regulatory Analysis Which is Used in the Planning of Occupational Safety and Health Regulations*, Ph.D. dissertation, University of Pennsylvania, 1981.

[24] For example, in OSHA's 1978 Cotton Dust standard, eroding competitiveness against producers abroad and the need to comply with the more stringent dust control requirements prompted many U.S. cotton textile manufacturers to aggressively modernize their plants; as a result dust control was achieved in a less costly way, and productivity and product quality benefits were reaped at the same time. (This case is discussed later in this chapter.)

"significant risk" findings.[25] But, more generally, the agency's analytic task does not require charting the maximum extent of hazard reduction feasible. And the logic of a feasibility demonstration does not depend on cataloging and ranking all possible means available to establishments to comply (including the use of new technologies that might be superior with appropriate further development) or estimating the share of affected establishments that may choose to respond through means other than those identified in the agency's rulemaking analyses.[26]

Another significant influence on the scope of the control options inquiry is the stringency of the hazard reductions targeted. Critics of OSHA's regulatory priorities, particularly since the early 1980s, observe that the agency has been regulating to risk levels that are *less* protective by one to several orders of magnitude than the targets EPA has used in its environmental regulations covering the public at large.[27] In addition, for much the same period, OSHA appears to have had diminished interest in setting standards involving technology forcing to any significant degree.

Both of these circumstances have contributed to a rulemaking context in which a comparatively narrow discussion of control measures has largely satisfied the prevailing procedural and evidentiary needs. Obviously, the nature of the control measures necessary to invoke in any particular rulemaking is a case-by-case empirical matter. But it seems likely that an agency policy decision to target substantially more stringent hazard reductions or a return to technology-forcing standards—or both—would drive the need for a wider and more explicit consideration of control technology options beyond conventional measures.

Yet even without such shifts in the agency's hazard reduction targets, there are several reasons why the narrow consideration of control options that has prevailed for some time now should be viewed in a critical light.

First, findings of *in*feasibility (due to constraints of a technological and/or economic nature) do arise in rulemakings (particularly in the health standard arena) and have led to the promulgation of compliance provisions that the agency acknowledges are not expected to completely remove significant risk. In such a circumstance, it is only reasonable to question whether the feasibility analysis has been based on too limited a concept of the available control measures. OTA has not, in the course of this study, been able to review all of OSHA's rulemakings in this respect. However, in at least one of the eight existing standards (and perhaps one other) examined in the retrospective case research (see next section), consideration of improvements in technological capabilities that could have been reasonably anticipated might have supported a more stringent standard than was ultimately promulgated.

Second, and equally important, it would seem only common sense that OSHA ought to be a progressive supporter of innovation and the adoption of advanced technologies to the extent that such enhanced capabilities could expand the set of feasible options for improving workplace

[25] As observed in the previous chapter, the courts have long affirmed the agency's authority to establish such "technology forcing" requirements, conditional on acceptable evidence of feasibility.

[26] That such developments should be observed in affected industries' compliance responses is not all that surprising. The agency's provisions involving technology for health standards have long been *performance* based (as opposed to specification based). And the provisions for new and amended safety standards are increasingly moving in this direction. As such, there are no barriers in the compliance requirement (other than the normal generic priority on engineering and work practice controls) that prevent an industry from adopting or inventing a better way to comply, regardless of whether or not such means were discussed in the course of the rulemaking.

[27] See Harvard Center for Risk Analysis, "The Role of Significant Risk in OSHA Reform" *Risk in Perspective* 1(3): August 1993, Harvard School of Public Health, Cambridge, MA. See also, AFL-CIO, Department of Occupational Safety and Health, "The Workplace: America's Forgotten Environment—A Comparison of Protections Under U.S. Workplace Safety and Environmental Laws," Washington, DC, April 1993. The AFL-CIO report (pp. 13–15) notes that with cancer-causing substances, whereas OSHA regulates to a risk level of 1 death per 1,000 workers, EPA regulates to a level somewhere between 1 death per 10,000 to 10,000,000 persons under the Clean Water Act, and 1 death per 10,000 to 1,000,000 under Superfund and the Clean Air Act.

safety and health. There is certainly ample evidence in the record to date that intelligently directed effort can yield hazard control options that provide greater protections at reduced cost, compared with conventional measures—attributes that would, no doubt, enhance the "win-win" (for regulated industries and their workforces) character of OSHA's compliance requirements in many cases and support the achievement of greater hazard reduction.[28] Arguably, some of the agency's attention could usefully be devoted to promoting (e.g., through experimental variances or new technology demonstration projects) the longer-term development and application of hazard reduction measures that are technologically and economically superior.

To play such a supporting role well, however, OSHA needs to have an up-to-date and informed perspective on the nature and relevance of new technological opportunities on the horizon—in the control technology industries and among regulated sectors and their competitors and suppliers. Yet the analyses of control technologies now routinely being performed in the course of rulemakings do not basically provide this function. Indeed, to have real impact, such knowledge will no doubt need to be available and salient before the terms of the standard-setting "contest" among the stakeholders become too solidified.

Lessons from the Retrospective Case Studies

For eight of OSHA's past rulemakings, OTA collected data on the post-promulgation outcomes in affected industries. Five health standards were considered in this way: Vinyl Chloride (1974), Cotton Dust (1978), Occupational Lead (1978), Ethylene Oxide (1984), and Formaldehyde (1987). Three safety standards were similarly examined: Grain Handling Facilities (1987), Mechanical Power Presses (1988), and Powered Platforms (1989). This effort was designed to examine the nature of the match between the rulemaking estimates of compliance response, costs, and other impacts with the corresponding actual outcomes, and to gain a further basis for appraising the analytic efforts supporting the agency's rulemakings.[29]

[28] See N.A. Ashford and G.R. Heaton Jr., "Regulation and Technological Innovation in the Chemical Industry" *Law and Contemporary Problems* 46:109–157 (1983). See also N.A. Ashford, C. Ayers, and R.F. Stone, "Using Regulation to Change the Market for Innovation," *Harvard Environmental Law Review* 9 (2), 419–466, Summer 1985.

[29] To stretch the modest resources OTA had for this project, credible, already published case studies were used were possible. This practice accounts for the Vinyl Chloride, Cotton Dust, and Ethylene Oxide standards in the case study set. (The Vinyl Chloride and Cotton Dust standards are also widely considered "classic cases" in OSHA's rulemaking history.) Original research efforts by qualified researchers (see citations in Appendix B) were commissioned in the other five cases. The Occupational Lead, Formaldehyde, and Grain Handling Facilities standards were included because of their controversial nature and prominent roles in OSHA's rulemaking history in the 1980s. The Mechanical Power Presses and Powered Platforms rulemakings were selected more or less at random from among the full group of safety standards promulgated by OSHA after 1985.

The essential regulatory elements of these eight standards are presented in table 3-1. Tables 3-2 and 3-3 summarize the comparative information (estimated vs. actual post-promulgation outcomes), with particular attention to the nature of the industry's compliance response and the economic impacts.[30] In some cases, to make the research feasible within OTA's resources for the study, the comparisons were focused on a limited number of affected industries. (An expanded summary for each of the cases appears in appendix A of this report. More detailed reviews of the rulemaking histories, analytical estimates, and outcome findings are provided in a comprehensive project working paper and in the individual case study research reports—see citations in appendix B.)

The eight cases OTA examined reflect a preponderance of rulemakings among the more controversial and challenging in OSHA's history. The sample is also a relatively small fraction of all the standards and all the industries covered by OSHA's rulemakings to date. Nonetheless, OTA believes that, as a whole, the set of cases considered reasonably illustrates the analytical challenges the agency has faced, and now faces, in promulgating health and safety standards.

[30] Each of the case studies provides an indication of the apparent change in targeted hazard levels realized in the post-promulgation period. However, the (important) issue of the benefits derived from regulation was not a principal topic for this study, and has not been addressed to any substantial detail.

TABLE 3-1: Features of the Case Study Standards Considered by OTA's Retrospective Evaluations

Standard	Principal features
Health rules	
Vinyl Chloride	■ Promulgated in October 1974. Among other provisions, the action reduced the prevailing time-weighted average exposure over an 8-hour workshift (TWA8) permissible exposure limit (PEL) from 500 parts per million (ppm) to 1 ppm. The case study considered both of the principally affected industries—vinyl chloride monomer synthesis and polyvinylchloride polymerization. ■ Although conducted in what is now an "earlier era" of OSHA's rulemaking, the Vinyl Chloride standard is widely remembered for the steepness of the reduction in exposure required, the difficulty that compliance was perceived to pose for key affected industries, and the agency's reliance on a "technology-forcing" PEL.
Cotton Dust	■ Promulgated in June 1978. In addition to other provisions, the action tightened the existing TWA8 PEL from 1,000 micrograms per cubic meter (g/m^3) to 200 µg/m3 for yarn manufacturing operations, 750 µg/m3 for slashing and weaving, and 500 µg/m3 for other operations where airborne cotton dust was generated. The case study examined the textile manufacturing sector—the half-dozen or so industries principally affected by the rulemaking. ■ Cotton Dust also is widely remembered because of the widespread fears of "high and burdensome compliance costs" and the sizable role that plant modernization played in the affected industries' eventual compliance response.
Lead—Occupational Exposures	■ Promulgated in November 1978. The existing TWA8 PEL was tightened from 200 $\mu g/m^3$ to 50 $\mu g/m^3$, in addition to various other provisions. The case study focused on the secondary smelting industry—one of the more than three dozen industries affected by the standard, and one of the few that had high existing exposure levels and was expected to have to make major changes in existing process equipment for compliance. ■ Lead exposures, which were (and remain today) widely regarded as a serious health concern, have been the subject of a long-running series of rulemakings by OSHA (and by EPA, with respect to environmental sources of exposures). The case study focused on one of the sectors where the feasibility of control was particularly challenging and controversial.
Ethylene Oxide	■ Promulgated in June 1984. Among other provisions, the existing TWA8 PEL was reduced from 50 ppm to 1 ppm. The case study examined hospitals—one of a half dozen industries identified as affected, and the sector in which the vast majority of directly exposed employees existed. ■ The EtO rulemaking is illustrative of the substance and approach of the agency's rulemakings in the first half of the 1980s that dealt with suspected carcinogens.
Formaldehyde	■ Promulgated in December 1987. The action tightened the existing TWA8 PEL from 3 ppm to 1 ppm, among other provisions. (Note: OSHA amended the PEL to 0.75 ppm on May 27, 1992. The case discussed here, however, considered only the 1987 action.) The study focused on metal foundries—one of more than three dozen industries or industry groups identified as affected, and the industry with a large number of workers with existing exposures above 1 ppm and compliance costs that were expected to be high. ■ Formaldehyde proved a particularly controversial rulemaking, but otherwise is illustrative of the substance and approach of the agency's rulemakings on suspected carcinogens in the mid- to later 1980s.

(continued)

TABLE 3-1: Features of the Case Study Standards Considered by OTA's Retrospective Evaluations (Cont'd.)

Standard	Principal features
Safety rules	
Grain Handling Facilities	■ Promulgated in December 1987. Along with more than a dozen other provisions, all grain elevator and grain mill facilities were required to develop and implement housekeeping plans to reduce dust emissions and to provide for the periodic removal of accumulated dust. The case study considered all the principally affected industries. ■ The rulemaking sought a wide range of improvements in equipment, work practices, and safety procedures to deal with a sharply rising incidence of destructive fires and explosions at grain-handling facilities. The action was quite controversial in respect to its anticipated economics.
Mechanical Power Presses	■ Promulgated in March 1988. The action amended the existing standard to allow voluntary adoption of an electronic presence-sensing device (instead of operators who manually moved a switch) to actuate power press strokes. Various other provisions to ensure the maintenance of safe conditions for use also were specified. The case study considered all the principally affected industries, which were widely spread across the manufacturing sector. ■ The rulemaking sought to relax an existing constraint, with the expectation of substantial economic benefits to industry and improvements in workplace safety. The rulemaking contained some (at the time) novel procedures intended to ensure the continuing maintenance of safe conditions for power press operations (particularly certification/validation by a qualified and independent outside organization of the engineering design, installation, and ongoing operational adequacy of the mechanical and control systems involved).
Powered Platforms for Building Maintenance	■ Promulgated in July 1989. The action widened the acceptable technologies for the horizontal stabilization of work platforms for maintenance activities on high-rise buildings and specified other provisions concerning the performance capabilities of the equipment used and the work practices employed. The case study considered all the principally affected industries, which chiefly included high-rise building owners/developers and the establishments providing various building maintenance services. ■ The rulemaking sought to accommodate the ongoing changes in the high-rise building designs with the need to ensure that safe conditions were maintained at building service sites. Generally, the rulemaking and the resulting compliance provisions are illustrative of the substance and approach of the agency's safety rulemakings in the later 1980s.

TABLE 3-2: OSHA's Rulemaking Estimates vs. Actual Outcomes

Content of Affected Industries' Compliance Response

Vinyl Chloride

- Promulgated in 1974
- Industries examined: vinyl chloride synthesis and polyvinyl chloride polymerization

In contrast to industry's vigorous contrary arguments during the rulemaking, full compliance was achieved handily within 18 months after the standard was enacted. Most of the actions implemented to reduce exposure levels were those anticipated by OSHA during the rulemaking—including reducing leaks and fugitive emissions, improved ventilation systems, modified reactor designs and chemistry, and process automation. A significant production improvement not foreseen, however, was the proprietary "stripping" process commercialized within a year of promulgation, which provided a substantially improved means for producing PVC resin while reducing vinyl chloride exposures.

Cotton Dust

- Promulgated in 1978
- Industries examined: focus on textile manufacturing sector

Most all of the engineering controls envisaged by OSHA throughout the rulemaking as central for reducing dust levels played a role in achieving compliance: retrofits of existing production machinery, such as expanded enclosure, added local exhaust ventilation, enhanced general ventilation and filtration. But this group of measures missed the sizable extent to which dust control was achieved as a by-product of an aggressive drive to rapidly modernize the industry's production base. The industry's existing, older equipment was either rebuilt with modern functions or replaced outright with modern equipment—all of which enabled improved production speeds, consolidation of operations, more effective use of floor space, reduced labor, and better product quality, along with lower dust levels.

Occupational Lead Exposures

- Promulgated in 1978
- Industries examined: focus on secondary smelting

To date (early 1994), the secondary smelting industry's compliance response has differed considerably from the control concept on which OSHA's promulgation of the standard was based. Most producers have adopted some additional engineering controls (particularly for point and area ventilation, along with increased automation). But the greater emphasis has been on respiratory protection programs (which virtually all producers now use) and improved employee hygiene (protective clothing, change houses, personal hygiene practices). Despite the final rule's mandate, few producers have invested in engineering controls to the full extent anticipated to be needed for PEL compliance. Airborne lead levels in plants, while lower now than in the late 1970s, still remain substantially above the PEL—with decades of further progress needed, given the slow rate of improvement that has prevailed to date. Furthermore, the "new technologies" envisaged at the time of rulemaking for compliance in the blast furnace area of plants have not progressed; the single U.S. secondary smelter using the Bergsoe process went bankrupt in the mid-1980s, and hydrometallurgy still remains "on the horizon." The new capacity coming on line in recent years (which has been substantial since the mid-1980s, particularly in the "integrated" end of the business, where old batteries are broken, smelted, and used to manufacture new units) has all relied on conventional control technologies—although, with closer attention to plant layout, material transfer/handling, and process operability vis-a-vis emission and exposure considerations.

Ethylene Oxide

- Promulgated in 1984
- Industries examined: focus on the hospital sector

In the main, the compliance steps taken by hospitals were well in line with what OSHA emphasized in the rulemaking's feasibility analysis, chiefly, retrofits of both post-cycle evacuation systems and local exhaust devices to the existing stock of sterilizer units, and various straightforward changes in existing work practices. Nonetheless, some hospitals did pursue other courses of action, such as exploiting existing equipment and facilities (e.g., relocating sterilizer equipment to a room with a high rate of ventilation) or constructing entirely new facilities with stringent exposure reduction capabilities. In addition, a sizable proportion of hospitals (including some already in compliance) acted to reduce exposure levels to a point well below the new PEL—the result chiefly of continuing concerns about the health risks of long term, low level ethylene oxide exposures and managers' desires to minimize vulnerability to future tort liability claims. A number of substantial improvements in control technology did emerge after the rulemaking, particularly the integration of control features into new sterilizer units and significantly expanded exposure measurement capabilities. But these advances occurred a good deal later than the main period of the sector's adjustment to the new standard's compliance requirements.

(continued)

TABLE 3-2: OSHA's Rulemaking Estimates vs. Actual Outcomes (Cont'd.)

Formaldehyde

- Promulgated in 1987
- Industries examined: focus on metal foundries

In the course of the rulemaking, OSHA identified a variety of engineering controls already commercially available for reducing exposure levels in the metal foundry industry; these included additional ventilation (fresh air curtains, general dilution ventilation, local ventilation), enclosure (e.g., ladle covers, side baffles, ventilated cooling enclosures), changes in resin and catalyst formulations (to reduce the level of free formaldehyde present in resin binders or released in curing), and isolation of scrap materials. To demonstrate economic feasibility, the agency assumed that compliance would be achieved predominantly through added ventilation and enclosure. But as events turned out, only a few foundries adopted the "ventilate and enclose" strategy. Most opted for low-formaldehyde resins, which were available at the time of the rulemaking, and successively improved in the post-promulgation period.

Grain Handling Facilities

- Promulgated in 1987
- Industries examined: grain elevators and grain mills

Housekeeping activities to clean and remove accumulations of grain dust are now clearly recognized throughout the grain-handling sector as an essential work practice. Pneumatic dust control systems also are widespread, although manual cleaning with brooms is still used and continues to be regarded as an effective method to control dust. Treating grain with edible oils, to reduce dust generation and flammability, also is fairly frequently employed. Office facilities, welding activities, and employee smoking have generally been relocated away from prime dust generation areas. Designs for new elevators and plants now incorporate a range of fire/explosion safety features, but there have been relatively few new facilities constructed in recent years. At the time of the rulemaking, all of these avenues for control were anticipated to result from the compliance provisions of the new standard.

PSDI Power Presses

- Promulgated in 1988
- Industries examined: various in manufacturing sector

Prior to OSHA's rulemaking action, presence-sensing device initiation (PSDI) had already been successfully used on compatible mechanical power presses in Western Europe, where it provided evidence of sizable productivity gains and improvements in workplace safety. Nonetheless, to date (1994), and despite the rulemaking's formal allowance of PSDI operations, there has been little if any U.S. adoption of the technology. As events turned out, one of the safety-related procedural provisions—periodic certification/validation of PSDI power presses and their associated safety equipment by an outside organization—has proved unexpectedly to be a serious impediment to adoption. Also it appears that the market for PSDI is currently being eroded by alternate technology, particularly "quick trip" light curtains with no-touch sensors, which provide safety and productivity improvements and can be adopted without certification/validation by an independent party.

Powered Platforms

- Promulgated in 1989
- Industries examined: high-rise building owners/developers, building maintenance service providers

The amended standard has had the intended effects of widening the options for stabilization methods available to building owners/developers and of increasing the incidence of safe work practices. The overall number of alternate stabilization systems installed to date, however, has been well below OSHA's expectation at promulgation, chiefly because the number of new high-rise buildings constructed has been considerably under the estimate on which the regulatory impact calculations were based.

SOURCE: OTA, drawn from the case study retrospective research findings (see Appendix A).

TABLE 3-3: OSHA's Rulemaking Estimates vs. Actual Outcomes

Economic Impacts of Compliance

Vinyl Chloride

- Promulgated in 1974
- Industries examined: vinyl chloride synthesis and polyvinyl chloride polymerization industries

In promulgating the final rule, OSHA did not provide its own estimate of the compliance costs for affected industries. The most credible figures put forth at the time were those of the agency's technical consultant, which estimated total costs at around $1 billion (1974 dollars), including capital expenses for new equipment, replacement of lost capacity, and incremental operating expenses. According to the post-promulgation survey of industry members, however, actual spending amounted to only about a quarter of this estimate, $228 million to $278 million.

Arguments made during the rulemaking debate suggested that the standard would greatly increase business costs and threaten the viability of the vast majority of the establishments in the industries. As events turned out, costs did increase and production capacity was eroded, but only modestly. Furthermore, there was little evidence that the financial status or ability to respond to customer needs in the affected industries had been strained.

Cotton Dust

- Promulgated in 1978
- Industries examined: textile manufacturing

OSHA's estimate in the Final Regulatory Impact Analysis placed the textile manufacturing sector's cost of compliance at $280.3 million annually (1982 dollars, for amortized capital spending, incremental operations and maintenance, and other new spending). However, actual spending is estimated to have been only about a third of this amount, $82.8 annually (also 1982 dollars), chiefly because of the advantageous economics of the plant modernization push that was widely undertaken across the sector.

Concern was expressed in the rulemaking that smaller textile firms could encounter substantial constraints in raising capital for compliance-related improvements, and that the standard would tilt the sector's competitive center toward newer and more modern plants. (Neither of these circumstances, however, was considered large enough to warrant a "thumbs down" economic feasibility judgment for the industry as a whole.) Also, control equipment suppliers argued during the rulemaking that serious bottlenecks would arise in trying to retrofit the industry's equipment in short order. Nonetheless, the actual effects in all these respects proved to be modest and generally bearable.

Occupational Lead Exposures

- Promulgated in 1978
- Industries examined: focus on secondary smelting

At promulgation OSHA did not provide a specific cost estimate for compliance with the 50 g/m^3 PEL—indicating that "the industry face[d] several options for long-run compliance." OSHA did, however, outline an outer bound of about $91 million (1976 dollars) in total capital spending, based on a complete rebuilding of the industry using the Bergsoe smelter technology (then considered to be the most cost-effective option). In an early 1980s revision of the estimates, OSHA placed the cost of PEL compliance at a capital requirement of $125 million (1982 dollars), or 1.3 cents annually per pound of production ($150 million and 1.6 cents/lb, respectively, in 1992 dollars). Nevertheless, the industry's actual spending to date (through early 1994) has been far below these levels. Cumulative capital investment appears to total no more than $20 million (1992 dollars), and some of this overlaps with expenditures to meet the various environmental requirements to which the industry has also been subject. Annual compliance spending appears to be averaging 0.5 cent/lb to 1.0 cent/lb (1992 dollars), and perhaps as low as 0.3 cent/lb, i.e. well below OSHA's expectations at the time of the rulemaking and largely reflective of the industry's strategy of minimizing expenditures on engineering controls and relying much more heavily on respirator and hygiene programs to reduce exposures.

The real price of lead dropped sharply and unexpectedly after 1979, not returning to a similar level until late in the 1980s. Numerous smaller, independent smelters, that had limited financial resources and faced the combined effects of increased costs for both EPA regulations (emission controls and liabilities for future cleanups) and OSHA requirements, elected to exit the industry. The remaining producers benefited from increased use of capacity but had to aggressively trim labor costs and improve productivity to compensate for the upward cost pressures. Today the industry is smaller, and, indeed, the most productive in the highly competitive global market. At the time of the rulemaking, OSHA acknowledged the limited extent to which most secondary smelters could pass on new compliance costs and correctly judged that some consolidation would occur after promulgation, as producers with high marginal costs exited the industry. But OSHA did not anticipate the steep drop in lead prices that occurred. It now appears likely that the industry's consolidation would have been a good deal more severe had the level of compliance spending the agency estimated at promulgation proved to be nearer the actual circumstance. *(continued)*

TABLE 3-3: OSHA's Rulemaking Estimates vs. Actual Outcomes (Cont'd.)

Ethylene Oxide

- Promulgated in 1984
- Industries examined: focus on the hospital sector

OSHA's final estimates placed the sector's total compliance costs at $23.7 million annually (1982 dollars), $12.5 million of which related to amortized capital spending for the necessary control equipment. Available field evidence suggests that OSHA's estimated unit cost figures for the presumed control technologies were reasonably accurate. However, the sector's actual overall spending appears to have at least modestly exceeded the agency's estimate, because of some spending on modifications to existing ventilation systems not anticipated in the rulemaking estimate and many hospitals acted to reduce exposures to a level substantially below the promulgated PEL.

There was little concern at the time of the rulemaking that the standard would entail substantial financial or economic consequences for the industry or the national economy, because average spending for compliance per hospital was estimated to total no more than $1,500 to $3,500 annually. There is no evidence that the outcome differed from these expectations.

Formaldehyde

- Promulgated in 1987
- Industries examined: focus on metal foundries

OSHA's final estimate placed the industry's compliance costs at $11.4 million annually (1987 dollars). (Cost savings of $1.7 million annually from avoided medical expenses also were identified.) Actual spending appears to have been about half this level, $6.0 million annually. Part of this result reflected the industry's adoption of low-formaldehyde resins (which avoided the need for major new capital expenses) rather than added ventilation and enclosure. But in some important components of the cost calculations (particularly the improvements to ventilation systems that some companies installed to achieve compliance), OSHA's rulemaking figures substantially *underestimated* the actual spending.

The industry continued to consolidate in the second half of the 1980s, with the number of establishments in the business declining rather quickly. There is no evidence, however, that more than a few foundries closed as a consequence of the more stringent control of formaldehyde. This finding vindicates the basic accuracy of OSHA's feasibility determinations and rebuts the arguments that the industry made during the rulemaking.

Grain Handling Facilities

- Promulgated in 1987
- Industries examined: grain elevators and grain mills

OSHA estimated the sector's total compliance costs in the range of $41.4 million to $68.8 million annually (1985 dollars; spanning the incremental need for equipment and actions across the 13 separate provisions) and avoided property losses at $35.4 million annually (as compliance reduced the number of facility explosions and serious fires). These calculations yielded an estimated net cost of compliance in the range of $5.9 million to $33.4 million annually. The agency went on to monetize the expected benefits from reduced employee injuries and deaths at $75.5 million annually, which, from a societal perspective, more than balanced the new costs imposed on the affected industries. Unhappily, the case study was not able to derive enough information from the field to directly check these estimates—an unfortunate circumstance, because these figures were intensely debated in the course of the rulemaking.

Now that nearly five years have passed since full compliance with the terms of the 1987 standard was mandated, the evidence is that few if any facilities have ceased operation as a result of the standard—an outcome contrary to the economic impact estimates the industry submitted to the rulemaking. (The sector has, however, been subject to substantial economic pressures over this period for reasons not related to OSHA actions.)

PSDI Power Presses

- Promulgated in 1988
- Industries examined: various in the manufacturing sector

OSHA's final estimate projected the total cost of adopting PSDI (among both existing and new power presses) at $49 million to $77 million annually (1984 dollars; for equipment modifications or enhancements and compliance with the other provisions of the standard, including for the various certifications and validations). Cost savings from productivity improvements were estimated at about $182 million annually, i.e. substantially greater than the new costs. However, little has happened thus far in the industry to allow an evaluation of these estimates, except, of course, that OSHA (and most of the other parties to the rulemaking) failed to foresee the unfavorable economics of the independent party certification/validation role in the "later 1980s and on" world. *(continued)*

TABLE 3-3: OSHA's Rulemaking Estimates vs. Actual Outcomes (Cont'd.)

Powered Platforms

- Promulgated in 1989
- Industries examined: high-rise building owners/developers, building maintenance service providers

OSHA's final regulatory analysis estimates placed the total incremental costs of the amended standard at somewhat over $1.4 million annually (1987 dollars, including the various incremental expenses for both building owners and contractors). However, the greater flexibility in choice of stabilization system conferred an estimated cost savings to building owners/developers of about $3.1 million annually. Thus adoption of the standard was projected to provide direct cost savings of around $1.7 million annually.

With one significant exception, the case study research largely confirmed the reasonableness of most of the unit compliance cost figures OSHA used in the regulatory analysis calculations—the exception being a considerable underestimate of the cost of one of the several competing stabilization systems on one of the trio of principal building materials in the marketplace. A more significant disparity, however, is the unexpected slowdown in new high-rise building construction, with the actual annual pace since the beginning of the 1990s only 20 to 40 percent of the rate OSHA expected. To date, the overall *net savings* appear to have been substantially lower than expected—$600,000 annually, assuming the higher side of the range in the pace of new building construction, or perhaps even a *net cost* of $400,000 annually, assuming the lower side of the range.

During the rulemaking, industry expressed concern that some erosion of productivity could accompany the widespread use of the stabilization system particularly favored by the amended standard (the intermittent tie-in system), although OSHA's analyses did not conclude this effect would be significant. The outcomes thus far have generally confirmed the agency's expectation on this matter.

SOURCE: Office of Technology Assessment, drawn from the case study retrospective research findings (see appendix A).

- ***Straightforward comparisons of the industry response and regulatory impact circumstances that have actually occurred with those projected by OSHA in promulgating standards exhibit both "hits" and "misses." But almost all of the cases contain at least some significant disparities.***

The case study comparisons indicate that OSHA's rulemaking analyses have reasonably grasped many of the essential features of the affected industries and the principal issues posed by compliance with a new standard. In addition, the hazard control measures receiving primary attention in rulemakings did, in most cases, play a role in the compliance actions actually taken. At the same time, it is clear that one or more significant disparities were present in almost all of the eight standards examined.

These disparities are tabulated together in table 3-4. As is apparent, they stem from different sources:

- unexpected discontinuities in the business environment affecting the content of compliance adjustments,
- failure to correctly anticipate the predominant compliance responses of affected industries,
- deliberate conservatism in assumptions about the control technology (also yielding an incorrect estimate of the actual compliance responses),
- misjudgment of affected industries' ability to adjust to more stringent compliance requirements, and
- significant errors in measuring key parameters.

The limitations in the 1988 Mechanical Power Presses and 1989 Powered Platforms rulemakings arose chiefly from discontinuities that OSHA did not anticipate in the operating environments of the affected industries. The problem appears to have been avoidable in the former case, but probably not in the latter. (As discussed further below, an unexpected change in a key economic variable, beyond the control of the affected industry, was also a consideration in the 1978 Occupational Lead standard.)

TABLE 3-4: OSHA's Rulemaking Estimates vs. Actual Outcomes

Major Disparities Apparent in Direct Comparisons

	Significant features of industry compliance adjustment not accurately anticipated
Vinyl Chloride (all principally affected sectors)	■ Actual compliance spending totaled about a quarter of the rulemaking's most credible estimate (but, in the flow of events back then, these figures were not officially put forward by OSHA). ■ The industry compliance response included significant unanticipated process innovations. ■ Compliance proved considerably easier for the principally affected industries than the rulemaking debate implied.
Cotton Dust (all principally affected sectors)	■ Actual industry compliance spending amounted to about a third of OSHA's final estimate. ■ A major reason for the overestimate of costs was a failure to anticipate the textile industry's aggressive retooling with modern production equipment.
Occupational Lead Exposures (secondary smelters)	■ The industry's control response to date has differed considerably from the rulemaking's expectations: only a small fraction of the engineering controls mandated by PEL compliance has occurred. ■ The expected "new technologies" for control—one basis for the "technology forcing" nature of the standard—have generally not panned out commercially. ■ Compliance spending to date has been well below the rulemaking's expectation, but not surprisingly so, given the very slow pace of adoption of engineering controls.
Ethylene Oxide (hospitals)	■ Unit costs of the principal engineering controls were, for the most part, correctly gauged—although the spending on general ventilation system improvements was more than what OSHA had estimated. But overall industry spending appears to have been at least modestly more than projected, because a substantial fraction of the sector acted to reduce exposure levels well below that required by the PEL.
Formaldehyde (metal foundries)	■ Most of the industry achieved compliance by adopting control measures that differed considerably from the rulemaking's conventional "ventilate and enclose" assumptions. ■ Overall actual spending appears to have been about half OSHA's final estimate, but the spending on ventilation system improvements by those companies that made this kind of change was considerably *under*estimated.
Grain Handling Facilities (all affected sectors)	■ No significant disparities exist; much of what OSHA described in the final regulatory analysis concerning the control steps and the economic feasibility of the standard has taken place. (However, insufficient post-promulgation data were available to the case study to fully examine the balance of benefits and costs, which was a particularly controversial aspect of the rulemaking's economic estimates.)
PSDI Power Presses (all affected sectors)	■ The standard's requirement for certification/validation by an independent outside party has unexpectedly proved to be a serious impediment to adoption of the PSDI technology, because of the sizable risk of large liability litigation expenses and a perceived lack of an adequate business opportunity.
Powered Platforms (all affected sectors)	■ The unit cost of one of the key stabilization options appears to have been substantially underestimated. ■ The estimated balance of costs and savings differs substantially from what has occurred to date; the principal source of error is that the pace of new building construction has been well below that assumed by OSHA in the rulemaking.

SOURCE: Office of Technology Assessment, summarized from tables 3-2 and 3-3 earlier, and from Appendix A.

In amending the Mechanical Power Presses standard, OSHA anticipated considerable adoption of the electronic technology for initiating power press stamping cycles (including both retrofits of existing presses and in newly installed machines) in the several years immediately following enactment. This assumption was based on the clear evidence available then that these systems significantly improved manufacturing productivity while maintaining or even enhancing the existing level of workplace safety. The scant adoption of the technology to date appears to have resulted primarily from the limited business viability of the outside ("third") party certification/validation (of the engineering design, installation, and ongoing operational adequacy of the mechanical and control systems involved) mandated by the standard. The analysis underpinning OSHA's feasibility and impact findings for the rulemaking was prepared (by a contractor) in the first half of the 1980s, but was not updated to adjust for the circumstances prevailing nearer the time of the standard's promulgation in 1988. In the mean time, the perceived threat of large liability litigation expenses apparently escalated to the point that the expectations for earnings became too small to entice an independent party to take on the role. This development was not anticipated by OSHA at the time of the rulemaking, nor for that matter by the many parties providing testimony and comments to the rulemaking record. However, it now seems likely that had the agency re-examined the feasibility of the provision nearer the time of promulgation, the prospect of a serious constraint would have been apparent.

In the Powered Platforms rulemaking, OSHA correctly gauged the intrinsic feasibility of the amendments (which expanded the options available to building developers/owners for horizontal stabilization of operating platforms, and mandated the adoption of additional safety-related equipment and procedures). However, OSHA's assumptions in the course of the rulemaking considerably overestimated the pace of construction of new high-rise commercial buildings. As the calculations worked out, this rate was a critical determinant of the overall balance of benefits and costs (building owners/developers and building maintenance suppliers combined) to result from compliance with the standard. Here again, the economic analysis published by the agency with the promulgated standard in 1989 derived largely from an analysis prepared a number of years earlier (in 1983). Nevertheless, even a reworking of this analysis in 1988 probably would not have more accurately forecast this parameter—as many capable analysts of the real estate, construction, and financial sectors of the national economy failed to predict the sharp downturn in commercial building construction beginning late in the 1980s.

A second generic source of the disparities evident across the cases involves incorrectly anticipating the control response choices of affected industries. This circumstance accounts for much of the outcome observed in the 1984 Ethylene Oxide standard.

OSHA's analyses for this rulemaking correctly gauged the feasibility of the tightened PEL and other compliance requirements and correctly anticipated most of the specific characteristics (engineering controls, work practice changes, and their unit costs) of the control measures implemented. Yet hospitals' overall spending for control appears to have at least modestly exceeded OSHA's final estimate in the rulemaking. A chief source of this disparity was the decision by a substantial proportion of hospitals to install equipment and make other changes to achieve exposure levels substantially more stringent than what the new standard required. Despite the considerable lowering of the PEL, concerns about the possible adverse effects of chronic low-level ethylene oxide exposures remained salient. Concomitantly, even with compliance with the new OSHA standard, some hospital managers perceived the need to take aggressive steps to reduce vulnerability to future tort liability claims. Looking back, it is not difficult to see that some hospitals had an incentive to undertake such action. Nonetheless, this kind of outcome is not a circumstance for which a typical regulatory analysis would normally search.

And, for the most part, the costs and benefits involved cannot directly be attributed to the OSHA standard.

A third class of estimation problems on display in the cases relates to the frequent "conservatism" in OSHA's assumptions about the predominant control measures that affected establishments will use to achieve compliance (see discussion earlier in this chapter, and also in chapter 2, box 2-3). Most of the disparities between the rulemaking estimates and actual outcomes in the 1978 Cotton Dust and 1987 Formaldehyde standards are explained by this circumstance.

In each of these cases, the affected industries achieved compliance through adopting control measures that differed considerably from those that OSHA's rulemaking analyses presumed in confirming feasibility. Substantial measurement errors were present in both cases—a large understatement of the spending on ventilation controls (in the companies where they were implemented) in Formaldehyde and a sizable overstatement of the number of exposed employees in Cotton Dust (with the errors in each case mainly attributable to insufficient breadth in the field data collection effort). Nonetheless, most of the overestimates of actual overall compliance spending in both rulemakings arose from the alternate paths the industries followed to achieve compliance: the textile manufacturing industry's aggressive plant modernization, and the metal foundry sector's shift to low-formaldehyde resins. In fact, the control actions actually adopted were clearly identified in the agency's discussion of control options (and were the subject of testimony during the hearings). OSHA elected in both cases, however, to base its analytical findings and estimates on conventional control measures (but which, in fairness, under the circumstances then prevailing, were clearly relevant options for the hazard control problems at hand).

Misjudgment of affected industries' capabilities to adapt to new compliance requirements is another generic source of the disparities apparent in the cases. This was the case with the 1974 Vinyl Chloride rulemaking and perhaps also with the 1978 Occupational Lead standard.

In the Vinyl Chloride rulemaking, OSHA policymakers pegged the intrinsic feasibility of the vastly tightened PEL better than is often appreciated. The rulemaking was conducted early in OSHA's history, and the agency did not present its own technology assessment or compliance cost estimates in the course of the policy debate. The estimates that proved most erroneous were those submitted by OSHA's consultant and by representatives of the principally affected industries—both of which were submitted to the record after the hearings and not subjected to substantial public review. Against this counsel, OSHA policymakers concluded that the standard was in all likelihood feasible—which subsequent events unequivocally confirmed. To be sure, some significant features of the industries' compliance responses were not anticipated, particularly the commercialization of the innovative "stripping" process for PVC synthesis. Nonetheless, much of the post-promulgation reduction in exposure levels occurred through the widespread adoption of steps that had been identified in the course of the rulemaking.

What OSHA did not gauge well was the relative ease with which the affected industries could comply; compliance took about 18 months, in sharp contrast to the seven years liberally provided in the final rule to accommodate the "expected difficulties" of the industry to fully adopt the necessary engineering controls. The rulemaking's lack of a more independent analysis and of substantial outside review (procedural problems the agency has subsequently addressed) no doubt made OSHA vulnerable to the industry's representations at the time about "the difficulties" of compliance. Nonetheless, there was no real field evidence available then showing how industry plants could achieve the PEL, and it is not clear that this miscalculation could have been straightforwardly remedied at the time.

OTA's examination of the 1978 Occupational Lead standard focused on an industry sector (secondary smelting) where compliance was particu-

larly challenging (given the relatively high level of existing exposures, the substantial extent of process and work practice changes required, and the highly competitive nature of the industry). The PEL and associated mandate for compliance chiefly through engineering controls were recognized to be technology forcing—but for which OSHA sought to compensate with a relatively long time allowance for compliance, five years.

To date, comparatively few of the engineering controls expected—and, in fact, commanded—by the 1978 standard have been adopted. The level of lead in workers' blood has come down markedly since the late 1970s, the result of both a systemic reduction in environmental lead levels (driven by various EPA standards) and the adoption by secondary smelters of OSHA-mandated controls such as protective clothing, respirators, and measures enabling improved personal hygiene. Nevertheless, airborne levels of lead in the industry's workplaces still remain quite high relative to the promulgated PEL, reflecting the very slow rate of progress in adopting engineering controls.

OSHA recognized at the time of the rulemaking that PEL compliance based on engineering controls would be a challenge for the secondary smelters sector (particularly in blast furnace areas). Also, the agency's field enforcement of the standard to date has been "complex"—pressing for exposure improvements on a case-by-case basis, but apparently tolerant of the difficulties encountered in adopting engineering controls to the full extent literally specified by the standard.

Still, there is little in the record to suggest that OSHA's feasibility analysis in the rulemaking sufficiently appreciated the implications of the largely *simultaneous* compliance burden imposed by the OSHA standard and the aforementioned EPA regulations. Moreover, the unexpected steep drop in the market price for lead (which remained depressed throughout much of the 1980s) made the kind of spending on engineering controls anticipated by the rulemaking for PEL compliance all the more difficult. Furthermore, the expected "new technology" that provided part of the rationale for the "technology forcing" character of the standard proved evanescent—the single U.S. secondary smelter using the Bergsoe process went bankrupt in the mid-1980s, and hydrometallurgy still remains "on the horizon" (much as it was characterized in the late 1970s).

Knowledgeable observers disagree in their appraisal of the adequacy of the rulemaking's feasibility analysis for the secondary smelters sector. Clearly, the outcomes to date differ from the rulemaking's expectations in significant respects. The rulemaking's analysis appears to have understated the challenge that compliance would pose for this sector. Yet the large and sustained drop in the market price of lead was obviously an influential and largely unexpected factor in this difficulty.

- ***Nonetheless, if the cases examined are judged on the basis of the accuracy with which feasibility was determined, OSHA's rulemaking estimates appear in a more favorable light.***

As already discussed, OSHA currently conducts its rulemaking examinations of control technology and regulatory impacts chiefly to demonstrate that the provisions of an intended standard are generally feasible, both technologically and economically, for affected industries. Hence examining whether or not feasibility was correctly judged and whether the analytical foundation was adequate to withstand judicial scrutiny arise naturally as criteria for evaluative comparisons.

As table 3-5 summarizes, OSHA correctly judged technological feasibility in seven of the eight cases examined. A similar scoring of economic feasibility showed six correct judgments out of the eight cases examined. Furthermore, in all four of the cases subsequently challenged in court, OSHA's promulgation determinations were affirmed.

TABLE 3-5: OSHA's Rulemaking Estimates vs. Actual Outcomes

Accuracy When Estimates Are Judged as Feasibility Determinations

	Did OSHA correctly judge the technical feasibility of final rule?	Did OSHA correctly judge the economic feasibility of final rule?	Did OSHA's rationale and evidence withstand subsequent judicial review?
Vinyl Chloride (all significantly affected sectors)	Yes	Yes	Yes
Cotton Dust (all significantly affected sectors)	Yes	Yes	Yes
Occupational Lead Exposures (secondary smelters)	Unclear—the events to date confirm the agency's rulemaking expectations in some aspects but not in others	Unclear—but as events have unfolded, costs seem to have been a more serious burden in some respects than expected	Yes
Ethylene Oxide (hospitals)	Yes	Yes	Not challenged
Formaldehyde (metal foundries)	Yes	Yes	Not challenged (at least, not on feasibility grounds)
Grain Handling Facilities (all significantly affected sectors)	Yes	Yes	Yes
PSDI Power Presses (all significantly affected sectors)	Yes	No—but only because of one very significant oversight	Not challenged
Powered Platforms (all significantly affected sectors)	Yes	Yes	Not challenged

SOURCE: Office of Technology Assessment, drawn from tables 3-2 and 3-3 earlier, and from Appendix A.

NOTE: In rulemakings, OSHA is obligated to provide evidence that an intended standard is generally feasible (both technologically and economically) for the establishments in an affected industry to successfully undertake (see Chapter 2, box 2-1). In this chart, a "yes" rating indicates that OSHA's final estimates provided a favorable appraisal of feasibility at promulgation and the post-promulgation evidence indicates that the industry predominantly did successfully adjust to the compliance requirements.

The exceptions are obviously few. As indicated earlier, the erroneous economic feasibility determination regarding the 1988 amendment to the Mechanical Power Presses standard stemmed principally from an unexpected discontinuity in one key aspect of the business environment. However, it appears likely this oversight could have been avoided if portions of the analysis had been more up-to-date. The verdict on the feasibility judgment in the 1978 Occupational Lead standard is less conclusive (and, perhaps, less representative), because the rulemaking was atypically complex both in the making and in the subsequent implementation.

Some further comment is needed, however, on matters beyond what is directly apparent in the table. In three of the cases—the 1978 Cotton Dust, the 1984 Ethylene Oxide, and the 1987 Grain Handling Facilities standards—there was substantial debate in the course of the rulemaking regarding the feasibility of control requirements more stringent than what the promulgated rule finally contained.

In the Cotton Dust rulemaking, some stakeholders argued for a substantially more stringent PEL (100 $\mu g/m^3$, rather than the 200 $\mu g/m^3$ established) in yarn-manufacturing operations (the earlier and dustier stages of production). OSHA

recognized that some plants had indeed achieved the more stringent exposure limit in some operations. The agency concluded, however, that there was no evidence that such a PEL could be realized consistent with the "most plants, most operations, most of the time" threshold normally employed in setting standards—and, on this basis, rejected the 100 $\mu g/m^3$ PEL as technologically infeasible.

The available post-promulgation evidence is generally regarded to confirm OSHA's rulemaking judgment on this matter. The retrospective research conducted in the early 1980s (several years after the standard took effect), which examined the textile industry's ongoing adjustment to the standard, could not find evidence that new control capabilities had become available in the interlude that would have made a substantially tighter PEL widely achievable.

In both the Ethylene Oxide and Grain Handling Facilities rulemakings, OSHA acknowledged that the compliance requirements that were promulgated did not fully remove significant risk, because of feasibility constraints. OSHA's rulemaking judgment in Ethylene Oxide was narrowly accurate at the time, but was eroded by improvements in (exposure measurement) technology comparatively shortly after the standard's enactment. In Grain Handling Facilities, political influences abruptly truncated the policy options considered, and the limit of control feasibility was only preliminarily examined, despite the continued existence of a substantial safety risk. Both of these circumstances illuminate policymaking weaknesses that are intrinsic to the agency's feasibility analysis procedures—and are discussed at greater length later.

- ***A number of larger lessons are suggested by these comparative findings:***

Based on the cases examined here, OSHA's rulemakings are not generally imposing an unworkable compliance burden on industry. In six of the eight cases considered (Vinyl Chloride, Cotton Dust, Occupational Lead, Ethylene Oxide, Formaldehyde, and Grain Handling), industry stakeholders and their representatives argued in the course of the rulemaking (modestly to vigorously, depending on the case) that compliance would pose unworkable problems. The stated reasons included such arguments as the requirements were not technologically feasible; were likely to impose unworkable production cost increases; were likely to force many establishments out of business or unhinge the competitive structure of the industry; or were likely to impose a significant inflation penalty on the national economy.

For the most part, the post-promulgation reality observed in this project's case study standards proved much the opposite of these representations.[31] In almost all these cases (the Occupational Lead standard excepted), the industries that were most affected achieved compliance straightforwardly, and largely avoided the destructive economic effects invoked by their rulemaking arguments. Very few companies left the industry chiefly because of the new compliance requirements. And, in a good many of the cases, the actual cost burden of compliance proved considerably less than OSHA's final estimate—about one-quarter the estimate in Vinyl Chloride, one-third in Cotton Dust, and one-half in Formaldehyde (metal foundries).

Furthermore, in half of the eight cases examined, the standard stimulated changes in the production technology of affected industries that yielded benefits beyond a means for health and safety hazard compliance. In Vinyl Chloride, several of the principal industry members capitalized on the altered business and regulatory setting to commercialize innovative processes for polyvinylchloride polymerization, which enhanced manufacturing productivity, allowed

[31] Again, given the nature of the selection process employed, it is not appropriate to view the sample of cases examined by this study's retrospective research as necessarily representative of all OSHA's rulemakings to date. Nonetheless, the set of cases oversamples both standards which were anticipated to be comparatively costly and pose difficult control challenges and industries where such concerns were more or less at their worst. Thus, if anything, the general import of this section's findings is all the stronger.

better rationalization of material inputs, largely eliminated the need for manual reactor cleaning (a prime source of high exposures for the workforce), and provided a new source of income to the technology's developers through licensing arrangements. In Cotton Dust, OSHA's mandate for greater dust control, combined with a strong need for more competitive production capacity, drove much of the textile industry to accelerate investments in modern production equipment—this modernization yielded improvements in manufacturing productivity and product quality while providing a more cost-effective means to bring dust levels within the terms of compliance.

In the hospital sector, the considerable concern about occupational Ethylene Oxide exposures triggered by OSHA's rulemaking prompted the eventual development and commercialization of a number of significant improvements in control technology, including substantially improved devices to measure low-level worksite exposures and a new generation of sterilizer units with built-in exposure control functions (at little real increase in cost). In the metal foundries industry, the need to lower formaldehyde exposures in line with OSHA's revised requirements promoted a continuing effort by the industry's principal suppliers to improve both curing processes and the resin and catalyst formulations used. This effort yielded processes with greatly reduced formaldehyde emissions and provided the suppliers with the expertise and products to build successful markets abroad for low-formaldehyde resins, improved foundry processes, and the plants based on them.

Admittedly, however, the experience of the secondary smelting sector's adjustment to the Occupational Lead standard has run much in the opposite direction of these generally favorable circumstances. The "new technology" invoked in the Lead rulemaking has not yet been a serious force. The bare fraction of the anticipated compliance spending that has resulted to date reflects chiefly the slow pace of the industry's investment in the mandated engineering controls. Overall, the compliance challenge appears to have been more difficult than OSHA's feasibility findings in the rulemaking suggested. It can be argued that this standard is atypical of OSHA's rulemakings—because of the highly competitive and economically mature character of the industry, the substantial extent of the controls required, and the "soft" nature of the agency's enforcement effort. Nonetheless, the case makes the point that OSHA's compliance requirements are not always easily dispatched or deftly turned to business advantage.

OSHA's present procedures for estimating compliance responses and the associated economic consequences provide considerable room for actual adjustment outcomes to differ. As already discussed, the methodological and pragmatic features of OSHA's usual analytic approach yield an emphasis on conventional control measures with wide applicability across an affected industry and relatively little attention to the options and incentives that the individual establishments comprising the industry may have to take one or another of the various compliance avenues available. By their nature, OSHA's analyses usually do not seek to explicitly consider the incentives that an industry's companies could have to minimize the economic burden of compliance requirements on the prevailing cost and profit functions by "working smarter." Such actions could include substantial and/or innovative shifts in production processes, via input substitution, process redesign, or product reformulation.

Because the agency's normal assumptions about control measures are usually "conservative" in this way and because the "work smarter" prospect is not normally explicitly accounted in analytic estimates, it is reasonable, in principle, to expect that the actual costs of compliance (for the "average" establishment or the industry in aggregate) will in many cases be somewhat (or even substantially) less than what OSHA's rulemaking estimates imply.[32] And, indeed, such a circumstance is evident in the outcome of several of the cases just reviewed above.

Nonetheless, there is another potentially significant effect also at play in the analysis process. The agency's cost estimates are typically an extended and interrelated series of calculations that depend on characterizations of the process equipment, work practices, and hazard controls in place; the incidence of exposures by job categories; the engineering issues involved in reducing exposures; and the unit costs incurred in making necessary changes. Yet, because of constraints on budget, work calendar, and access to the industry (as discussed in an earlier section), OSHA cannot in many cases reliably estimate all these factors as they are actually distributed across affected industries and must instead move ahead with "working averages" and stylized model plants. Under such conditions, *both* overestimates and underestimates are conceivable outcomes (with corresponding biasing effects on impact calculations). And OTA's case studies provide evidence of such errors in both directions.

These two effects—the often "conservative" assumptions about the control measures adopted and the prospect of errors in the measurement of pertinent industry characteristics—make it reasonably likely that actual outcomes (for the "average" affected establishment or in total across the industry) will differ from OSHA's rulemaking estimates in at least some respects. But, importantly, measurement errors could either offset or add to the "conservative" assumptions bias, thus making it a challenge (in the general case) to fathom in advance the likely overall direction of bias in OSHA's estimates.

Too narrow a concept of the feasible technology can hinder the agency in establishing justifiable health and safety protections. Among the cases OTA considered, the 1984 Ethylene Oxide standard illustrates a shortcoming of the agency's current feasibility analysis procedures that can arise when apparent constraints in available technological capabilities are a critical policymaking determinant and there is not an effort to anticipate reasonably near-term improvements in relevant technologies.

Health concerns and "significant risk" argued for a tighter PEL than the 1 ppm level that was ultimately promulgated. (In the early 1980s, NIOSH had recommended a 0.1 ppm PEL, in light of the seriousness of the potential adverse health effects). The less stringent exposure limit specified by the standard, which OSHA explicitly recognized in issuing the final standard as not removing all significant risk, reflected a binding technological constraint. The exposure detection capabilities of the day were not able to measure ethylene oxide with acceptable reliability at substantially lower levels. However, only a few years (1986/87) after the effective date of the standard, detection methods that removed this constraint had been demonstrated, the result of targeted development efforts by NIOSH scientists and others.

There is little evidence in the record of this rulemaking that the prospect of reasonably near-term improvements in this obviously important capability had been examined. Had this apparently imminent technological development been more directly considered, the argument of those

[32] As discussed earlier in Chapter 2, the controls on which OSHA bases its regulatory impact estimates are normally the least-cost measures among all the controls which can clearly be shown to be feasible for the industry as a whole. Of course, for those establishments perceiving the menu of available control choices as coincident with OSHA's feasible set, it is reasonable (by virtue of being least-cost) to expect OSHA's assumed measures to be the most likely outcome. Nevertheless, the compliance terms of OSHA standards generally do not prevent an establishment from exploiting opportunities to adopt (or invent) a less costly way of complying.

pushing for a tighter PEL in the course of the rulemaking would, no doubt, have been strengthened.

Feasibility analysis can be short of influence in driving the consideration of competing policy options. Aspects of the rulemaking for the 1987 Grain Handling Facilities standard illustrates the intrinsic weakness of the agency's normal feasibility analysis routine in compelling the examination of risk reduction targets that may merit consideration on objective risk reduction grounds but are hobbled by other considerations.

Between the first consideration of proposals for the grain handling standard (circa 1983) and the coalescence of the content of the final rule (1985-86), the rulemaking shifted, under substantial external pressures (from OMB and, indirectly, from the industries that were principally affected), from seeking to remove "significant risk" to the substantially lesser objective of addressing a level of risk that all parties agreed was unacceptable. Earlier in the rulemaking, the feasibility analysis examined options for risk reduction over a fairly wide range of stringency (particularly with regard to the level of dust buildup that triggered cleanup and removal actions)—from the modest level of hazard reduction finally promulgated, down to a level where removal of "significant risk" began to be engaged.

Shortly after the proposal for the standard was published, strong political influences limited the examination of options chiefly to verifying the feasibility of the (not all that stringent) standard that was ultimately promulgated. OSHA's analyses performed this task acceptably, and indeed faced vigorous criticisms from industry stakeholders over the basis for its findings. But the feasibility analysis routine, by itself, was obviously not able to compel an even-handed, "on the merits" consideration of more stringent policy targets that might also have been feasible.

This case is a useful reminder that the agency's feasibility analysis process is far more a "confirming" exercise, oriented toward showing that a hazard reduction target is generally achievable, and much less an analysis "engine" capable of driving a search for optimal policy across a fairly comprehensive set of options with varying trade-offs. The agency's current feasibility analysis procedures are certainly consistent with the statutory mandates. Nonetheless, the aforementioned circumstances in the grain handling rulemaking point to a shortcoming that would appear to warrant OSHA's further examination, and perhaps some changes in the accepted norms or procedures to assure that the policy analysis effort provides all due support for the agency's overall health and safety mission.[33]

- ***One additional lesson from OTA's case research for this project is that it is surprising how little systematic information on the actual outcomes and impacts of the agency's standards is available.***

OSHA has long operated in one of the most controversial realms of public policy. Given the seemingly unending public debate over the burdens and benefits of health and safety regulations and the likely value in future rulemakings of a sound understanding of past outcomes, it is surprising how little systematic information documenting the actual effects of the agency's standards on regulated industries is available. There is no end of anecdote and speculation, but not nearly enough hard data.

[33] The aforementioned U.S. Court of Appeals decision in 1991, addressing petitioners' challenges to the 1989 Hazardous Energy Sources safety standard (*International Union, UAW* v. *OSHA*) provides some useful commentary on this apparent limitation—at least, by parallel construction. In the 1991 case, the court expressed concern that in the absence of procedural attention to balancing the expected benefits and costs of a rulemaking, OSHA's wide policymaking discretion could lead to costly and minimally protective standards. Nonetheless, the other extreme ought to be an equal concern on the same grounds, that is, more stringent protections achievable through justifiable additional costs. The essential point is that OSHA's feasibility analysis—at least as now conducted—does not really have the "backbone" to drive a search for the "balance" to which the court points.

Industry's spending for occupational health and safety compliance is not covered in the Pollution Abatement Costs and Expenditures (PACE) survey, administered annually since 1972 by the Department of Commerce's Bureau of Economic Analysis.[34] The information OSHA collects in the course of its enforcement activities (maintained primarily in IMIS files) provides some field data on outcomes. But this information is relatively narrow in the scope of hazards covered; addresses chiefly exposure levels; sheds no real light on actual compliance costs; and often does not provide a representative sample of an affected industry.[35] OSHA's FAT/CAT reports (documenting workplace incidents involving fatalities or hospitalized injuries—see discussion earlier in this chapter) and the periodic national surveys conducted by the Bureau of Labor Statistics and others (see discussion in chapter 1, box 1-1) provide useful (if not entirely complete) time series data on workplace fatalities, illnesses, and injuries. Nonetheless, OSHA does not, in general, have mechanisms in place to systematically describe (or estimate) the actual control actions taken by an affected industry in response to promulgated standards, the new costs experienced and the effects on productivity, and the benefits realized (reductions in hazard exposures and adverse health effects, costs avoided, and improvements in employee behaviors).

This situation is understandable in many respects. Good answers to these questions involve substantial data collection at the establishment level and considerable analysis of such information. Attention must be given to measuring the specifics of the new costs incurred (including the actual financial effects, appropriately allocating any joint spending for health/safety compliance and production improvements), the effects on productivity and resource requirements, the impacts on industry structure and competition, and the benefits realized from hazard reduction. Outcomes attributable to OSHA compliance need to be distinguished from those arising chiefly from other influences. Furthermore, the number of industries affected under contemporary OSHA standards is often quite sizable. These various features of the evaluation problem imply staff and resource requirements for research that are quite sizable, and probably could not be achieved, within the confines of the agency's present (tightly constrained) budget, without undesirably diverting resources from other, higher-priority activities.

Nevertheless, OSHA would, by all appearances, gain considerably from having informed answers to provide—to Congress, to the public, to those with a stake or influence in future rulemakings—regarding the hazard reductions achieved, the costs truly imposed and avoided, and other benefits realized. In this vein, it deserves to be carefully explored whether there are avenues within the agency's reasonable grasp that could be pursued to build a more substantial base of information than presently available on actual post-promulgation outcomes.[36]

This might, for example, involve monitoring the information available in trade journal articles documenting control experiences, drawing on other agencies' studies (such as from NIOSH or EPA), and conducting discussions (through focus groups or more informal one-on-one conversa-

[34] The PACE survey annually collects company-level data on new capital expenditures and annual operating expenses incurred for environmental protection (i.e., EPA regulations) through pollution abatement and related control of wastes. This information is collected by the Bureau of Economic Analysis chiefly to incorporate pollution abatement expenditures into the U.S.'s National Income Product Accounts.

[35] OSHA's IMIS provides computerized information on a large cumulative number of samples over time, but its utility for new rulemakings is limited since around three-quarters of all these samples concern around a dozen chemicals. In addition, the sampling of establishments reflects, for the most part, the logic of the agency's enforcement efforts, rather than a representative sample of the establishments in any given industry. Furthermore, the data collection provides information on job classifications, exposures, and in-place control technology, but little on economic considerations.

[36] To be sure, OSHA has recently begun to think about this matter. See, for example, Savant Associates, Inc., Princeton, NJ, "Design of a Prospective Method to Review the Impact of an OSHA Standard," unpublished draft contract report, prepared for the Office of Program Evaluation, Occupational Safety and Health Administration, U.S. Department of Labor, Washington, DC, Oct. 21, 1993.

tions) with knowledgeable participants in affected or related industries (such as the suppliers of production or control equipment). In addition, OSHA could make a more regular effort to conduct retrospective case studies akin to the few that are presently available (such as those performed or drawn upon for this report). Furthermore, there may be ways to establish acceptable mechanisms for more systematically collecting data on outcomes (including control measures adopted, compliance spending, changes in hazard exposure levels) as a component of the compliance content and implementation of new standards .37

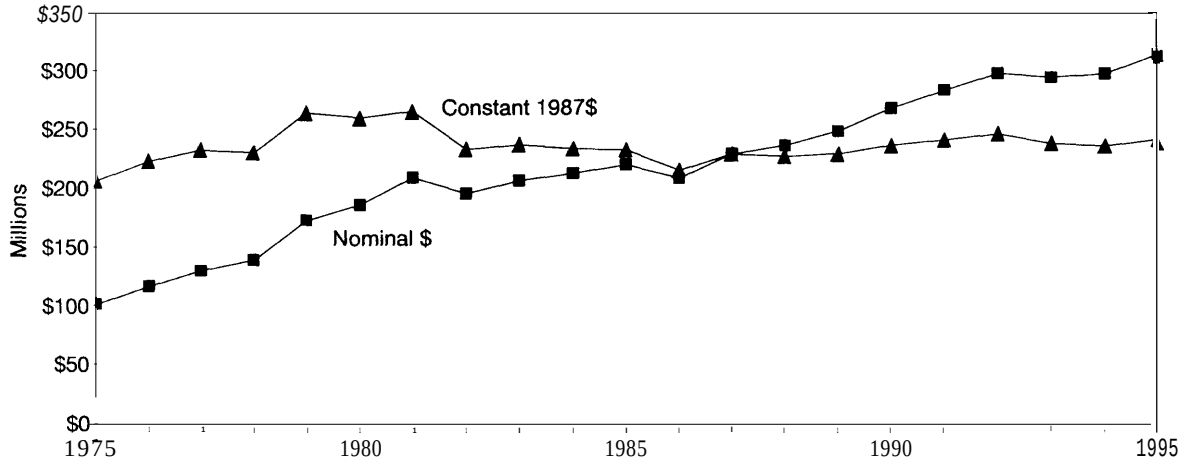
Organizational and Resource Considerations

OTA devoted some effort in the course of the study to examining OSHA's internal organization and budget resources, as they relate to the conduct of technology and regulatory analyses. The findings reported below derive chiefly from a series of interviews with current and past OSHA staff and with other observers familiar with the agency's tasks and procedures, and from an examination of internal and public information on the agency's budget.[38]

- ***The level of resources supporting the agency's technology and regulatory analysis efforts is hard to precisely pin down, but it is apparent that demand has long been substantial and the resources thin.***

Congress's annual appropriation to support OSHA's various activities (standard setting, enforcement, education/assistance, statistics, administration, and so on) shows a progressive expansion over the past 20 years on a current-dollar basis—from around $100 million in 1975 to somewhat over $310 million in 1995 (figure 3-1 and table 3-6). Nevertheless, when the figures are adjusted for inflation, it is evident that the agency has had to operate under a generally tighter budget since the funding "high water mark" of the late 1970s and very early 1980s. Expressed as constant 1987 dollars (see figure 3-1), the agency's annual appropriation was some-

FIGURE 3-1: OSHA Budget Approp



SOURCE: Budget of the United States, various years.

37 This possibility is considered in more detail in Savant Associates' 1993 report for OSHA, pp. 42-46.

38 For a more detailed discussion, readers should consult the project research paper prepared on this topic: Robert F. Stone, Econotron Inc., Framingham, MA, "An Evaluation of OSHA's Resources for Regulatory Analysis," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, March 1995.

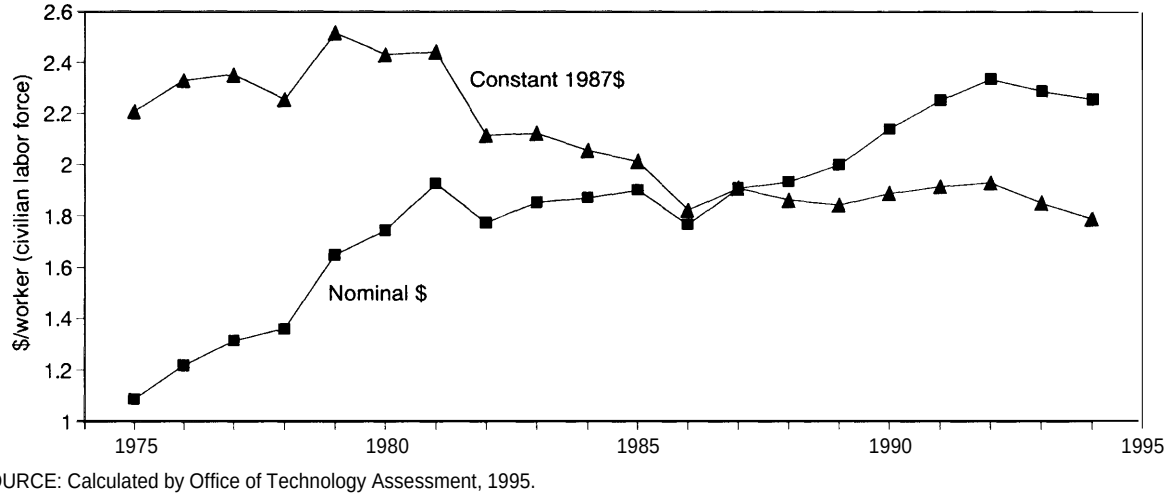
what above $260 million in the 1979-81 period, but has dropped to the $230 million to $245 million range since the later 1980s. In addition, the agency's permanent staff has declined from a total of around 3,000 full time equivalent (FTE) employees in 1980, to about 2,300 at the end of 1994-a cumulative decrease of about 23 percent.

As this report is being completed OSHA's budget for fiscal year (FY) 1996 remains a matter of vigorous debate. The President's February 1995 budget proposal outlined an appropriation of about $347 million (see table 3-6), a current-dollar expansion over the FY 1995 level of around 11 percent, or 7 to 8 percent on an inflation-adjusted basis. However, substantial *reductions* over the FY 1995 level have been proposed in Congress. In August 1995, the House committee responsible for the funding of labor, health and human services, and education programs passed an appropriations bill placing OSHA's FY 1996 funding at $264 million—about a 16 percent reduction from the level in FY 1995 and, in inflation-adjusted dollars, a level somewhat below that prevailing in 1975. Nevertheless, Senate and conference committee action on this matter remains in the future.

Put in a broader perspective, the growth of OSHA's budget since 1980 in inflation-adjusted dollars has not kept pace with the expansion of the U.S. workforce. The agency's budget per worker (across the civilian labor force) increased throughout 1970s, peaking at approximately $2.50 per worker (1987 dollars) in 1979 (figure 3-2). Since then, it has dropped steadily, to less than $1.80 per worker (1987 dollars) in 1994—a cumulative decline of almost 30 percent.

Tallying the annual resources the agency devotes to regulatory analysis activities is not entirely straightforward, given the wide involvement (as noted in the previous chapter) of various agency and DOL offices in the process. In addition, on several past occasions, OSHA has secured some supplementary funding for its rulemaking-related research from other agencies, via interagency budget transfers (e.g., from the Department of Energy for the ongoing Ergonomics rulemaking and from EPA for the 1989 Hazardous Waste Operations and Emergency Response Standard).

FIGURE 3-2: OSHA Budget Per U.S. Worker



SOURCE: Calculated by Office of Technology Assessment, 1995.

TABLE 3-6: OSHA Budget Allocations

Appropriations, Direct Programs, Selected Years, 1980-1996

$ (thousands)

Authority	1980	1985	1990	1995E	President 1996P	House 1996P
Safety & health standards	6,510	5,483	7,581	9,221	9,471	8,354
Enforcement						
Federal	78,048	86,452	119,138	145,323	155,854	98,000
State programs	42,360	53,021	59,827	70,615	75,915	65,319
Technical support	13,024	12,285	16,467	19,068	21,668	17,467
Compliance assistance	32,176	36,242	35,272	45,189	55,332	53,601
Safety & health statistics	6,906	21,036	21,945	15,640	20,669	14,707
Executive direction & administration	7,370	5,125	6,838	7,444	7,594	6,537
Total	186,394	219,644	267,068	312,500	346,503	263,985

SOURCE: 1980, 1985, 1990: Budget of the United States. 1995: estimate from President's FY 1996 Budget (Feb. 1995). 1996: fiscal 1996 proposals available to date—President's FY 1996 Budget, U.S. House committee bill (Aug. 1995).

If only the funding for OSHA's Office of Regulatory Analysis (ORA) is considered, however, the agency's principal resource for regulatory analysis, the overall level of available resources in inflation-adjusted dollars (including funding for ORA's staff and for outside research contracting) has ranged from somewhat under $2 million to somewhat over $5 million annually since 1980 (figure 3-3). Obviously, this represents a small fraction of the agency's $230 million to $260 million total annual budget over the same period. Since the later 1980s, moreover, it is apparent that ORA's resources have dropped sharply. In addition, over the same period, ORA's professional staff (chiefly economists) has declined from 16 or 17 FTEs to less than a dozen.

The observers with whom OTA spoke (all long familiar with the agency's operations) characterized the resources available for technology and regulatory impact analysis as "too thinly spread" and the necessary work often undertaken "on a shoestring."[39] The general appraisal provided was that this situation has inappropriately limited the scope of the analytical effort that can be mounted in any given rulemaking. Reportedly, the resource constraint, on some occasions, has forced some undesirable "triaging" of the available budget according to the estimated degree of controversy associated with a rulemaking and, in a few cases, prevented otherwise appropriate analyses from being undertaken.

- ***The existing resource constraints notwithstanding, developments on the horizon portend the need for an even larger regulatory analysis effort.***

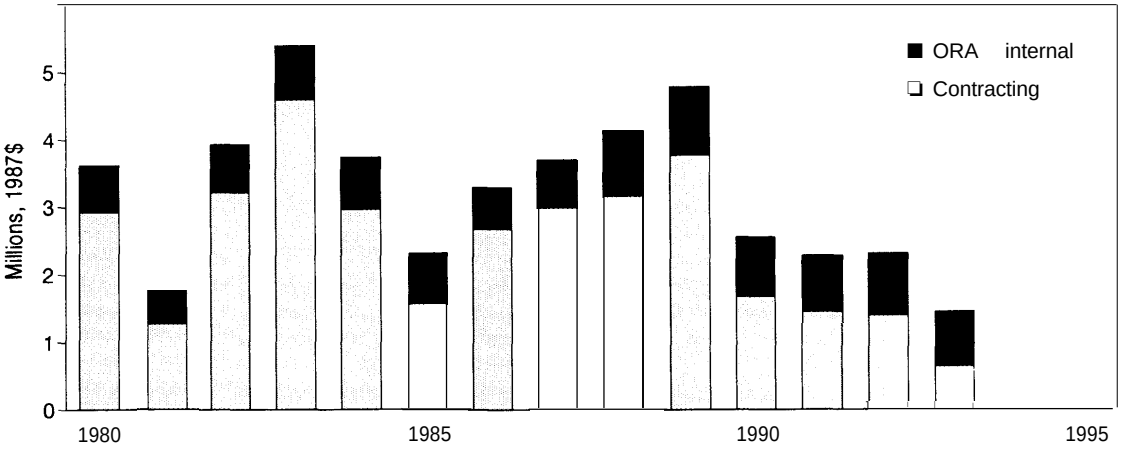
[39] Meaningful comparisons with the circumstances in other agencies that have health, safety, and environmental regulatory responsibilities are not easy, as differing statutory and programmatic mandates prevail (and thereby differing analytic requirements). However, one of the reasonably parallel cases OTA could identify is OSHA's 1992 Process Safety Management standard and EPA's Risk Management Plan to comply with the 1990 Clean Air Act Amendments. Here OSHA relied on 3 full-time staff and $200,000 for outside contract research to conduct its regulatory analysis; EPA, by considerable contrast, has, to date, used 10 full-time staff and $4 million for outside contracts.

Increased pace of rulemaking. From its inception in 1971 through 1992, OSHA has completed an average of about four rulemakings a year (a rate roughly true for the 1985-1992 period as well). However, the agency's present director has envisioned a more ambitious schedule—a pace closer to 10 final rules and 10 proposed rules per year. Whether such a goal can still be pursued, given the large shift of the political balance in Congress in January 1995, is unclear. But meeting such a schedule, without dropping below the threshold of acceptable analysis defined by the courts, will, by all appearances, compel the agency to commit significantly greater resources to the existing regulatory analysis effort.

New analytic support for priority setting. OSHA's present senior management has indicated a strong desire to establish an ongoing system for setting future rulemaking priorities. (Such a system would respond to what many observers have identified as a long-standing deficit in the agency's policy-planning capabilities.) The system will need substantial data resources to identify and compare the levels of risk associated with various existing workplace hazards. There may also be a role for some initial, "big picture" regulatory assessments, examining the availability of technologically and economically feasible opportunities for removing/reducing significant risks. Such pre-rulemaking analysis activities, should they be pursued to any substantial extent, would represent an addition to the agency's existing technology assessment and regulatory analysis efforts.

Increased rulemaking controversy. OSHA is obliged to consider all credible statements submitted to the rulemaking record. In the case of comments on the agency's regulatory impact findings and estimates, handling this task has often required considerable effort from ORA staff, and can create the need for significant review and potential revisions in the agency's analytical findings and estimates. In the past, most of the agency's rulemakings elicited fewer than 1,000 comments. Until recently, the 1991 Bloodborne Pathogens standard held the record, with approximately 3,000 written comments, but the ongoing rulemaking on Indoor Air Quality could ultimately total some 45,000 to 50,000 comments. Before the "hold" recently established by the agency's director (in June 1995), the Ergonomics rulemaking also was generating a large volume of comments. Should these recent cases prove to more nearly define the norm for future rulemakings, the added strain on the resources available for regulatory analysis is obvious.

FIGURE 3-3: Office of Regulatory Analysis Spending



SOURCE: OSHA, Office of Regulatory Analysis, 1994

An enlarged scope for judicial review. Congress could well soon choose to enlarge the scope of the agency's rulemaking findings and analyses open to review by the courts, through changes to the terms of the 1980 Regulatory Flexibility Act or a broadly encompassing scope for review established for all federal agencies' regulatory impact analyses as an outgrowth of the ongoing "regulatory reform" debate.

To date, OSHA's analyses of regulatory impact on small businesses (and other relevant small organizations), in line with the Regulatory Flexibility Act, have been specifically excluded as a possible topic for attention by reviewing courts. Legislation to remove this restriction was introduced but unsuccessful late in the 103rd Congress; differing versions passed both the House and Senate, but joint action died in conference as the term ended. Nevertheless, similar bills have again been introduced in the current Congress.[40]

OSHA's regulatory impact documents already provide rather detailed analyses of the expected impacts on small businesses.[41] But should such legislation become law, the threat of "substantial evidence" review by the courts extended to this area of analysis could drive OSHA to enlarge the analytic procedures or documentation, to ensure the ability of a rulemaking's record to withstand this widened scrutiny.

The "regulatory reform" efforts now underway in both the House and Senate also could expand the scope of the court's review of agency rulemakings (see earlier discussion in this chapter). The specific provisions vary in the several bills forwarded thus far, but most seek (among other objectives) to codify provisions on regulatory impact analysis provisions in line with what the various executive orders have long required, and to make the findings and policy conclusions from these analyses fully subject to potential scrutiny by the courts (which has not been the case to date with the executive order-mandated analysis requirements).

OSHA already prepares most of its analyses at a considerable level of detail and with substantial documentation. But widened judicial review clearly brings with it the prospect of additional agency analysis and documentation to ensure the adequacy of a rulemaking's record in this revised procedural setting.

Expanded analysis of control options and impacts. The various earlier observations in this report commenting on the "narrow" content of the control option and impact analyses that OSHA now prepares for rulemakings imply a number of avenues along which existing procedures might be enlarged, including more comprehensive quantification of the full range of regulatory benefits expected, greater emphasis on forecasting expected outcomes in preparing feasibility and regulatory analyses, and a systematic effort to monitor the potential of advanced and innovative technologies in providing options for reducing workplace hazards.

Various events could drive the agency to embark on such improvements—such as a new judicial or congressional push toward greater attention to benefit-cost balancing in setting compliance requirements, an increase in rulemakings involving a technology-forcing component, or the emergence of a combined effort with

[40] *United States Code*, Section 611(b) of Title 5 places Regulatory Flexibility Act-related analyses off-limits to judicial review. In the 103rd Congress, H.R. 830 and S. 490 both proposed removing this restriction and made their way to conference—but a corresponding new law did not eventually emerge. Similar bills were placed early in the current Congress (104th)—H.R. 937 (introduced February 1995, and referred to the Committee on the Judiciary and the Committee on Small Business), S. 350 (introduced February 1995, and referred to the Committee on the Judiciary). In addition, removal of the judicial review constraint and some expansions in the required content of Regulatory Flexibility analyses have been addressed in many of the various proposals for "regulatory reform" now being considered in both chambers.

[41] For some time, OSHA's feasibility and regulatory impact analyses, in line with the "regulatory flexibility" mandate, have typically distinguished establishments with fewer than 20 employees from larger ones. (Some analyses have examined a larger number of size classifications.) Normally, the agency conducts its economic feasibility and industry impact analyses in each of these size-stratified groups and considers the differential results (if any are found to exist) in its final rulemaking actions.

EPA to examine the frontier of technological options available for joint "pollution prevention" and safety/health hazard reduction in the workplace. Nonetheless, most such expansions in the inquiry represent a deepening (in concept, methodology, and data collection) of the scope of analysis now implemented, and, as such, would require significant expansion of the agency's existing analytic effort.

- ***A number of ways to improve the agency's existing procedures for conducting and using regulatory analyses appear to merit consideration. (Indeed, some are already the focus of ongoing agency initiatives.)***

Improved interoffice integration. In principle, OSHA has always used a team approach for rulemakings (typically consisting of a health or safety scientist, an engineer, a lawyer, and an economist), with members cooperating in designing and analyzing the intended regulatory action, and bringing the resources of their respective directorates or offices to bear as needed. In recent years, however, this integration has been less inclusive than intended, with ORA staff (mostly economists), on occasion, operating in some isolation.

According to some insiders with whom OTA spoke, this circumstance has contributed to tensions among various agency offices over the preparation of rulemaking actions and has impaired the design and conduct of the regulatory analysis effort. Although, conversely, others noted that some tension was inevitable between those agency staff chiefly responsible for defining standards and those charged with considering regulatory impacts, and that a key leadership task is to manage these differences constructively and to the general advantage of the rulemaking.

OSHA's current senior management, apparently appreciating the significance of these matters, has recently affirmed the importance of the integrated team approach and seems to recognize the need to better manage the coordination among staff with contrasting responsibilities.

Expanded interaction with NIOSH. NIOSH is widely regarded as a capable and credible resource in the technical and scientific aspects of the industrial health and safety arena. OSHA has long made use of NIOSH research in its rulemakings—chiefly through the Institute's Health Hazard Evaluations (HHEs), which, for the most part, are conducted and published independent of, and in advance of, OSHA's rulemakings.

In the past, there have been a number of reasons why OSHA has not been able to draw more substantially on NIOSH's research capabilities. In part, schedules did not coincide; NIOSH typically required two to three years of lead time to prepare a report on a specific hazard, whereas OSHA was unable to provide information on its rulemaking schedule any further than six months in advance, and required products with a much shorter calendar for completion. Moreover, for much of the 1982-92 period, the OSHA Administrator and the NIOSH Director clashed frequently on policy matters; as a result, interagency communication and cooperation were limited. Furthermore, the geographic distance (until its recent relocation to Washington, DC in 1993, NIOSH's main office was located in Atlanta, Georgia; whereas OSHA is in Washington, DC) and executive branch separation (NIOSH is formally a part of the Department of Health and Human Services and OSHA resides within the Department of Labor) have not helped.

For the past two years, however, OSHA and NIOSH have been working to improve cooperation. OSHA is also trying to make better use of NIOSH's research capabilities during the course of standard setting. And NIOSH has been seeking to expand its research activities in the important area of control technologies.

Links with new-technology research at EPA. One seemingly productive area for expanded OSHA interaction with EPA is in the general area of "pollution prevention." The ongoing efforts to encourage industry to adopt technologies in this vein have a natural integration with efforts to reduce workplace safety and health hazards. The Office of Pollution Prevention in EPA's Office of Pollution Prevention and Toxics has become a rich source of data on inherently

cleaner (less polluting) technologies, through information generated by EPA labs (in Cincinnati and Research Triangle Park) and industry. Opportunities to expand OSHA's use of and participation in such efforts deserve to be more substantially considered.

Inputs from the DOL Policy Office. Several experienced observers of OSHA noted to OTA that in past rulemakings, the Department of Labor's Office of Policy (see figure 2-1 in the previous chapter) had been a useful reviewer of OSHA's regulatory impact analysis drafts, and had provided valuable technical advice on regulatory and economic research issues. However, deep and successive budget cuts have reduced this Office's research budget from close to $5 million annually early in the 1980s to less than $150,000 more recently. The result has been that the much diminished technical staff is now able to provide only minimum technical support, and drafts of regulatory analyses can be reviewed only in exceptional cases. Although this is apparently not yet a major item on the OSHA leadership's action list, there seems to be significant support within OSHA for restoration of enough of the budget to enable the office to reassume its past advisory and review roles concerning matters of regulatory analysis.

Interdisciplinarity at the Office of Regulatory Analysis. There was some comment on the overwhelming predominance of economists on ORA's professional staff. Clearly, a good deal of this is warranted, because a primary thrust of ORA's role in rulemakings involves examining the economics of proposed standards on affected industries and the larger economy. Nonetheless, a portion of the responsibility also involves assessing control technologies—an activity that would certainly appear to benefit from staff with skills in engineering disciplines (industrial, chemical, mechanical, and so on) or, ideally, combined skills in engineering and economics/business. Even if outside contractors, NIOSH, or staff from the Safety or Health Directorates continue to be used to analyze compliance technology, it would be an advantage for ORA to have an in-house staff capable of designing and evaluating research on technology-related topics. Furthermore, should ORA seek to become more substantially involved in gauging the potential of advanced technologies and industrial innovations to address workplace safety and health hazards, this kind of multidisciplinary mix would surely be essential.

Observations from Benchmarking

As a basis for comparison and a source of suggestions on possible avenues for improvement, OTA examined what other government organizations undertake in the way of assessments of control technologies assessments and analyses of regulatory impacts to support their rulemaking actions. This inquiry compared OSHA with other federal rulemaking agencies and with the government safety and health organizations of some of the major international trading partners of the United States.[42] The findings reported in this section are based chiefly on discussions with agency staff involved in the preparation and use of the analytic material, review of relevant scholarly literature, and various inputs from other knowledgeable commentators.[43]

- ***OSHA's regulatory analysis tasks are, in some respects, more complicated than those of its counterparts elsewhere in the U.S. federal bureaucracy. Nonetheless, the agency's work is generally comparable with the best***

[42] The other U.S. regulatory agencies considered by this analysis included the Consumer Product Safety Commission (CPSC), Environmental Protection Agency (EPA), Federal Aviation Administration (FAA), Food and Drug Administration (FDA), Mine Safety and Health Administration (MSHA), National Highway Traffic and Safety Administration (NHTSA), and Nuclear Regulatory Commission (NRC). The foreign nations examined included Canada, France, Germany, Japan, Britain, and the European Community.

[43] OTA's findings on this topic are discussed at greater length in a project working paper prepared on the topic: D. Butler, "OSHA's Brethren—Safety and Health Decisionmaking in the U.S. and Abroad," Office of Technology Assessment, U.S. Congress, Washington, DC, September 1995.

practices of other health and safety regulatory agencies.

In many ways, OSHA's experiences as a health and safety regulatory agency are not unusual. The other agencies OTA examined have similarly stringent requirements for technical and economic feasibility analysis, imposed by statute and its judicial interpretation, executive orders, or internal agency policy.[44] The scrutiny OSHA has received from the Congress, the courts, the executive branch, and regulated parties also is unremarkable. Many agencies have been specifically instructed to promulgate regulations, have had their budgets made contingent on particular actions, or have been subjected to great pressures to modify or abandon proposed regulations. Furthermore, two particular agencies (the Consumer Product Safety Commission and the National Highway Traffic and Safety Administration) appear to have changed their overall regulatory focus in response to judicial interpretation of their statutes.[45]

Nevertheless, some aspects of OSHA's statutory mandate do make its job more complicated than that of many other U.S. health and safety regulatory agencies. Three particularly significant differences are discussed here.

OSHA is one of the few agencies that *regularly* promulgate regulations applying to a wide range of businesses, from industrial giants to "mom-and-pop" operations. This situation complicates the task of evaluating the impact and feasibility of proposed regulations. It can also result in standards that may be feasible and acceptable to a majority of regulated parties but unworkable or otherwise unacceptable to a few—a statutorily permissible, but nonetheless procedurally problematic, situation. EPA regulations under the Toxic Substances Control Act (TSCA) can have a similarly broad impact, but very few regulations have been issued under the act's authority, and those that have, have been litigated and delayed in a manner analogous to that experienced by OSHA.

None of the other agencies examined by OTA are required to demonstrate that exposed populations face a "significant risk" before promulgating a regulation to address the hazard. Some analysts of the agency's policy decision processes have characterized this requirement (which was imposed by a 1980 Supreme Court interpretation of OSHA's enabling statute—see chapter 2), as "a significant impediment to the effective implementation of OSHA's statutory mandate."[46] CPSC and EPA regulations under TSCA have a similarly stringent requirement ("unreasonable risk"), but both of these agencies have other regulatory instruments they can bring to bear.

Finally, in many circumstances, OSHA cannot use a regulatory tool that other agencies may apply when hard-to-control hazards are identified. Although the option can be difficult to implement, other agencies often can choose to directly eliminate a hazard by having it prohibited, recalled, or otherwise withdrawn from use. This "banning" option provides a means to deal with a hazard when no technically and economically feasible alternative can be identified. However, banning is simply not possible for many hazards under OSHA's regulatory purview. Lead processing and cotton milling, working outside high-rise buildings, and fixing broken industrial equipment cannot be banned, eliminated from the workplace, or made so costly as to no longer be practical. OSHA has no choice but to find an approach that is both achievable and protective of worker health and safety.

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[44] Indeed, some form of feasibility analysis appears to be routinely carried out for the vast majority of health and safety regulations. Where there are agency-to-agency differences, they more nearly relate to the extent to which the enabling statutes allow feasibility considerations to be factored into regulatory decisions.

[45] See, for example, J.L. Mashaw and D.L. Harfst, "Regulation and Legal Culture: The Case of Automobile Safety," *Yale Journal on Regulation* 4(2):257–316, Spring 1987.

[46] S.A. Shapiro and T.O. McGarity, "Reorienting OSHA: Regulatory Alternatives and Legislative Reform," *Yale Journal on Regulation* 6(1):1989, p. 46.

OTA did not conduct an exhaustive review of the practices that other health and safety regulatory agencies use to conduct regulatory impact analyses, but our broad survey suggests that OSHA's work is generally comparable with the best practices of other agencies in the U.S. federal government with similar missions. However, as elaborated more fully later, OTA believes that some of the more innovative approaches EPA is now pursuing may be worth OSHA's consideration.

- ***OSHA's regulatory analysis tasks are far more demanding than those of its foreign counterparts because the United States requires far more detailed economic and technical feasibility analysis to promulgate occupational safety and health regulations.***

The U.S. approach generally is based on the principle that quantitative analysis provides an objective basis for regulatory policymaking. U.S. regulators must prepare and defend detailed empirical justifications for regulations in order to demonstrate that the choices meet statutory intent and are rationally related to the facts at issue. These analyses also provide the basis for defending the decision should a later challenge in court arise. Such justifications can not only be costly and time consuming, they are also vulnerable to second guessing because the science and analyses underlying them cannot usually be made airtight. While this second-guessing may be motivated by disagreement over the soundness of an analysis, it may also be used as a means of disputing an outcome or delaying implementation of a decision for political, economic, or social reasons.

One or another of a pair of contrasting approaches is used in the other nations OTA examined. Some grant greater autonomy to regulators to make occupational safety and health decisions, typically with the advice of elite authorities designated by the government. Others employ some form of consensual mechanisms for promulgating occupational safety and health standards. In this second system, stakeholders—business, labor, and at times, other groups—work with government regulators to identify the level and manner in which hazards are controlled. Feasibility (technological and economic), while an important consideration in such proceedings, tends to be dealt with qualitatively rather than quantitatively. Where regulators act autonomously, feasibility is more nearly treated as a matter of professional judgment than as an analytical determination. In stakeholder-based systems, participants assess feasibility in order to inform their bargaining positions and in order to be able to factor feasibility constraints into their negotiating stances and into the compromises they are willing to accept. Explicit engineering and economic analyses do not, however, drive the decisionmaking process under either regime.

- ***Occupational safety and health regulators in other nations seem to be able to promulgate standards more quickly than OSHA and without the discord and rancor that often arise in OSHA proceedings. However, applying the means used elsewhere to limit conflict in U.S. rulemakings is problematic.***

The form and operation of each nation's regulatory governance are functions of a complex set of interrelated political, social, historical, and cultural factors. In the United States, these influences combine to create a system that emphasizes public accountability for decisionmakers and respect for an individual's right to question the actions of the state. The other countries studied by OTA employ regulatory mechanisms that are based on either respect and deference for government authority, or emphasize consensus and cooperation among the parties most affected by regulation.

Several practical implications flow from the differences in the structures of the regulatory systems. The means used to constrain bureaucratic autonomy and to maintain oversight in the United States—promulgating prescriptive legislation, imposing administrative procedures on rulemaking, overriding bureaucratic decisions through legislation or executive order, examining agency actions in public hearings, and using the budgetary process to compel or end actions or to

indicate preferences—are seldom employed among the major trading partners of the United States. These procedures limit the ability of unelected officials to carry out policies that are contrary to the wishes of the elected branches, but they do so at the expense of speed and flexibility, two characteristics often identified as advantages of other regulatory systems. Oversight mechanisms also provide avenues for judicial intervention in decisionmaking. This intervention allows a wide range of individuals and groups to have a voice in regulatory policy and conduct, but it also delays regulations without regard to their usefulness and necessitates the creation of extensive records to document the rationale underlying agency decisions. The time spent and paperwork generated in these exercises are often decried as weaknesses of the U.S. system.

Constraints on bureaucratic authority appear to be less important in some foreign nations because of long-standing traditions of respect for government authority, and in other foreign nations because key stakeholders are an explicit part of the regulatory decisionmaking process. By giving stakeholders a seat at the table, these governments eliminate a prime motivation for strict oversight. By vesting them with part of the responsibility for standards and highly constraining their ability to challenge regulatory decisions once they are made, the nations encourage good-faith negotiations among stakeholders and promote support of the agreements reached.

Thus some of the perceived weakness of occupational safety and health decisionmaking in the United States (and of the U.S. regulatory approach in general) can also be viewed as an outgrowth of principles that citizens value. It is certainly worth considering whether other systems for formulating regulations—in particular, cooperative approaches like those used in Britain and some Canadian provinces—may have utility here. It is important to remember, however, that one reason that such regulatory strategies may work elsewhere is that they are rooted in different beliefs about the various checks and balances needed between government and the citizenry.

- ***Some of the initiatives related to setting safety and health standards now under way at EPA, an agency with similar regulatory analysis requirements, may merit OSHA's attention and consideration.***

EPA's ability to conduct regulatory analyses is enhanced by its size, resources, and some of its enabling statutes. The agency's budget was more than 20 times that of OSHA in fiscal 1993, and its full-time-equivalent employment was more than 5 times larger. Undoubtedly, these greater resources allow EPA to maintain more staff and more internal expertise on control technology and economic issues, and to tap outside sources of information more easily. Some of the statutes under which EPA operates also help the agency obtain reliable information on which to base standards. The Clean Air Act, for example, permits EPA to compel industry to provide it with data or to enter facilities to obtain information relevant to potential regulatory initiatives. EPA's Science Advisory Boards (SABs), created by statute, have the task of reviewing the technical adequacy of proposed standards. SAB reviews serve as an internal check on the merit of feasibility analyses and provide an imprimatur that may enhance their credibility to the courts and stakeholders.

That said, EPA has shown a willingness to use some innovative approaches to formulating standards and assessing their feasibility that may be worth consideration by OSHA. OTA has not conducted a thorough examination of EPA regulatory reform initiatives or of the agency's typical technological and economic analysis methods, and draws no conclusions regarding the initiatives or the quality of EPA's work. But this report has identified several EPA efforts, many at the pilot stage, which appear promising. In the realm of setting standards, these include:

- improving consultation with stakeholders;
- giving greater attention to "pollution prevention" measures, that is, approaches that seek to directly reduce, rather than control, emissions (hence exposures)—including changes in pro-

cesses and changes and substitutions of materials;
- providing information and technical assistance to state and local governments and to businesses seeking to accelerate the development and deployment of innovative technologies; and
- selectively promoting technologies that achieve compliance goals at low initial or long-term cost.

As for control options assessments, EPA analyses have included consideration of speculative technologies based on adaptations of currently available devices, and have examined cutting-edge foreign research that might produce greater reductions in hazards at lower cost. EPA has also used contractors to obtain, analyze, and summarize compliance cost information without compromising manufacturers' confidential business information. OTA has not conducted the research to determine how widely these methods are applied across EPA's various regulatory activities, but the available evidence certainly indicates that more encompassing approaches to examining control options are possible.

It appears that OSHA could benefit by carefully monitoring EPA's success and failures with these efforts as they unfold.

Policy Issues 4

OSHA AND THE CURRENT CONGRESS

At the time of this report's completion (late August 1995), various committees of the current (104th) Congress are actively considering a number of bills that could directly affect OSHA's procedures and regulatory activities. Many of the initiatives now under debate represent substantial reconsiderations of the agency's procedures and capabilities.

"Regulatory reform" continues to be a major topic of attention—with principal themes including the conduct of scientific risk assessments, the analysis of benefits and costs, the consideration of benefit-cost balancing in rule promulgation, and expansions in the scope of judicial review of regulatory analyses. This broad area of issues has been the subject of numerous bills since the beginning of the session. Most such proposals, if enacted, would affect OSHA along with many other federal regulatory agencies.

Early last March, the House passed H.R. 9 (the Job Creation and Wage Enhancement Act of 1995), which rolled together several existing bills, including H.R. 1022 (addressing risk assessments), H.R. 926 (benefit-cost analysis, regulatory flexibility), H.R. 925 (private property rights), and H.R. 830 (paper work reduction). Among the numerous provisions, H.R. 9 specifies guidelines for the conduct of scientific risk assessments and benefit/cost analyses and commands the use of these findings in "major" rulemakings (i.e., for risk assessments, a rule imposing $25 million annual effect on the economy; and for benefit-cost analyses, a rule imposing $50 million annually). It also mandates consideration of the expected balance of benefits and costs (or cost-effectiveness) to be realized in setting standards and removes the long standing restriction against judicial review of small business regulatory impact analyses prepared in accordance with requirements of the 1980 Regulatory Flexibility Act.

In the Senate, S. 343 (the Comprehensive Regulatory Reform Act of 1995) has received greatest attention in the last several months. S.343 also requires extensive risk assessment and benefit/cost studies for: "major" regulations (i.e. a gross annual economic effect of $50 million). In addition, the bill mandates a showing that the benefits of a proposed regulation justify the costs imposed on society, widens the scope of judicial review to encompass nearly all such analyses, expands the opportunities for regulated parties to sue federal agencies over their adherence to administrative procedures, and allows individu-

als to petition agencies to modify or revoke regulations. Competing bills exist in the form of S. 291, S. 333, and S. 1001—which, in most respects, would institute less extensive reforms in existing regulatory procedures than S. 343 has proposed.

In another initiative, the House Government Reform and Oversight Committee, in mid-July, approved H.R. 994 (the Regulatory Sunset and Review Act of 1995), which would require agencies to review many existing regulations over a seven year period and modify or revoke those determined to be unnecessary, outdated, or overly burdensome. A similar proposal has been introduced in the Senate (S. 511).

There are also a number of bills focused more narrowly on OSHA, with some proposing substantial revisions of OSHA's regulatory mission and procedures. H.R. 707 (the OSHA Reform Act of 1995) proposes broad reforms in the agency's practices, including establishing benefit-cost balancing as a formal basis for standard setting, mandating that an increased share of the agency's budget be devoted to technical assistance and other consultive services for industry, increasing the incentives for voluntary compliance, and revising the basis for the agency's conduct of on-site inspections. A similar bill in the Senate, S. 592 (the Occupational Safety and Health Reform Act of 1995), also contains far-reaching proposals, including those for increasing the influence of scientific risk assessments and benefit-cost balancing in standard setting, transferring NIOSH to the Department of Labor, mandating the conduct of comprehensive evaluations of the costs and benefits of existing OSHA standards every several years, and promoting the formation of employer-employee safety committees to deal with workplace hazard reduction. H.R. 1433 (the Occupational Safety and Health Administration Consultation Services Authorization Act) proposes that the Secretary of Labor establish cooperative programs to allow businesses to consult with state officials on OSH Act compliance matters. S. 917 (the Small Business Advocacy Act) would create new mechanisms for small businesses to become involved in OSHA's (and EPA's) regulatory development efforts. Several other current bills deal with specific aspects of workplace hazard protections.[1]

Finally, as discussed in the previous chapter, OSHA's budget appropriation for the coming fiscal year is currently a major topic of debate. The President's proposal (of February 1995) specified FY96 funding for OSHA of around $347 million, about 11 percent above the $313 million level in the current year. Nonetheless, in recent action (August 1995), the House approved an FY96 Labor-Health and Human Services-Education appropriations bill that allocated only $264 million to OSHA, a 16 percent decrease over the current year's level. The corresponding Senate bill remains in progress at this time.

DISCUSSION OF SALIENT ISSUES

The present study has, for the most part, concentrated on several particular aspects of the agency's policy analysis activities and has not taken on the full range of issues encompassed by the wide breadth of Congress's current legislative agenda on OSHA. Nonetheless, there are a number of matters on which this study's main areas of inquiry intersect with current congressional concerns. A number of observations on these issues follow below.

Consideration of Regulatory Impacts in Rulemakings

It is apparent from the many rulemaking records examined in this study that OSHA already devotes a good deal of attention to the assessment of regulatory impacts (i.e., compliance costs, expected benefits, feasibility of economic

[1] H.R. 750 (the Worker Protection Warnings Act) would require the establishment of uniform labels addressing the proper procedures and effectiveness limits for personal protective equipment. H.R. 1783 (To Require Changes in Regulations Under the OSH Act) would modify the prevailing procedures governing the use of respirators in oxygen deficient or hazardous chemical containing environments.

burden imposed, ripple-through effects to directly affected industries and the larger economy) in its standard setting activities. The substantial body of case law interpreting the agency's procedural burdens, the various executive orders (commanding the preparation of "regulatory impact analyses"), and subsequent legislation (particularly, the Regulatory Flexibility Act) arising since promulgation of the OSH Act in 1970 have erected a comprehensive set of mandates for preparing such analyses as a routine feature of rulemakings. Since the later 1970s the agency has implemented a set of analytical procedures intended to be responsive to these requirements. Rulemaking records since that time have generally accorded substantial attention to regulatory impact matters—and in this respect vastly "outweigh" the records of earlier rulemakings.

OSHA standards are not formally established on the basis of explicit benefit-cost comparisons—largely because of the way Congress originally wrote the OSH Act and the subsequent interpretations of the courts. Nonetheless, the agency has, for some time, routinely prepared and submitted to the record considerable information on both the estimated costs and the more easily quantified benefits of intended standards. In part, this has been done to comply with the aforementioned, externally imposed requirements for preparation of regulatory analyses. But it is also apparent that stakeholders' (often competing) estimates and perceptions about the balance between incremental costs and benefits to result from a new regulation often become a prime consideration in the usual administrative flow of rulemakings.

Elevating the role of benefit-cost considerations in rulemakings is one of the major objectives of many of the "regulatory reform" bills now before Congress. In view of the substantial benefit and cost information OSHA already routinely assembles for its rulemakings, it is apparent that the enactment of new laws in this vein would not usher the agency into some vastly new rulemaking landscape.[2] Although, it would certainly drive the agency to devote greater attention on the record to showing how the expected costs of an intended new regulation would be "balanced" by the benefits of the hazard reductions to be realized. In addition, stakeholders unsatisfied with such findings and their rationale will, no doubt, have received another possible basis for challenging OSHA's regulatory actions in the courts.

It appears that, under such a revised rulemaking regime, OSHA would have strong incentive to seek to quantify more comprehensively than it now does the full range of benefits expected to result from a new standard, and to revise its feasibility analysis procedures to more nearly provide "most likely" forecasts of industry control responses and compliance spending. These actions would represent a significant and methodologically appropriate deepening of the "feasibility" analyses the agency already prepares, but both are resource intensive additions and would surely require a greater level of resources that OSHA now normally devotes to its regulatory analysis efforts.

The effects of such revisions of the agency's decision framework on the content of future standards would probably not be uniform, and, depending on the hazard at issue, might support the promulgation of either more *or* less stringent compliance requirements than are produced under the present policy decision logic.

Knowledge about Regulatory Outcomes

Adequate workplace health and safety protections are too important a public policy matter and OSHA's rulemaking activities so long heatedly

[2] A second major element of many of the "regulatory reform" bills Congress is now considering consists of provisions to expand the role of *risk assessments* in rulemakings. This analytic area has not been a focus of this project, but it is apparent from the numerous rulemaking records examined that the consideration of scientific risk assessment findings is already a major and routine aspect of OSHA's decision logic.

debated for there to be as little systematic information as there is that characterizes the actual regulatory outcomes in affected industries.

Admittedly, the evaluation task is a challenging one. Safety and health standards change hazard circumstances and impact industry behaviors, production costs, and profitability amidst or in conjunction with myriad other economic influences that must be sorted out. In addition, OSHA's regulatory scope is often quite wide, spanning many separate industries and various classes of establishments.

Nonetheless, OTA's findings from the case research conducted for this study strongly suggest that the regulatory impacts analyses prepared in rulemakings often do not well reflect the compliance paths chosen by affected industries or the costs and economic burdens that actually result. The regulatory analyses OSHA prepares for rulemakings are specifically intended to demonstrate the feasibility of proposed rules, and are not necessarily the outcomes most likely to arise. They cannot be considered a reasonable substitute for evaluative findings on actual post-promulgation outcomes.

OSHA, principal stakeholders, and the public generally would, no doubt, be well served by a more routine effort to collect and analyze information on outcomes (including control measures adopted, compliance spending incurred, other production and economic impacts sustained, workforce effects, hazard reductions achieved) as a normal part of implementing a standard. Such a program would need to be designed and implemented with care, to avoid becoming an overly vast, expensive, and intrusive data collection activity. But reasonably developed, such information and findings would provide valuable feedback to the policymaking process and provide a more solid basis for critically examining the various competing claims put forward by stakeholders and other observers.

Such an effort is clearly in line with some of the aforementioned "regulatory review" and "sunset" legislation presently being considered by Congress. And indeed, as discussed in the previous chapter, OSHA has already begun to consider the issues involved in mounting this kind of analytic activity on a more routine basis.

Nevertheless, it needs to be recognized that such research, even at a fairly modest level of effort, will be time and resource-intensive. Furthermore, access to and cooperation with industry for data collection purposes must be adequate—historically, a sensitive public policy issue. Should Congress seek to encourage OSHA's deeper involvement in such outcomes research, it should take some pains to carefully outline its expectations and assure that a satisfactory level of funding is available in the agency's budget to support the effort. Additionally, it should consider reviewing existing statutes governing OSHA's access to industry for data collection purposes (particularly Paperwork Reduction Act requirements) to assure that an appropriate balance between access for data collection and protection for industry from intrusive and overly burdensome data collection will exist.

Understanding the Potential of New Technology in Hazard Reduction

The most critical aspects of this report's appraisal of OSHA's current analytic procedures relate to the comparatively little attention typically devoted to considering the role of advanced technologies and production innovations in achieving hazard reductions. The historical record provides ample evidence that intelligently directed research and development (R&D) efforts can yield hazard control options that are technologically or economically superior to the conventional control measures (more ventilation, more enclosure) that usually receive the preponderance of attention in the agency's rulemakings. Such measures may also provide avenues to achieve "win-win" outcomes for industry and workers, yielding increased protection in a more cost-effective manner and perhaps in conjunction with other production benefits, such as productivity increases or improved product quality.

Nonetheless, the evidence indicates that OSHA has not routinely focused its thinking and information gathering in this area. Tracking

emerging technologies and identifying opportunities for R&D investments (including the strategic use of experimental variances or new technology demonstration projects) do not play a sizable role in the agency's current policy planning efforts. Most consideration of control technology options occurs in the context of ongoing rulemakings. But here, the realpolitik of the rulemaking process and the agency's often tightly limited resources for analysis usually work to narrow the scope of consideration chiefly to applications of existing, conventional control measures.

Fixing this shortcoming would appear to have a variety of components. OSHA needs to devote more time and effort, independent of particular rulemakings, to tracking and staying abreast of new technological developments in major application areas with relevance to industrial hazard control needs. Furthermore, the new technology perspective needs to be more explicitly engaged in the course of rulemaking analyses and debates—and OSHA needs to exercise more leadership in making this widening of the dialogue on control options happen. In addition, it appears that OSHA could benefit substantially from closer cooperation with NIOSH and EPA on new technology development and transfer. NIOSH represents an important resource for staying abreast of and conducting substantive research on new control technology options. EPA's current efforts in promoting the development and adoption of "pollution prevention" process technologies represents one area where linkages with workplace hazard reduction efforts could be particularly fertile.

To be sure, OSHA's involvement in these various endeavors seems likely to be more nearly a matter of having adequate time and resources, than generating intrinsic interest. The tight budget constraints under which the agency's analytical efforts have generally had to operate work against the kind of widened inquiry about control options that is envisaged here. Even so, the likely long-run consequence of the slower growth of knowledge that results is unnecessarily slow progress in developing and commercializing new generations of hazard control options that are likely to be more effective at addressing workplace hazards and better capable of providing "win-win" options for management and labor to adopt.

OSHA's increased attention to new technology in these respects would, no doubt, be encouraged by Congress's expression of interest in the topic. Nonetheless, a central consideration is assuring that adequate budget resources are available to the agency to support such efforts.

Alternative Process Approaches for Identifying Feasible Controls

Interest in the use of alternative policymaking procedures with greater emphasis on consensus building among stakeholders has been growing for some time. The Clinton Administration's Executive Order 12866 directs agencies "to explore and, where appropriate, use consensual mechanisms for developing regulations, including negotiated rulemaking." In the past, Congress also has expressed interest in the applicability of such approaches.

The cross-national comparisons OTA conducted for this study indicate that other nations successfully promulgate occupational health and safety standards using consensual mechanisms (i.e., what would be called "negotiated regulation" in the United States). In most of these cases, technical and economic feasibility considerations are addressed in the context of the general dialogue among interested parties, rather than as an independent exercise in exacting quantitative analysis. The early, direct involvement of stakeholders and their vesting in the decisionmaking that typically result seems to promote various efficiencies (compared with the more combative U.S. system) in resolving feasibility debates: focusing discussion on the most salient issues, promoting interactions of a problem-solving rather than a resisting nature, and providing early warning on where problems in policy options under consideration could arise.

Admittedly, unique contextual circumstances—such as the strong orientation toward

the public conduct of public business, the broad and well-defended rights of interested parties to challenge bureaucratic decisions in court, and basic cultural differences (e.g., less trust in government and authorities)—pose barriers to the success of negotiated rulemaking approaches here in the United States. Nonetheless, many specialists in regulatory policymaking believe that some aspects of negotiated approaches may be beneficial. EPA, for example, is one of several federal regulatory agencies that has been looking for ways to increase the use of consensual processes in its regulatory activities.

In light of such developments at other regulatory agencies, this may be an appropriate time for OSHA to re-examine the possible usefulness of such processes for its own rulemaking needs. In addition to reviewing its past experiences with consensual approaches, the agency should perhaps become an active participant in some relevant "experimental" cases, to see whether these approaches could, in the current policymaking setting, foster appropriate workplace health and safety protections more efficiently. Congress may wish to encourage OSHA to embark on such an exploratory effort.

Another avenue available to OSHA is to make greater use of balanced panels of experts as a means to identify and consider relevant control technology options.[3] The OSH Act provided the agency with statutory authority to convene such panels to assist in specific rule-makings. Similarly, the National Advisory Committee on Occupational Safety and Health (NACOSH), a standing committee on occupational safety and health matters also authorized by statute, could be used as a forum for discussing compliance options.

Some observers looking at OSHA's past use of advisory committees have concluded that they failed chiefly because the strict requirements for management and labor representation and limits on committee size mandated by statute politicized the panels and limited the number of independent experts that could be appointed.[4] Mandatory limitations on the life of individual committees imposed by the Federal Advisory Committee Act also curtailed their usefulness.

However, Congress could ameliorate such problems by amending the existing statutes to loosen or eliminate the limitations on committee size and terms, and change strict composition requirements to the simple stipulation that advisory committees be "balanced."[5]

[3] See, for example, N.A. Ashford, "Advisory Committees in OSHA and EPA: Their Use in Regulatory Decisionmaking," *Science, Technology, and Human Values*, 9 (1): 72–82, Winter 1984.

[4] T.O. McGarity and S.A. Shapiro, *Workers at Risk: The Failed Promise of the Occupational Safety and Health Administration* (Westport, CN: Praeger Press, 1993), p. 195.

[5] See McGarity and Shapiro, 1993, p. 195.

Appendix A: Extended Summaries of Retrospective Case Comparisons A

OSHA's Final Regulatory Impact Estimates vs. Post-promulgation Outcomes

HEALTH RULES

▮ Vinyl Chloride

Promulgated October 4, 1974 (39 FR 35890).

Industry sectors examined: vinyl chloride monomer (VCM) synthesis, polyvinylchloride (PVC) polymerization (the principally affected industries).

The new standard reduced the prevailing time-weighted average exposure over an 8-hour workshift (TWA8) permissible exposure level (PEL) from 500 parts per million (ppm) to 1 ppm. Other provisions included requirements for routine medical surveillance and exposure monitoring, regulated areas, hazard signs/labels.

Feasibility: In setting a stringent, "technology forcing" PEL, OSHA went against the grain of its own consultant's findings and the affected industries' arguments, both of which reflected an "it's infeasible" perspective. Nonetheless, the agency's judgments proved largely accurate, as the principally affected industries achieved full compliance with comparative dispatch in the 18 months following enactment.

Industry Adjustment: Most of the actions implemented to reduce exposure levels were anticipated in the rulemaking: these included reducing leaks and fugitive emissions, improved ventilation systems, modified reactor designs and chemistry, and process automation. Not foreseen, however, was the proprietary "stripping" process commercialized within a year of promulgation, which provided a significantly improved means for PVC resin production along with lowering the potential for vinyl chloride exposures.

Compliance Costs: In promulgating the final rule, OSHA did not provide its own estimate of the affected industries' compliance costs. The most credible figures considered in the rulemaking were those of the agency's technical consultant, which placed total costs at around $1 billion (1974$), including capital expenses for new equipment, replacement of lost capacity, and incremental operating expenses. Actual spending, however, appears to have amounted to only about a quarter of this estimate, $228 million to $278 million.

Other Impacts: Arguments made during the rulemaking debate suggested the standard would greatly increase business costs and threaten the viability of the vast majority of the industries' establishments. In reality, costs did increase and

production capacity was eroded, but only to a modest extent. Also, there was little evidence that the affected industries' financial status or ability to respond to customer needs had been strained.

Judicial Review: Soon after promulgation, Industry challenged the standard in several respects, on issues related to the health justification of the 1 ppm PEL and the agency's authority to impose a "technology forcing" standard needing control actions not yet commercially evident in the industry. In the latter matter, the U.S. Court of Appeals (2nd Circuit) concluded generally that the agency could, with sufficient evidence, promulgate "technology forcing" rules and that the agency had provided an adequate demonstration.

Comments: OSHA's Vinyl Chloride rulemaking is widely and justifiably remembered for the considerable inaccuracy of the "it's infeasible" arguments presented by industry representatives and the agency's technical consultant, which, in the end, OSHA policymakers elected to reject. Nevertheless, this case is less useful in commenting on the agency's present practices, because procedural changes introduced in the succeeding years have worked to minimize some of the problems that were particularly glaring. Such changes include: 1) the widened opportunities for stakeholders to review and extensively comment on the agency's feasibility and impact estimates at a relatively early stage, which arose with the regulatory impact analysis steps established in the later 1970s; and 2) the more extensive analyses of feasibility and impact matters that became normal at about the same time, which provided a more explicit basis for debate on the appropriate analytical assumptions.

Cotton Dust

Promulgated June 23, 1978 (43 FR 27350).
Industry sectors examined: textile manufacturing (including all the principally affected industries).

The new final rule tightened the existing TWA8 PEL from 1,000 micrograms per cubic meter (µg/m^3) to 200 µg/m3 for yarn manufacturing operations, 750 µg/m3 for slashing and weaving, and 500 µg/m3 for other operations in which airborne cotton dust was created. Other provisions included requirements for routine medical surveillance and exposure monitoring, employee training, and regulated areas.

Feasibility: The promulgated standard proved clearly feasible in both technological and economic terms, although these judgments were the subject of extensive debate during the rulemaking. For yarn manufacturing operations, OSHA elected, on technological feasibility grounds, not to set a PEL more stringent than the 200 µg/m^3 specified. For slashing and weaving operations, the agency defended its decision to establish a substantially less stringent PEL on both economic feasibility and health risk grounds. The post-promulgation evidence largely confirmed both judgments.

Industry Adjustment: The engineering controls envisaged throughout the rulemaking as central to reducing dust levels—retrofits of existing production machinery, such as additional enclosure, added local exhaust ventilation, enhanced general ventilation and filtration—all clearly played a role in achieving compliance. But this emphasis missed the substantial extent to which dust control was achieved as a by-product of an aggressive modernization drive by the textile manufacturing industry, driven by sharply intensifying competition from foreign companies. In numerous operational areas, the industry's existing, older equipment was either rebuilt with modern functions or replaced outright with modern equipment, much of which enabled faster production speeds, consolidation of operations, more effective use of floor space, reduced labor, and improved product quality, all along with lower levels of dust.

Compliance Costs: OSHA's estimate in the Final Regulatory Impact Analysis (RIA) placed the textile manufacturing sector's cost of compliance at $280.3 million annually (1982$, including amortized capital spending, incremental operations and maintenance, and other new spending). Actual spending is estimated to have been only about a third this level, $82.8 annually

(also 1982$). A chief reason for this large disparity relates to the advantageous economics of the plant modernization the sector implemented. (Estimates produced earlier in the rulemaking process, which were vastly higher, would have been even further off the mark, although, preliminary versions of the standard contained substantially more stringent dust control provisions.)

Other Impacts: Concern was expressed at promulgation that smaller textile firms could encounter substantial constraints in raising capital for compliance-related improvements and that the standard would tilt the sector's competitive center toward newer and more modern plants. (However, neither of these circumstances was considered large enough to warrant a "thumbs down" economic feasibility judgment for the industry as a whole.) Suppliers of control equipment also argued during the rulemaking that serious bottlenecks would arise in trying to retrofit the industry's equipment in short order, but the actual effects proved to be more modest and generally bearable in all these regards.

Judicial Review: The 1978 standard was extensively challenged in court. Notably, in 1979, the U.S. Court of Appeals (DC Circuit), in addressing an industry petition, affirmed OSHA's technological and economic feasibility findings for the textile manufacturing sector.

Comments: OSHA's more qualitative observations in the Final RIA largely anticipated the lower-cost, modernization adjustment to the standard that did occur. But more conservative assumptions (emphasizing chiefly retrofit measures) were used to develop the technological and economic feasibility determinations for the rulemaking. Furthermore, it does not appear likely that a more accurate anticipation of the industry's actual compliance response would have substantially altered the content of the standard's provisions.

Occupational Exposures to Lead

Promulgated November 11, 1978 (43 FR 52952).
Industry sectors examined: secondary smelting (one of the more than three dozen industries affected by the standard, but one of the handful that had high existing exposures and were likely to need major changes in existing processes to achieve compliance).

The new standard tightened the existing TWA8 PEL from 200 µg/m³ to 50 µg/m3. Other provisions included requirements for routine medical surveillance and exposure monitoring, housekeeping procedures, protective clothing, respirator use, hygiene facilities, preventive maintenance, employee training, medical removal protection, regulated areas.

Feasibility: Numerous control equipment and operating practices were identified during the rulemaking to reduce exposures, including greatly increased enclosure and ventilation of solids handling operations, automation of operations (particularly battery breaking), increased isolation of employees from processing areas, and improved maintenance practices. There was wide agreement among the rulemaking parties that aggressive use of these conventional measures could greatly reduce average exposures, and substantial evidence that most facilities could reach a PEL of 100 µg/m³ on this basis. Achieving a 50 µg/m3 PEL principally through engineering and work practice controls (as the standard ultimately specified), however, was controversial. In promulgating the more stringent exposure level (set on health protection grounds), OSHA appealed to the aggressive adoption of existing conventional measures; major process redesign (including new plants built with the best available emissions control, such as the design outlined by Gould); and to foreseeable new technology (particularly the process improvements in scrap lead smelting then being introduced by Bergsoe and, over the longer term, a shift to hydrometallurgy). Recognizing that a 50 µg/m3 exposure level would not be immediately achievable, OSHA specified an extended phase-in period (5 years for secondary smelters), during which, the agency judged, the industry's physical plant could be substantially rebuilt, if necessary, and appropriate new technologies brought to the marketplace. In the interim, the final rule called for the adoption of all feasible engineering and

work practice controls, supplemented as needed by respiratory protection.

Industry Adjustment: Since more than a decade ago when the standard took full force to the present (1994), the industry's compliance response has differed substantially from the concept that underwrote promulgation. Most producers have adopted some additional engineering controls (particularly for point and area ventilation, along with increased automation). But the greater emphasis has been on respiratory protection programs, which virtually all producers now use, and improved employee hygiene (protective clothing, change houses, personal hygiene practices). Temporary removal from the workplace of employees whose blood lead levels exceeded a specified limit also has been used at one time or another by about half the industry, although present use of this measure is infrequent because fewer levels exceed the limit. Despite the final rule's mandate, however, few producers have invested in engineering controls to the full extent anticipated for PEL compliance. Airborne lead levels in plants, while lower now than in the late 1970s, still remain well above the PEL. (Indeed, most plants remain out of compliance with the previous 200 µg/m^3 PEL, with decades of further progress, given the slow rate of improvement that has prevailed to date, needed to reach the now prevailing 50 µg/m^3 PEL.) Furthermore, the "new technologies" envisaged by OSHA at the time of rulemaking have rather visibly not progressed; the single U.S. secondary smelter using the Bergsoe process went bankrupt in the mid-1980s, and hydrometallurgy still remains "on the horizon." The new capacity that has come on line in recent years (which has been substantial since the mid-1980s, particularly in the "integrated" end of the business, where old batteries are broken, smelted, and used to manufacture new units) has relied on conventional technology (but with closer attention to plant layout, material transfer/handling, and process operability with respect to emission and exposure considerations).

Compliance Costs: At promulgation, OSHA's "best" estimate placed the industry's capital requirements for compliance with a 100 µg/m^3 exposure limit at $34.1 million (1976$), or 2.5 cents annually per pound of production on a pre-tax basis, including amortized capital and operation/maintenance expenses ($77.7 million and 5.7 cents/lb., respectively, in 1992$). Corresponding estimates for the 50 µg/m^3 PEL were not presented, however, as the agency indicated that figures could not be determined at the time, given that "the industry face[d] several options for long-run compliance." However, an outer bound of about $91 million (1976$) in total capital spending was mentioned, based on a complete rebuilding of the industry using the Bergsoe smelter technology (considered then to be the most cost-effective option). In an early 1980s revision of the estimates, OSHA placed the cost of PEL compliance at a capital requirement of $125 million (1982$), or 1.3 cents annually per pound of production ($150 million and 1.6 cents/lb in 1992$). Nevertheless, the industry's actual spending to date (through early 1994) has been well below these levels. Cumulative capital investment appears to total no more than $20 million (1992$), and some of this overlaps with expenditures to meet the various environmental requirements to which the industry has also been subject (i.e., the Clean Air Act, National Ambient Air Quality Standards, Clean Water Act, Resource Conservation and Recovery Act, and Superfund liabilities). Annual compliance spending appears to be averaging in the range of 0.5 to 1.0 cent/lb (1992$), and perhaps as low as 0.3 cent/lb. Such levels are well below OSHA's expectations at the time of the rulemaking, and in large measure reflect the industry's strategy of minimizing expenditures on engineering controls and relying much more heavily on respirator and hygiene programs to reduce exposures.

Other Impacts: The real price of lead dropped sharply (and unexpectedly) after 1979, not returning to a similar level until late in the 1980s. Numerous smaller, independent smelters, that had limited financial resources and faced the combined effects of increased costs for both EPA regulations (emission controls and liabilities for future cleanups) and OSHA requirements,

elected to leave the industry. The remaining producers benefited from increased utilization of capacity but, nonetheless, had to aggressively reduce labor costs and improve productivity to compensate for the upward cost pressures. The industry today is smaller and, indeed, the most productive in the highly competitive global market. At the time of the rulemaking, OSHA acknowledged the limited extent to which most secondary smelters could pass on new compliance costs, and correctly judged that some consolidation would occur after promulgation, as producers with high marginal costs exited the industry. But OSHA did not anticipate the steep drop in lead prices that occurred. It now appears likely that the industry's consolidation would have been a good deal more severe had the level of compliance spending the agency estimated at promulgation proved nearer the actual circumstance.

Judicial Review: The 1978 standard was extensively challenged in the courts soon after promulgation by both labor and industry, with various remands and amending actions by OSHA continuing into the 1990s. The adequacy of OSHA's demonstration of the technological feasibility of the standard for secondary smelters was upheld by the U.S. Court of Appeals (DC Circuit) in 1980, along with that for nine other industries. (However, the judges were badly split on the decision, as in the lack of consensus over feasibility in the rulemaking earlier.)

Comments: The blood lead levels of this industry's workers have come down appreciably since the late 1970s, the combined result of the modest reduction in air lead levels (from new engineering controls), improved hygiene and work practices, and the general reduction in environmental lead levels. Nonetheless, the considerable distance yet to be crossed to bring air lead levels in line with the PEL (long after the requirement took effect) contrasts strikingly with the assumptions at promulgation. While judged in the end to be achievable, OSHA recognized that compliance would pose particular challenges for this industry, given its economic/technical maturity and limited ability to pass on new costs. One mitigating consideration is that OSHA's enforcement of the engineering control requirement appears to have been limited in several significant respects (both in its productive engagement of the industry and in comparison with EPA's contemporaneous regulatory actions). On the other hand, the rulemaking's analysis did not well grasp the nature of the burden that the joint OSHA and EPA compliance requirements would entail, or ways in which these intertwined needs might have been better optimized. The unexpected drop in lead prices made the full extent of engineering control investment envisaged by OSHA more difficult than anticipated. And the "new technologies" to which OSHA appealed as a longer-term compliance solution proved overly optimistic. Capable analysts differ widely in their interpretations of the lessons of this rulemaking. Nonetheless, the post-promulgation events to date hardly put to rest the feasibility debate that preoccupied the rulemaking in the beginning.

Ethylene Oxide

Promulgated June 22, 1984 (49 FR 25734).

Industry sectors examined: hospitals (one of a half-dozen affected industries, but the sector with the vast majority of exposed workers).

The new standard reduced the prevailing TWA8 PEL from 50 ppm to 1 ppm. Other provisions included requirements for routine medical surveillance and exposure monitoring, employee training, emergency planning, hazard communications.

Feasibility: Within a year and a half after promulgation, the vast majority of hospitals were operating with ethylene oxide (EtO) exposure levels in compliance with the new PEL. Indeed about three-quarters had taken steps to reduce exposures to a point well below the specified level. Clearly, OSHA had correctly gauged the feasibility of the requirements the standard imposed. Some credible parties to the rulemaking argued, on health risk grounds, for a substantially more stringent PEL, at about 0.1 ppm. OSHA determined, however, that 1 ppm was the

lowest exposure level then technically feasible; the limiting constraint was the availability of acceptably reliable exposure measurement methods. This judgment proved correct in the period immediately after promulgation, but not long after, improved technologies, stimulated by the concern about EtO exposures, largely removed this barrier.

Industry Adjustment: The predominant responses were well in line with the engineering and work practice controls that OSHA outlined in the feasibility analysis, including retrofits of post-cycle evacuation and local exhaust ventilation devices to existing sterilizer units, various changes in existing work practices. Nevertheless, some hospitals did pursue other courses of action, such as exploiting existing equipment and facilities (e.g., relocating sterilizer equipment to a room with a high rate of ventilation) or constructing new facilities with highly stringent EtO exposure reduction capabilities. A number of significant improvements in control technology, particularly sterilizers with exposure controls built-in and greatly improved exposure measurement capabilities, did emerge in the period after the standard's enactment. But the timing of these advances was beyond the main period (1984-85) of the sector's adjustment to the new standard's compliance requirements.

Compliance Costs: OSHA's Final RIA estimates placed the sector's total compliance costs at $23.7 million annually (1982$), $12.5 million of which was related to amortized capital spending for the necessary control equipment. The available field data suggest that the unit cost figures for the principal control technologies that OSHA assumed in its compliance estimates were reasonably accurate. However, the sector's actual overall spending appears to have at least modestly exceeded the agency's estimate, because of spending on modifications to existing ventilation systems (which were assumed to be zero in the estimate) and because many hospitals elected to reduce exposures to a point substantially below the promulgated PEL (reflecting, for the most part, concerns about the health risks of long term, low level ethylene oxide exposures that remained salient beyond OSHA's promulgation of the permanent standard and hospital managers' desire to mimimize vulnerability to possible future tort liability claims).

Other Impacts: Because the estimated average spending for compliance per hospital was amount to tally no more than $1,500 to 3,500 annually, there was little concern at the time of the rulemaking that the standard would entail substantial financial/economic consequences for the industry or nation. There is no evidence that anything other than these expectations actually occurred; even a substantially larger compliance spending total than now appears to have been the case would have amounted to a barely visible share of the overall increase in expenses that all hospitals bore over the primary period of adjustment to the EtO standard.

Judicial Review: Debate on the content of the 1984 EtO standard continued into the late 1980s, with the chief issue whether the exposure limit provision should be amended to include a short-term exposure limit (STEL) in addition to the PEL. Some of these matters ended up in the courts. Nevertheless, OSHA's original feasibility determinations were not the subject of challenge.

Comments: It appears likely that the arguments of those pushing for a PEL more stringent than 1 ppm would have been strengthened if it had been better appreciated during the course of the debate just how quickly the technology for exposure measurement would improve in the period soon after promulgation. Also, the extent to which so many hospitals would act to achieve exposure levels well below the PEL requirement was unexpected, although this action mainly reflects considerations beyond the OSHA requirements and is not something a normally implemented regulatory impact analysis would explicitly seek to recognize.

▮ Formaldehyde

Promulgated December 4, 1987 (52 FR 46168).

Industry sectors examined: metal foundries (one of more than three dozen industries/industry groups identified as affected, but the industry

with a high expected level of compliance costs and a large number of workers with existing exposures above 1 ppm).

The new standard tightened the existing TWA8 PEL from 3 ppm to 1 ppm. Other provisions included requirements for routine medical surveillance and exposure monitoring, protective clothing/equipment, hygiene facilities, emergency planning, hazard communications. (Note: OSHA amended the PEL to 0.75 ppm on May 27, 1992. The case discussed here focuses, however, on the 1987 action.)

Feasibility: The foundries sector was subject to considerable economic pressures (from weak demand and strong foreign competition) throughout the 1980s, including late in that decade when formaldehyde compliance actions were mandated. OSHA concluded from its analyses, nonetheless, that suitable control steps were reasonably available to the industry, at a generally acceptable cost. These judgments proved accurate. The feasibility of engineering controls to achieve a PEL substantially below 1 ppm was discussed in the course of the rulemaking, but no consensus on the matter emerged among the major rulemaking parties. The PEL was ultimately set at 1 ppm on "significant risk" grounds and, as a practical matter, the debate became moot.

Industry Adjustment: OSHA's technological feasibility finding was based on the conclusion that numerous engineering controls were already commercially available to reduce existing exposure levels: additional ventilation (fresh air curtains, general dilution ventilation, local ventilation), enclosure (e.g., ladle covers, side baffles, ventilated cooling enclosures), changes in resin and catalyst formulations (to reduce the level of free formaldehyde present in the resin binder or released as a consequence of the curing chemistry), and isolation of scrap materials. The agency's economic feasibility analysis assumed, however, that compliance would be achieved predominantly through the added ventilation and enclosure avenues. As things turned out, however, only a few foundries adopted the "ventilate and enclose" strategy; most opted for low-formaldehyde resins.

Compliance Costs: In the Final RIA, OSHA estimated the industry's compliance costs to be $11.4 million annually (1987$). (Cost savings of $1.7 million annually from avoided medical expenses also were identified). Actual spending appears to have been about half this level, $6.0 million annually. Part of this is explained by the industry's adoption of low-formaldehyde resins (which avoided the need for major new capital expenses), rather than added ventilation and enclosure. But in some important portions of the calculations (particularly, for ventilation system improvements), OSHA's figures substantially underestimated actual spending.

Other Impacts: The industry continued to consolidate in the second half of the 1980s, with the number of establishments in business declining at a substantial pace. But there is little evidence that more than a few foundries closed their doors as a consequence of the more stringent control of formaldehyde; hence the basic accuracy of OSHA's feasibility determinations was vindicated and industry arguments made during the rulemaking were rebutted.

Judicial Review: Both industry and labor challenged the standard (on differing grounds) soon after promulgation; one outcome was that the PEL was amended in 1992 to a more stringent 0.75 ppm. None of this debate, however, questioned OSHA's 1987 feasibility, cost, and impact findings.

Comments: Much of the contentious debate in this rulemaking related to exposure levels and the extent of reduction needed to remove significant risk, matters in which the agency's examination of control options and their costs and other impacts were not major players. The agency's tallying of feasible control steps did include all the principal actions the industry ultimately adopted. And it is puzzling why the compliance cost estimates did not more directly consider the use of low-formaldehyde resins, as the technology was commercially well known at the time.

SAFETY STANDARDS

Grain Handling Facilities

Promulgated December 31, 1987 (52 FR 49592). Industry sectors examined: grain elevators and grain mill facilities (the principally affected industries).

The new standard mandated the development and implementation of a "housekeeping" plan to reduce dust emissions and provide for periodic removal of accumulated dust. However, grain elevator "priority areas" (i.e., work areas with equipment and activities where the potential for accidental ignitions was substantial) had to implement immediate cleaning/removal once accumulated dust reached a one-eighth inch dust level. Other provisions dealt with the preparation of emergency plans; employee training and contractor knowledge about relevant safety considerations; permitting procedures for managing "hot work" and worker entry into bin, silo, and tank areas; and various process equipment requirements to minimize the prospect for circumstances capable of igniting accumulated grain dust.

Feasibility: The final rule ultimately promulgated was only modest in its stringency. Many of the provisions did not involve technology, and those that did relied on actions and components already in general use. While the affected industries were particularly sensitive to new expenses, compliance was not generally expected to cause generally unbearable economic burdens. The industries' success at compliance to date confirms that OSHA's feasibility determinations were essentially correct. Early in the policymaking debate, however, a far more stringent action level (one-sixty-fourth inch) for cleaning/removal of accumulated grain dust received consideration and was vigorously advocated by some parties as essential for removing most significant risk. On the basis of the available evidence at the time, however, OSHA concluded that such a diminutive level was likely to be neither technologically nor economically feasible, and dropped the option from consideration.

Industry Adjustment: Housekeeping activities to clean and remove grain dust accumulations are now clearly recognized, throughout the grain-handling sector, as an essential work practice. Pneumatic dust control systems are also widespread, though manual cleaning with brooms is still used and regarded as an effective dust control method. Treating grain with edible oils, to lower dust generation and flammability, is fairly frequently employed. Office facilities, welding activities, and employee smoking have generally been relocated away from prime dust generation areas. Designs for new elevators and plants now incorporate a range of fire/explosion safety features, although there have been relatively few new facilities constructed in recent years. All of these outcomes were generally expected, at the time of the rulemaking, to result from the compliance provisions of the new standard.

Compliance Costs: In the Final RIA, OSHA estimated the sector's total compliance costs in the range of $41.4 million to $68.8 million annually (1985$; spanning the incremental need for equipment and actions across the 13 separate provisions) and avoided property losses at $35.4 million annually (as compliance reduced the number of facility explosions and serious fires), yielding an estimated net cost of compliance in the range of $5.9 million to $33.4 million annually. The agency went on to monetize the expected benefits from reduced employee injuries and deaths at $75.5 million annually; thus, from a societal perspective, these benefits more than balanced the expected new costs imposed on the affected industries. Little in the way of useful field information was available to enable OTA to directly check these estimates—an unfortunate circumstance, because these figures were intensely debated in the course of the rulemaking, where a "battle of the benefit-cost analyses" between OSHA's numbers and industry's lower benefits and higher costs figures prevailed for some time. However, now that nearly five years have passed since full compliance with the terms of the 1987 standard should have been achieved, the evidence is that few, if any, facili-

ties have ceased operation as a result of the standard—in contrast to the implications of the industry's figures. (Nonetheless, the sector has certainly been subject to substantial economic pressures for other reasons over this period.) Furthermore, the data on grain dust explosions/fires, deaths, and injuries for the post-promulgation period suggest that grain-handling facilities have become safer roughly to the degree anticipated by OSHA's impact estimates, although a longer time series of data is needed to confirm this effect.

Judicial Review: The rulemaking on grain dust was long and particularly contentious. Challenges were mounted by both industry and labor representatives soon after promulgation. Notably, OSHA's economic feasibility determination and associated analysis were subjected to scrutiny by the U.S. Court of Appeals (Fifth Circuit) in 1990, where the agency's findings were affirmed in full.

Comments: Sentiment remains today that the dust cleaning/removal action level should have been set more stringently then it was and that political considerations at the time overwhelmed a decision that should have more nearly been made on the substantive merits. Unfortunately, however, post-promulgation developments (which have been in response to the less stringent action level promulgated) do not provide a basis to examine the adequacy of OSHA's early infeasibility finding regarding a more stringent action level.

▮ Mechanical Power Presses (Presence Sensing Device Initiation)

Promulgated March 14, 1988 (53 FR 8322).

Industry sectors examined: manufacturing generally, but particularly fabricated metal products, non-electrical machinery, and electrical/electronic equipment.

This rulemaking amended the existing standard to allow voluntary use of an electronic presence sensing device (instead of operators having to move a switch) to actuate power press strokes. Other provisions included various revised requirements for the performance of system/safety components, regular inspection and maintenance procedures, employee training, periodic certification and third party validation.

Feasibility: Despite considerable successful experience with the technology (in Europe and elsewhere) and compelling economic advantages, presence sensing device initiation (PSDI) has yet to be installed on compatible U.S. mechanical power presses. Surprisingly, a "third party" has not yet come forward to take on the independent validation/certification role specified by the standard. The apparent reason is that potential "third parties" (e.g., insurance companies, underwriting organizations) do not perceive enough of a business opportunity to compensate for the economic risk involved, particularly that related to exposures to liability litigation. In part, OSHA's feasibility findings, based on analyses and testimony in the record circa 1984 and not updated for promulgation in 1988, did not adequately take into account the concerns of insurers and other potential independent parties that workers could defeat (either deliberately or through accident) the machine safety systems. Also, the surge in litigation related to product liability had only begun in 1984. Furthermore, beginning in the late 1980s, insurers' earnings became far more variable than had previously been the case, causing many to rethink their thresholds for risk bearing and the economics of the products offered.

Industry Adjustment: None to date. Moreover, there is evidence that the market for PSDI is currently being eroded by alternate technology, particularly by "quick trip" light curtains with no-touch sensors, which provide safety and productivity improvements but can be adopted without "third party" certification/validation.

Compliance Costs: OSHA's Final RIA estimated the total cost of adopting PSDI (among both existing and new power presses) at $49 million to $77 million annually (1984$; for equipment modifications/enhancements and compliance with the other provisions of the standard, including the various certifications and validations). Cost savings from productivity

improvements were estimated at about $182 million annually, that is, the anticipated cost savings substantially exceeded the expected costs. Little has happened thus far in the industry to validate these expectations, other than, of course, that OSHA (and most of the other parties to the rulemaking) misjudged the economics of the "third party" certification/validation role in the later-1980s-and-on world.

Other Impacts: OSHA's analyses concluded that small establishments would not bear a disproportionate burden in affected industries' adoption of the PSDI technology. Also, a wider economic benefit was expected to arise from the productivity enhancement underwritten by the technology. But, again, not enough has happened to date to check these expectations.

Judicial Review: To date none of the standard's provisions have been challenged.

Comments: Unforeseen developments routinely confound forecasting efforts in most realms. Nonetheless, had OSHA's feasibility analysis been updated nearer to the time of promulgation (1988), it appears likely that at least the prospect of serious problems with the business-worthiness of the "third party" role would have been clear.

Powered Platforms for Building Maintenance (Alternate Systems for Horizontal Stabilization)

Promulgated July 28, 1989 (54 FR 31408).
Industry sectors examined: high-rise building owners/developers and building maintenance service providers (the principally affected industries).

This action amended the existing standard to widen the acceptable technologies for horizontal stabilization of high-rise work platforms. Other provisions included revised requirements for platform equipment performance capabilities, emergency planning, personal fall protection equipment, employee training, regular inspection and maintenance procedures.

Feasibility: OSHA's amendment of the existing standard dealt with technologies that were already market proven and provided demonstrated economic advantages. Thus, at the time of the rulemaking, feasibility was neither controversial nor uncertain.

Industry Adjustment: The amended standard has had the intended effects, vis-à-vis widening the options for stabilization methods available to building owners/developers and increasing the incidence of safe work practices. However, the overall number of alternate stabilization systems installed to date has been well below OSHA's expectation at the time of the rulemaking, principally because the number of new high-rise buildings constructed has been considerably under the estimate on which the regulatory impact calculations were based. (The estimates presented at the standard's promulgation in 1989 were based chiefly on a consultant's study prepared in 1983; as a result, they missed the considerable slowdown in commercial building construction that has prevailed in the United States since the late 1980s.)

Compliance Costs: OSHA's figures in the Final RIA placed the total incremental costs of the amended standard at somewhat over $1.4 million annually (1987$; including the various incremental expenses for both building owners and contractors). However, the greater flexibility in stabilization system choice conferred an estimated cost savings (entirely to building owners/developers) of about $3.1 million annually. Thus adoption of the standard was projected to provide an overall cost savings of around $1.7 million annually. With one significant exception, the case study research largely confirmed the reasonableness of most of the unit compliance cost figures used in the regulatory analysis calculations, the exception being a considerable underestimate of the cost of one of the several competing stabilization systems on one of principal building materials in the marketplace. A far more substantial disparity, however, is the aforementioned slowdown in new high-rise building construction, with the actual annual pace since the beginning of the 1990s only 20 to 40 percent of the rate OSHA expected. In consequence, the overall cost savings to date appear to be substantially lower than expected—$600,000 annually, assum-

ing the higher side of the range in the pace of new building construction, or perhaps even a *net cost* of $400,000 million annually, assuming the lower side of the range.

Other Impacts: During the rulemaking, concern was expressed by industry commentators that some erosion of productivity could accompany the widespread use of the stabilization system particularly favored by the amended standard (the intermittent tie-in system). In contrast, OSHA's analyses did not conclude this effect would be significant. The outcomes thus far have confirmed the agency's conclusion on this matter. Also, the safety-related provisions of the standard were expected to yield some reduction in the safety risks of work activities on powered platforms. Here the number of accidents (involving fatalities or hospitalized injuries) has been "down" since promulgation. But there is still too little of a time series record to fully confirm the anticipated effect.

Judicial Review: To date none of the standard's provisions has been challenged.

Comments: This is another case of surprise developments in critical variables affecting the impact calculations. The long length of time between the analyses on which the final economic estimates were based is an appropriate subject for criticism. Nevertheless, given the timing of the end of lengthy business expansion of the 1980s, even a substantial update of the analysis in late 1988 or early 1989 (the standard was promulgated in mid 1989) would probably not have identified the depth of the slowdown in commercial building that subsequently occurred. Furthermore, the analysis does appear to have in the main correctly identified the essential technological and economic issues related to adoption at the unit building level.

SOURCE: Office of Technology Assessment, 1995. The findings for the Vinyl Chloride, Cotton Dust, and Ethylene Oxide standards draw from existing retrospective studies (which OTA reviewed at length). Original evaluative research was conducted by OTA for the Occupational Lead, Formaldehyde, Grain Handling facilities, Mechanical Power Presses, and Powered Platforms standards. Each case study is discussed at greater length in a comprehensive OTA working paper on the case research findings and in the separate case study reports (see Appendix B for citations).

Appendix B: Working Papers and Commissioned Research

B

PROJECT WORKING PAPERS

Mark A. Boroush, "Hazard Control Responses and Economic Impacts in Selected OSHA Health and Safety Standards—Expectations vs. Outcomes," unpublished project working paper, Office of Technology Assessment, U.S. Congress, Washington, DC, July 1995; available from the National Technical Information Service (NTIS), Springfield, VA.

David Butler, "OSHA's Brethren—Safety and Health Decisionmaking in the U.S. and Abroad," unpublished project working paper, Office of Technology Assessment, U.S. Congress, Washington, DC, Sept. 1995; available from the National Technical Information Service (NTIS), Springfield, VA.

CONTRACTOR REPORTS

Mark A. Boroush, Washington, DC, "OSHA's 1984 Ethylene Oxide Standard: Retrospective Evaluation of the Rulemaking's Feasibility/Impact Estimates," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, March 1994; available from the National Technical Information Service (NTIS), Springfield, VA.

Mark A. Boroush, Washington, DC, "OSHA's 1978 Cotton Dust Standard: Retrospective Evaluation of the Rulemaking's Feasibility/ Impact Estimates," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, January 1994; available from the National Technical Information Service (NTIS), Springfield, VA.

Mark A. Boroush, Washington, DC, "OSHA's 1974 Vinyl Chloride Standard: Retrospective Evaluation of the Rulemaking's Feasibility/Impact Estimates," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, November 1993; available from the National Technical Information Service (NTIS), Springfield, VA.

Charles Rivers Associates, Boston, MA, "Economic Impact Analysis of OSHA's Rulemaking Process: Lead Case Study," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, April 1994; available from the National Technical Information Service (NTIS), Springfield, VA.

Robert Goble and Dale Hattis, Center for Technology, Environment, and Development,

Clark University, Worcester, MA, "When the Ceteris Aren't Paribus: Contrasts Between Prediction and Experience in the Implementation of the OSHA Lead Standard in the Secondary Smelting Industry," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, July 1995; available from the National Technical Information Service (NTIS), Springfield, VA.

Molly K. Macauley and Paul R. Portney, Washington, DC, "Comparing Expected and Actual Economic Impacts of OSHA Safety Regulation: A Case Study of the Use of Alternative Stabilization Systems for Powered Platforms," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, February 1994; available from the National Technical Information Service (NTIS), Springfield, VA.

Molly K. Macauley and Paul R. Portney, Washington, DC, "Comparing Expected and Actual Economic Impacts of OSHA Safety Regulation: A Case Study of Presence Sensing Device Initiation for Mechanical Power Presses," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, January 1994; available from the National Technical Information Service (NTIS), Springfield, VA.

James C. Robinson, School of Public Health, University of California, Berkeley, CA, "The Impact of Environmental and Occupational Health Regulation on Productivity Growth in U.S. Manufacturing," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, July 1994; available from the National Technical Information Service (NTIS), Springfield, VA.

Ruth Ruttenberg, Ruth Ruttenberg and Associates, Bethesda, MD, "Compliance With the OSHA Grain Handling Rule: Safety Measures Save Lives and Dollars," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, June 1994; available from the National Technical Information Service (NTIS), Springfield, VA.

Robert F. Stone, Econotron, Inc., "An Evaluation of OSHA's Resources for Regulatory Analysis," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, March 1995; available from the National Technical Information Service (NTIS), Springfield, VA.

Robert F. Stone, Econotron, Inc., Framingham, MA, "A Retrospective Analysis of the Economic Impact on Foundries of OSHA's 1987 Formaldehyde Standard," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, August 1994; available from the National Technical Information Service (NTIS), Springfield, VA.

Robert F. Stone, Econotron, Inc., Framingham, MA, "A Preliminary Examination of OSHA's Analytic Approaches for Estimating the Compliance Costs and Other Economic Impacts of Regulation," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, March 1994; available from the National Technical Information Service (NTIS), Springfield, VA.

Robert F. Stone, Econotron, Inc., Framingham, MA, "Three Case Studies of OSHA's Regulatory Impact Analysis in Support of Recent Rulemaking," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, February 1994; available from the National Technical Information Service (NTIS), Springfield, VA.