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## **Assessing the Accuracy of OSHA's Projections of the Benefits of New Safety Standards**

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## **Executive Summary**

For 6 safety standards issued since 1990, we compare OSHA's projections of their impact on fatalities with actual fatality changes and explain the reasons for the differences. Accurate projection of impacts is important so that OSHA has a good understanding of both the uses and the limits of its actions.

We reviewed the preambles to OSHA standards and the Regulatory Impact Analyses prepared for them to identify the baseline and the prevention factor that OSHA used to project the number of deaths that would be prevented. We used 3 data sources to track the relevant categories of fatalities: the Census of Fatal Occupational Injuries (CFOI), the National Traumatic Occupational Fatality program, and OSHA's Fatality/Catastrophe investigations.

In all 6 cases, OSHA appeared to overestimate the number of deaths prevented by the standards. The availability of CFOI led to better estimates of the fatality baseline, but the prevention factor was always overestimated, especially for standards which emphasized training. Part of the problem is that OSHA is required to assess economic and technological feasibility under the assumption of full compliance. It understandably brings the same assumption to projections of effects, despite the unreality of the assumption. We are not able to distinguish here between overestimates due to lack of compliance and overestimates due to the overstated effectiveness of the standard. There is some evidence that the projections were more accurate for standards that were more costly and subjected to more outside scrutiny. However, the low cost standards also tend to be the ones that rely primarily on training provisions; thus the role of the outside scrutiny is not clear.

OSHA needs to invest in developing better methods for projecting injury impacts. In some cases, like non-fatal injuries, new data collection efforts are needed. More generally, there is a need for research that will help OSHA understand the likely consequences of regulations requiring behavioral changes, e.g., on the effects of training.

## **Assessing the Accuracy of OSHA's Projections of the Benefits of New Safety Standards**

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### **1. Introduction**

In the preambles to the safety and health standards that it has promulgated since 1987, the Occupational Safety and Health Administration (OSHA) projected that the new rules would prevent over 2600 deaths per year, about 800-900 from safety standards and the remainder from health. (Mendeloff, 2003) By any measure, this would be a significant public health achievement. Questions have naturally arisen about the accuracy of these projections. The issue of accuracy is important for outside evaluators, but it is also important for the agency itself. Major mistakes may lead to giving priority to the wrong hazards. For example, too high an estimate of effectiveness may lead to a judgment that a hazard has been adequately addressed when it has not been. Too low an estimate of effectiveness or too high an estimate of costs may reduce the priority given to a rule in the regulatory development process. To improve the process of priority setting, we need to pay attention to the quality of the projections that regulatory agencies make.

The costs and benefits of federal government safety and health standards have been extensively reviewed by analysts interested in the effectiveness and efficiency of government regulation (Morrall, 1986; Mendeloff, 1988; Hahn, 1996, Heinzerling, 1998). The source of the estimates has generally been the information provided by federal regulatory agencies. A series of federal executive orders have required agencies to produce these estimates since the late 1970s for regulations imposing annual costs above \$100 million.

On the cost side, a small number of retrospective studies have been conducted (Harrington et al, 1999). They have found cases where costs had been overestimated as well as cases where costs had been underestimated, although the former are more common. Agencies rely primarily on data supplied by the industries that will be regulated. Although not all firms in an industry have the same expected gains or losses from regulation, in general we expect that firms have an interest in establishing that standards will be very costly and unattractive. In addition, firms may not be fully aware

of the low-cost opportunities for reducing hazards, but may discover more of them once they decide that they must comply. On the other hand, the regulatory agency has an incentive to make the standard appear as attractive as possible in order to undercut potential challenges.

Studies of the accuracy of the estimates of regulatory benefits are less common. For health hazards, we could examine changes in the number of workers exposed to different concentrations to find out whether the standard had been effective. However, for hazards with long latency periods, we could not easily assess whether the projected reduction in diseases had occurred.

Estimating the actual effects of safety standards seems more straightforward. It should be possible to observe whether the ex ante estimate of the change in fatal or non-fatal injuries was on target. Of course, even if we can observe these changes, we must try to answer the key evaluation question: what would have happened in the absence of the new standard? Do the changes we observe represent the impact of the standard or do the impacts of other factors need to be accounted for?

A few retrospective studies of the effects of individual OSHA safety standards have been carried out. A 1995 report by the U.S. Office of Technology Assessment, examined the validity of the techniques used for estimating the costs of OSHA standards. It noted that two safety standards had not been implemented as extensively as OSHA had projected. In compliance with the “look-back” provision of the 1995 Small Business Regulatory Enforcement and Fairness Act, OSHA has completed studies on two safety standards, the grain handling standard (OSHA, 2003) and the “lockout-tagout” standard (OSHA, 2000). Another study examined the effects of the OSHA trench and excavation standard (Suruda, et al. 2002). However, none of these last 3 studies attempt to compare the effects with the projections OSHA’s made at the time the standard was promulgated.

This paper presents a more systematic attempt to compare the ex ante projections with ex post estimates of the effects of OSHA’s safety standards. We use longitudinal data from different sources and have begun with the most recent standards for which enough time has elapsed to merit an evaluation.

We believe it is important not only to identify whether the predictions of impact have been accurate, but also to learn the reasons for major errors in order to be able to improve the predictions. For example, it may be that the data that OSHA has available is

not very useful for predicting the impacts of new standards. In that event, it would be important to examine whether better data could be made available. We should also emphasize that, in this paper, we are interested in the existence and magnitude of errors, but are not attempting the more difficult task of estimating the precise effects of the standards, much less the task of assessing their costs and benefits.

## 2. Materials and Methods

Our comparison of the actual and projected numbers of injuries prevented by the standards involved several steps. We obtained a list of all OSHA safety standards from its Office of Regulatory Analysis. To limit the size of the task and to make it more relevant to current practices, we look only at the eleven standards promulgated since 1990. (See Table I) We omitted the three most recent standards, which had been promulgated after 1996, on the grounds that there may not have been enough time to track their effects. That left eight standards. We reviewed the preambles to these rules as they appeared in the *Federal Register* at the time of promulgation. The preambles present the conclusions of the studies on the expected costs and safety effects of the standards. On the basis of the information in the preambles, we excluded additional standards.

As we explain below, the data available for tracking fatal injuries is much better than the data available for tracking non-fatal injuries. On this basis we excluded: a) the 1994 rule for Personal Protective Equipment for General Industry, which OSHA had projected would prevent 4 deaths per year; and b) the 1990 rule on Stairways and Ladders in Construction, which OSHA had projected would prevent 3 deaths per year. As the data in Table II indicate, the standards we are examining were all projected to prevent at least 40 deaths per year.

We also excluded the 1994 standard on fall prevention in construction. Addressing primarily falls from roofs and through floors in new construction, the new provisions of this standard were projected to prevent 22 fatalities per year. In addition, OSHA projected that full compliance with the existing standard would prevent another 57 deaths per year. As a percentage of the baseline number of deaths, the 22 represented

only about a 15% reduction, a change that could be difficult to discern, relative to other standards with larger absolute and percentage reductions.

The omission of these 3 standards and the focus on standards with relatively large projected effects may make it less likely that we find cases where the effects are underestimated. However, although this is important to note, we believe that a focus on cases with bigger estimated effects is justified in a study of OSHA's accuracy: the importance of the error is larger if a projection of 60 deaths prevented is wrong by a factor of 2 than if a projected effect of 3 deaths is wrong by a factor of 2.

The published preambles for the six remaining standards often failed to clearly explain how the estimates of safety effects were made. Which data sources were used to establish the baseline? How did OSHA estimate what the reductions in deaths and injuries would be? In order to find the answers, we also examined the Regulatory Impact Analyses (RIAs) that OSHA prepared for these standards. Although White House Executive Orders require RIAs only when the expected annual impacts exceed \$100 million annually, OSHA has regularly made estimates of both the expected effects and the expected costs. The latter are required as evidence of the "economic feasibility" of a standard. The former usually helps to establish that other legal requirements are met: that a standard addresses a "significant risk" and that it is "reasonably necessary." We obtained and reviewed RIAs for each of the standards we report on here as shown in Table 2.

On the basis of the preambles and the RIAs, we identified several pieces of information which were important for our attempts to evaluate the effectiveness of the standards. These items included:

- The effective date for compliance with the standard
- Whether the standard was expected to affect all states equally, or whether some states already had comparable standards in place
- Which industries (SICs) would be affected by the standard
- Which injury types would be affected (Injury type could include not only the causal "event," but, depending on the data available, also the nature of injury, part of body affected, and "source" of the injury.)

## **Data**

### *Fatal Injuries*

For fatal injuries, we looked at three different data sets: the Census of Fatal Occupational Injuries (CFOI), the National Traumatic Occupational Fatality data (NTOF), and the Fatality/Catastrophe Investigation reports compiled by OSHA (FAT/CATs).

### CFOI

The Bureau of Labor Statistics (BLS) carried out this census for the first time for deaths occurring in 1992. It covers all cases in which the decedent was working for pay or profit at the time of the event in a legal work activity or was present at the site as a requirement of the job. Multiple sources are examined to identify occupational fatalities. To be included, a case must be verified from two independent source documents or from a source document and a follow-up questionnaire. About 30 data elements are collected. Cells with fewer than 5 cases are not reported.

### NTOF

Beginning with 1980 data, the National Institute of Occupational Safety and Health (NIOSH) has collected death certificates from all states for workers 16 years and older for whom an external cause of death was noted and where the certificate gave a positive answer to the “Injury at Work?” item. The death certificate is supposed to list the “usual” industry and occupation of the decedent. Errors in this coding, however, appear to occur in 25-40% of cases. The main information on the cause of death comes from the external source of injury code. Cells are not reported if they have fewer than 3 cases.

### FAT/CATs

Employers are supposed to report fatalities and some multi-hospitalization events to OSHA by telephone within 24 hours of the event. OSHA usually investigates if it has reason to believe that a violation of a safety and health standard might be involved. (For that reason, the FAT/CAT data do not include deaths due highway motor vehicle accidents, assaults and some other significant causes of mortality.) From 1984 through

early 1997, a text version of the event has been maintained in OSHA's information system (IMIS), although the last year or two of data are obviously not as complete as earlier years. Key words can be used to retrieve particular types of injury events. Since mid-1990 inspection data from all states has been entered into IMIS. California did not participate before July 1987, left again in June 1989 and then returned in July 1990. Washington State began submitting data in January 1990. Michigan health reports began in October 1988; safety reports, in October 1989. (OSHA, 1993 RIA). Because of these late entrants, we have adjusted the FAT/CAT numbers before 1991 upward on the basis of the population in those states (6% in 1990, 10% in 1989 and 5% in 1988, 11% in 1987, 17% in 1986 and earlier).

### *Non-fatal Injuries*

For non-fatal injuries, we looked at the Survey of Occupational Injuries and Illnesses, conducted annually by BLS. Prior to 1992, the Survey provided no information about the characteristics of injuries, other than whether they involved days away from work, only restricted work activity, or nothing more than medical care. The Survey also collected information about the estimated duration of injuries with days away from work. Beginning in 1992, the Survey began to collect additional information about the subset of injuries which involved days away from work. The number of these injuries has been declining steadily since 1990, largely because employers have increasingly adopted return to work policies that substitute "restricted work activity" for time away from work.

As the description of data sources above suggests, we have considerably better ability to track fatal than non-fatal injuries. It also turns out that, according to OSHA's projections, these standards would have a disproportionate impact on fatal injuries. Thus, for the private sector as a whole, there are about 6,000 acute fatalities per year and about 2 million lost workday injuries, a ratio of 333 non-fatal injuries for each fatality. In contrast, the baselines of the standards reviewed here have a median ratio of 123 injuries per fatality. Also, OSHA concluded that the prevention rate for fatalities would be at least as high, if not higher, than for non-fatal injuries. In the analyses that follow, we limit our analyses to fatalities. The estimated costs and effects are shown in Table II.

## Evaluation Designs

In order to track injuries, we first identified the industries that, according to OSHA, were covered by the new standards and the effective date of the standards. Next, for all except the Logging Operations standard, we identified the injury types that the standards were projected to affect. As described below, we were not always able to track each effect. For the logging, confined spaces, and process safety management (PSM) standard, we were able to take advantage of the partial coverage of the standard to compare changes in fatalities in states covered by the new standard and states covered by earlier standards. In light of the limited number of annual observations we do not apply statistical tests to the differences we find. We did estimate the effect of cyclical changes (as measured by changes in the unemployment rate) or changes in the economy-wide fatality rate (as measured by NTOF and the Current Population Survey). On average, a 1 point drop in the unemployment rate raised the fatality rate by 0.1 point, an increase of about one or two percent. Given this small effect, we did not consider it further.

## 3. Findings

We discuss the standards in chronological order.

### Electrical Work Practices for General Industry

The electrical standard for general industry became effective in late 1990. OSHA estimated that the first year costs would be \$75 million, followed by recurring costs of \$20 million per year. It projected that the standard would prevent 97 fatalities per year. OSHA's baseline figure for electrical deaths in general industry was 235 per year. Thus the reduction of 97 would constitute a 41% reduction.

#### *Baseline*

The baseline estimate came from an estimate of the number of electrocution deaths reported for general industry in the BLS Annual Survey of Occupational Injuries and Illnesses for 1980-84. This was extrapolated to the figure of 235 for 1985.<sup>1</sup> (OSHA, 1987) In the final standard, OSHA explicitly excluded coverage for SICs 491 and 493

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<sup>1</sup> Note that the RIA itself was produced by OSHA in 1987, 3 years before the standard was promulgated.

(the industries addressed by the later Electrical Power Generation standard), which would lead to a somewhat lower baseline.

We made an effort to construct an estimate of what the number of deaths before 1992 had been. In that year, CFOI became available, providing more accurate information. Figure 1 shows trends from all 3 data systems for private industry, except agriculture and construction, and (except for NTOF) without SICs 491 and 493. For CFOI the category is “contact with electric current.” For FAT/CATs it is the keyword “electrical.” For NTOF, it is deaths with E-codes 925.2 and 925.9. For the years from 1992 through 1995, we can compare the CFOI and FAT/CAT estimates. The CFOI numbers were, on average, 25% higher. We used this adjustment figure, along with the adjustment for missing data in FAT/CATs because some states did not contribute data before 1991. Based on these “adjusted FAT/CAT” figures, we estimate that there were about 135 deaths in 1985. This is well below the OSHA baseline of 235; less than half of the difference can be accounted for by the exclusion of SIC 491 and 493. (We report below that there were never more than 30 deaths per year with the keyword “electrical” for SICs 491 and 493 in the FAT/CAT system. Even after we adjust this upward for missing states and for the potential 25% underreporting, the number is less than 50.)

### *Prevention Factor*

OSHA’s contractor estimated that 89% of all electrical injuries in general industry would be covered by the standard; that 75% of all injuries “are not due to faulty equipment but are related to work practices;” and that the fraction of workers exposed to fatality risks who would undergo training required by the standard would be 73%. Finally, OSHA estimated that 85% of all electrical injuries “are not caused by human error and are therefore amenable to regulation.” (OSHA, 1987) Multiplying these 4 percentages together, OSHA arrived at a predicted reduction in fatal injuries of 41.4%.

The logic for the last step in this calculation is hard to follow. The major provision of the new standard, at least in terms of cost, called for training workers. It is not evident why training would be useful unless many injuries had been caused by “human error.”

Nevertheless, if we look for the 41% predicted drop, what do we find? The answer depends largely on the years we choose to compare. If we use 1990 as the

baseline (because the standard became effective in December of that year), we don't find any noticeable reduction until 1995. However, there was an unusually steep drop in deaths from 1988 to 1989 as well as further drops after 1994.

In order to see whether changes in employment might have accounted for the changes we see, we also calculated the rate for electrical fatalities, using CFOI data for the numerator and employment data from County Business Patterns for the denominator. We calculated the fatality rate in each industry sector in 1992 and then calculated what the fatality rate for all of general industry would have been in subsequent years if the distribution of employment among sectors had remained as it had been in 1992. The resulting changes were not much different than those shown for the changes in the number of deaths and are not shown here.

Figure 1 shows clearly that the overall reduction in fatalities from the mid-1980s to the late 1990s was large—from an average of 151 in 1985-88 to an average of 78 in 1997-2000, down 48%. Given the timing of the reductions, it seems unlikely that the OSHA rule can claim the major credit for this drop, although some role is certainly possible. However, since the baseline for this calculation is considerably lower than the baseline used by OSHA, the actual number of deaths prevented, even assuming a causal role for the standard, was also considerably lower than the 97 deaths projected by OSHA.

### **Process Safety Management (PSM) in General Industry**

Triggered in part by the disaster at the Union Carbide chemical plant in Bhopal, India, the PSM standard called for firms to adopt procedures to reduce the risk of releases and explosions involving chemicals and other dangerous materials. According to the RIA, implementation “will prevent the occurrence, and minimize the consequences, of significant releases of toxic substances, as well as fires, explosions and other types of catastrophic accidents.”

For this standard, the RIA noted clearly that “OSHA excluded from this final impact analysis establishments in California, Delaware, and New Jersey, where process safety management statutes have already been enacted. In these three states the compliance burden is unaffected by the federal rule.” Excluding these states, OSHA estimated that the new standard would cost \$889 million and prevent 132 deaths during each of the first 5 years. During the subsequent 5 years, the annual costs would drop to

\$406 million while the deaths prevented would double to 264. The impact was expected to grow because the proportion of establishments that had completed their self-audits would grow over the first 5 years. The standard became effective toward the end of May, 1992.

### *Baseline*

OSHA reviewed FAT/CATs from 1983-1990 in the industries covered by the standard. It found 1,712 fatalities “related to process hazards covered under the OSHA standard.” Next, OSHA adjusted this number upward by a factor of 1.54, due to expected underreporting of FAT/CATs. The result was an average of 330 per year from 1983-1990.

The major problem with the procedure is found in the first step. OSHA said that “cases were extracted from the [FAT/CAT] data base in which the source of injury, the type of event, the environmental factor involved, or the human factor involved could be directly linked to the absence of process safety management.”

The use of the word “or” here is crucial. For example, the two “event codes” used were “inhalation” and “absorption.” But, to be included, an accident did not have to include them. It might only have involved one of the “human factor” codes that were judged to be “related” to the standard. These included:

- Misjudgment of hazardous situation
- Safety devices removed or inoperative
- Procedure for handling materials not appropriate to task
- Defective equipment, knowingly used
- Insufficient or lack of engineering controls
- Insufficient or lack of written work practices programs.

It seems evident that these human factors could be present even when an accident has nothing at all to do with chemicals or with explosions. The two other types of codes add even further to the list of “related” accidents.

Yet OSHA did observe that the estimates it made were in the range of figures from the BLS Annual Survey of Occupational Illnesses and Injuries. Although that

Survey's estimates of deaths have limited reliability, most of the criticisms suggested the numbers were too low. (National Research Council, 1987) We reviewed the FAT/CATs since 1985. As Figure 2 shows, the annual number of deaths elicited by citing the keywords "explosion" and "electrical" never totaled more than about 120. Although these categories do not capture all of the deaths related to the PSM standard, they do include some that are not related—e.g., explosions of tire rims. The figures from 1992 through 1995, when we have both FAT/CAT and CFOI data, suggest that the earlier FAT/CAT data may have accurately counted this category of deaths, and thus that the adjustment OSHA made to account for underreporting may have been excessive.

### *Prevention Factor*

For its estimate of the prevention role that the new standard would play, OSHA relied on one of its contractors, who concluded a study of the chemical and petroleum industries with the statement that "60 percent of the fatalities that occurred in establishments with some elements of a [process safety management] program could have been prevented and 80 percent of the fatalities that occurred in establishments with no program could have been prevented." A different contractor "identified a range of 16 to 56 percent reduction in both injuries and fatalities following the implementation of the OSHA standard."

OSHA also noted that a well-known organization representing many of the nation's largest firms had stated that "Experience by ORC member companies indicates that most, if not all, process-related incidents involve a breakdown of one or more of OSHA's Process Safety Management elements. Given effective implementation and compliance with the provisions of the proposed standard, we agree with OSHA's estimate of at least an 80% reduction in serious process incidents."

What has actually happened to deaths since the standard took effect? In Figure 2, we tracked the industries that OSHA identified as the sites of PSM-related deaths for all 3 of the major event types—explosions, fires, and inhalation (other than confined spaces). Certainly the experience since 1992 is not consistent with even a 40% reduction, much less an 80% drop. Another piece of evidence is that the fatality trends are similar in the 3 states unaffected by the new standard.

However, the FAT/CAT data (for all states) do indicate that a substantial drop occurred from 1991 to 1992. It is possible that some of this represents an anticipatory effect or an effect that began when the standard was promulgated in February, 1992. (1992 was a recession year, but the size of the change is far beyond anything that could be explained primarily by changes in employment.) However, the RIA, which projected a 40% average decrease in deaths for the first 5 years and an 80% decrease for the next 5 years, clearly contemplated a steadily increasing preventive effect as more firms carried out their self-audits.

In conclusion, it is highly implausible that the PSM standard will have prevented 264 deaths (80% of 330) by the 10<sup>th</sup> anniversary of the standard.

### **Permit-Required Confined Spaces for General Industry**

The safety standard for preventing injuries in confined spaces became effective in April, 1993. The general industry confined spaces standard is designed to protect entrants in confined spaces from serious hazards, primarily those due to toxic or asphyxiating atmospheres. (Some other injury types were included, e.g., deaths due to engulfment.) The annualized compliance cost was projected at \$ 202.4 million.

#### *Baseline*

OSHA estimated an annual baseline of 63 fatalities in workplaces affected by this standard. For fatalities, this baseline was based upon a review of FAT/CATs from 1986-1990, which found 32 deaths in the affected industries. OSHA doubled this number to attempt to adjust both for underreporting and for the failure of some states to report to the IMIS.

Although doubling the FAT/CAT numbers usually tends to lead to overestimates, a 1994 study by NIOSH, drawing from its NTOF data base, identified 670 cases over the 10 years from 1980-89 that it classified as occurring in “confined spaces.” Over half of the cases involved atmospheric hazards, although “engulfment in loose material” accounted for one-third. This average of 67 per year is close to the figure that OSHA used as the baseline, suggesting that OSHA’s figure was a reasonable one.

### *Prevention Factor*

OSHA's RIA noted that six states—California, Kentucky, Maryland, Michigan, New Jersey, and Virginia—currently had permit entry rules for confined spaces. It judged that “Despite the increased protectiveness provided by the state permit programs... OSHA believes that this federal standard will provide the needed additional protection to employees in these states and throughout the nation.” Although OSHA did not omit these states from its calculations of benefits or costs, the implication here is that the impact in these states should be less because of their “increased protectiveness.”

OSHA applied an 85% prevention rate to its baseline number, leading to a projected reduction of 54 fatalities. OSHA justified this prevention factor on the grounds that: a) some firms seemed to have eliminated these accidents, b) several respondents agreed that an 85% reduction seemed achievable, and c) OSHA had used similar prevention factors in other safety RIAs.

In CFOI, we identified two event types which include most of the atmospheric deaths affected by the standard: “inhalation in enclosed, restricted, or confined spaces,” and “depletion of oxygen in enclosed, restricted, or confined spaces.” The sum of these two from CFOI for 1992 for general industry in all states was 38. For evaluating the effect of this standard, we used the two categories to compare confined space related fatalities in the 6 states which OSHA had stated would be less affected because of their existing standards with the effects in the other 44 states.

Figure 3 shows that from 1992 to 1993, the year the standard became effective, deaths dropped from 31 to 24 in the states that we judged more affected by the standard, and from 7 to 3 in the other six states. The trends in both groups of states continued to be quite similar through 2001. From the 38 total private sector deaths in CFOI in 1992, the maximum drop came in 1999 with 12 deaths, a 68% reduction.

The reduction in deaths in confined spaces has been impressive and the OSHA standard may have contributed substantially. The main qualm is the equal or greater decline in those states that we expected to be less affected by the standard. Although it seems unlikely that deaths fell 85% (54 deaths) in response to the standard, a greater than 50% drop seems very plausible.

## Electrical Power Generation

The electrical power generation standard, effective at the end of May 1994, applied primarily to the power generating industry (SICs 491 and 493). Although electrical injuries, like contact with electric current (CFOI event code 31X), dominate the expected fatality benefits, OSHA's estimates also included a broader set of event categories. OSHA stated that the baseline number of fatalities was 85.5 and it said that compliance with the final standard would prevent 59 of them, a 68% prevention rate.

OSHA derived the baseline here from several sources. First it looked at the annual average of fatal injuries in these two SICs that had been reported as FAT/CATs from 1988 to 1992. It doubled this number (from 39 to 78) in an attempt to take account of potential underreporting. OSHA also used the newly available CFOI data, which reported 53 private sector deaths for SICs 491 and 493 in 1992.<sup>2</sup>

To estimate preventability, OSHA relied heavily on data collected by the International Brotherhood of Electrical Workers, which indicated that 68% of the deaths in the electric utility industry would be preventable by full compliance with the new standard.

Our evaluation tracks deaths only in SIC 491 and 493. We applied the 68 per cent prevention factor to the 53 deaths private sector deaths in this sector, for a predicted prevention of 36 fatalities per year. With FAT/CAT and NTOF data, we looked at electrical deaths in those industries. With CFOI we looked both at all deaths and at only those deaths due to contact with electric current. Figure 4 and 5 show essentially the same pattern. Deaths and death rates dipped in 1993, the year the standard became effective, then went back to their pre-standard levels through 1997. From 1997 to 1999, CFOI reports that electrical fatalities fell from 25 to 12 and total fatalities fell from 44 to 29. Conclusions about the impact of the standard depend partly upon how we interpret the spike upward in 1997 in the CFOI data and whether we pay more attention to the deaths due to contact with electric current or to all deaths. None of the 3 data sources suggest any decline in the electrical fatality rate after the effective date of this standard.

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<sup>2</sup> OSHA made several additional adjustments in its final baseline. It eliminated deaths among municipal utilities in state-plan states. It reduced deaths in SIC 493 to reflect the fact that one-fourth of the employment there worked in gas, not electric, utilities. Adding in electrical contractors (9.4 deaths), line-clearance tree-trimmers (8.6), and non-utility establishments (6.8) raised the total baseline to 85.5. (See Table 3-23 in the "Economic Analysis")

We spoke with one individual from the Edison Electric Institute to inquire whether there had been developments in the industry which might have offset some of the preventive effects of the OSHA standards. Our respondent was not aware of any major developments of this nature.<sup>3</sup>

Clearly there has not been a decline commensurate with OSHA's 68% projected drop. We lack a strong evaluation design for this standard, but, if the standard had been effective, we probably should have expected to see declines appearing earlier than 1998, 5 years after the standard became effective.

### **Logging Operations**

The Logging Operations standard was promulgated in 1994 and became effective in February 1995. It expanded the set of issues covered by OSHA's existing standard for logging. OSHA reported in the Preamble to the standard that 6 states – California, Washington, Oregon, Michigan, Alaska, and Hawaii – had “adopted standards which provide more protection than OSHA's [pre-existing] pulpwood logging standards by covering all logging operations within their States. The standards of the five western states also contain a much higher level of detail and specification than either the 1978 ANSI logging standard or OSHA's pulpwood logging standard.” In its Preliminary Regulatory Impact document (1988), OSHA observed that the annual cost per firm to comply with the new standard “ranges from \$27 in California, where firms are at a high level of compliance with their own state standard, to \$452 in the South.” On this basis, we would expect to find that the new standard would have bigger effects among the 44 states which had not had their own standards. We compare the two groups of states with respect to the number of logging fatalities and fatality rate per 1000 logging employees.

OSHA estimated that the baseline number of fatalities in SIC 241 was 158 and that compliance with the standard would reduce this number to 47, a 70% reduction. As in most other cases, OSHA did not provide a timeline for these effects. It was not clear if they would occur almost immediately following the effective date or if they would occur only after several years.

Figure 6 shows the number of deaths reported by CFOI for all states as well as separately for the 6 states where OSHA believed the standard would have less effect and

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<sup>3</sup> Chuck Kelly, Director of Safety, Edison Electric Institute.

for the 44 states where it claimed that there would have more effect. In Figure 7, we have converted these fatality numbers into fatality rates for these three categories based upon employment figures from County Business Patterns. Thus, 158 fatalities among the 58,591 workers employed in SIC 241 in 1992 in the states covered by the standard translates to a baseline fatality rate of 2.70 per thousand and a projected fatality rate of 0.80 per thousand.

Several points about these Figures are worth noting.

- 1) Although deaths dropped in the affected states from 1992 to 1994, prior to the promulgation of the standard, they remained essentially constant in the period from 1994 through 1999.
- 2) Looking at fatality rates in Figure 7, we see that the national rate was quite stable. Moreover, the fatality rate in the 6 less affected states, already relatively low, dropped more than the rate in the other states.
- 3) Based on these figures, it seems that there has been no sizable drop in deaths since the new standard took effect. Based on the figures in the less affected states, it seems unlikely that some other factor was pushing deaths rates up in a way that would mask the true preventive effect of the standard. The rate has not been getting closer to the projected fatality number or rate.

We also spoke with two individuals familiar with the logging industry to find out whether there were important factors at work during this period that might have counteracted the preventive effects of the new standard.<sup>4</sup> Instead, both indicated that the major change had been a growth in the use of mechanized cutting and trimming procedures, a change which should have reduced fatalities further. OSHA appears to have been overoptimistic in projecting that the logging operations standard would prevent 111 deaths per year.

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<sup>4</sup> Steve Jarvis, Director of Forest Programs, Forest Resources Association; and Robert H. Shaffer, Professor of Forestry Operations, Virginia Tech.

## Scaffolding

The scaffold standard, effective in November 1996, applied to the construction industry. Here we looked at fatalities coded by CFOI as “falls from scaffolds”, FAT/CATs with the keyword of “scaffold” and NTOF-reported deaths with ICD9 E-code 881.1, “fall from scaffolding”. The provision for employees erecting and dismantling scaffolds took effect in September 1997.

The 1996 scaffolding standard projected annual costs of \$12.6 million per year. Over \$5 million was for training workers who use scaffolds or erect or dismantle them. Almost \$6 million was for scaffold inspection and about \$1.5 million was for fall protection for erectors and dismantlers. Except for one provision dealing with fall protection for scaffold erectors and dismantlers, the standard’s effective date was November 29, 1996.

OSHA’s “Final Economic Analysis” relied for its baseline on the 1994 CFOI finding that there had been 79 scaffold-related deaths in that year. Based upon a review of FAT/CATs in 1995, OSHA identified 51 scaffold deaths. It judged that 33% of these would have been prevented by compliance with the existing standard. It also judged that all of those plus an additional 59% would have been prevented by full compliance with the new standard. Only 8%, 4 of the 51, were judged non-preventable. OSHA applied these percentages to the 1994 CFOI total of 79 scaffold deaths, leading to the projection that 26 deaths could have been prevented by full compliance with the existing standard and an additional 47 by full compliance with the new standard.

The standard is not limited to preventing falls from scaffolds; some provisions deal with preventing falling objects from injuring workers on scaffolds; others with avoiding contact with electrical current. However, the CFOI report showed that 72 (91%) of the 79 scaffold-related deaths in 1994 were due to falls from scaffolds.<sup>5</sup> For that reason, we used that category of falls from scaffolds to track the effects of the standard. If we apply the 59% reduction factor to the 72 fatal falls from scaffolds, we get a projected reduction of 42 deaths.<sup>6</sup>

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<sup>5</sup> The percentage of scaffold deaths that were not due to falls from the scaffold was higher in the OSHA FAT/CAT data.

<sup>6</sup> The BLS website gives a total of 68 deaths in 1994 for “fall from scaffold, staging”, CFU20116X8E, , not the 72 figure used by OSHA.

Figure 8 shows that the number of these deaths was only 4 lower in 2000 than it had been in 1996. However, when we adjust for changes in the number of construction workers, we see in Figure 9 that there was a 21% decline in the fatality rate for falls from scaffolds from 1996 to 2000. The variability in these rates should lead us to avoid heavy reliance on any particular year-to-year comparison. Again, however, it seems clear that the decline in the number and rate for deaths due to falls from scaffolds in 2000 remained much smaller than the level projected by OSHA when the standard was promulgated in 1996. Again, we asked a long-time scaffold consultant whether there had been major developments which might have offset the preventive effects of the standard and received a negative response.<sup>7</sup>

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#### **4. Discussion**

In Table III, we summarize our findings about the accuracy of a) the baseline number of fatalities; b) the percentage of those deaths that will be prevented (the prevention factor); and c) the overall estimate of the number of deaths prevented, which is a function of the first two. In the earlier standards the baseline numbers were usually overestimated, but subsequent use of CFOI has led to greater accuracy. Prevention factors were always overestimated as well the total projections of the number of deaths prevented.

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<sup>7</sup> Dave Glabe, Secretary of the Scaffold Industry Association

<sup>8</sup> Dave Glabe, Secretary of the Scaffold Industry Association

We need to keep in mind that the long-term trend in work fatalities and fatality rates has been downward. Economic incentives to prevent injuries and technological changes that embody safer technologies have played a role, along with regulation. Thus even when we do find declines in fatalities, the changes may not be the result of the new standards. Somewhat paradoxically, the only case where we found clear evidence of technological changes that were believed to be safety-enhancing was for logging, where we see no evidence of any decline in fatalities.

Why has OSHA usually overestimated the effects? One point that OSHA staff emphasized in response to these findings was that the figures they produce should not be viewed as “predictions;” rather, they are estimates of what the impact would be if there were full compliance with the standard.

### **The Issue of Full Compliance**

OSHA staff is well aware that there is not full compliance with OSHA standards. However, despite its lack of realism, the assumption of full compliance seems generally reasonable given the task that the regulatory analysts face. OSHA is required by statute to demonstrate that its standards are technologically and economically feasible, and this demonstration must be made under the assumption that there is full compliance. And if costs are estimated under this assumption, then calculations of the benefits these costs would generate should use it as well.

However, there is a point at which the full compliance assumption does go beyond reasonableness. OSHA appears to assume that if a standard requires workers to avoid working in a hazardous manner or provides them training to change their behaviors, then all such unsafe behavior will be eliminated. This assumption creates the potential for estimating unrealistically large reductions in injuries. When training and work practices are major components of a standard, OSHA should be required to analyze their impacts in a more deliberative and realistic fashion.

But this admonition is a rather empty one in the absence of better scientific understanding. For example, what can we expect to result from training? What percentage of those trained can be expected to change particular types of behavior? Without a stronger research base, these questions can't be answered. OSHA's relatively

weak commitment to research, even research applied directly to its mission, has not served it well here.

OSHA has an incentive to make new standards it proposes look as attractive as possible. The agency invests a good deal of effort and prestige in standard-setting and wants to convince others that the standards are worthwhile and that the agency is contributing to worker health. The plausibility of the analysis can be scrutinized by both OIRA and by the courts. When such scrutiny is lacking, it is likely that the pressures to make the analysis cogent are weaker. Standards with expected costs below \$100 million per year are not required to prepare RIAs and OMB is not required to review them. Typically, safety standards are cheaper than health standards, and less likely to be challenged and reviewed in the courts. Therefore, the small safety standards which comprise the bulk of our sample may represent the least well-justified analyses of impacts. Our small sample is not adequate to provide a strong test, but it is suggestive that Table III indicates that the most accurate projection was for the \$200 million per year confined spaces standard, while the least accurate was for the \$12 million per year logging operations standard

Systematic errors about the preventive effects of new standards can distort the agency's understanding in ways that cause harm. If a new standard is projected to prevent 85% of the deaths caused by a hazard, and the other 15% are judged "unpreventable," then it would appear to make little sense to give further attention to that hazard other than to enforce the standard. But if the true effect is closer to 20% than 85%, the diagnosis might be quite different. If we erroneously think we are preventing a large number of injuries and deaths, we may become less likely to make serious efforts that really would prevent the deaths in question.

For the objective of producing more accurate estimates, we need to inquire further into the factors that generate bad estimates and into what, if anything, might be done about them. The magnitude of the predicted effect is a function of two factors: the baseline estimate and the "prevention factor" (i.e., the percentage of the baseline numbers that OSHA believes will be prevented).

We saw in several cases that the baseline selected by OSHA appeared to be too high. Prior to the establishment of CFOI, OSHA lacked a good source of data about fatality characteristics and incidence. Unlike CFOI, the BLS Survey provided little detail

and clearly underreported deaths, especially at small establishments, which have the highest death rates. OSHA and its contractors often relied on making adjustments to the FAT/CAT numbers. We found extrapolations that ranged from 1.5 to 2.25 for establishing the baseline. Based on the limited comparison we did for the electrical work practices standard, the low end of that range was probably more appropriate. Now that the CFOI is available, overestimates of the baseline appear to be less of a problem. CFOI is a more accurate data system because it reviews more sources of information (reducing the number of missed cases) and because it requires multiple sources to verify each death (reducing the number of false positives). In addition, it collects information about each death that allows better identification of the industry and of causal factors.

More troubling are the estimates of the “prevention factor.” In general, we found little persuasive evidence provided to justify OSHA’s calculations. In a number of cases, there are circular references to the “prevention factors” used for other standards, implying that if it was plausible there, it should be plausible here as well. For example, OSHA applied an 80 % effectiveness rate for the reduction of baseline fatalities and injuries in the RIA of the Process Safety Management standard because (p.v-7) “the prevention rate is consistent with sensitivity analysis estimates used in previous regulatory analyses like the electrical work practices standard, lockout/tagout standard and confined spaces standard.”

When a serious effort was made to estimate the effect, it generally relied upon a review of the FAT/CAT database. Reviewers would try to answer the question of whether the provisions of the new standard would have prevented the fatalities which occurred in affected workplaces. Unfortunately, these judgments are not easy to make and depend greatly on the assumptions that the reviewer brings to the task. The case of training provisions, cited above, is probably the most egregious example. Although OSHA does often cite experiences at individual establishments, which often report dramatic reductions, it makes no effort to assess the representativeness of those experiences. In contrast, there were no references to any effort to evaluate the effects on injuries in states that had adopted similar standards in earlier years, which would potentially seem to provide the most valid basis for projecting effects. In fairness, however, we should note that good evaluations of these programs are often not easy to carry out.

We should note that in one of its more recent standards, for Powered Industrial Truck Operator Training, issued in December 1998, OSHA stated that it “had adopted a more conservative methodology for estimating the number of fatalities and injuries that could be prevented by the final standard.” (OSHA, 1998) There it projected that only 11 of the annual toll of 101 industrial truck-related fatalities would be prevented by the standard. However, because OSHA also acknowledged that “about 75% of affected establishments currently provide training that is equivalent, or nearly equivalent, to that required by the final standard, the degree of conservatism may be less than that implied by OSHA.

An important issue is to what extent overestimates of the prevention factor occur because the standard really was not very effective and to what extent it occurred because employers did not comply with it. Both probably play some role, but the relative importance matters because the implications for policy could be quite different. Stronger enforcement could be called for if noncompliance dominates, but might not be appropriate if compliance had little preventive value. Unfortunately, we are not able to provide further insight here.

Finally, it seems clear that more attention needs to be focused on the problems of predicting the effects of new safety standards on *non-fatal* injuries. Here, it turns out that some of the more insightful analyses were found in older, not newer, RIAs. The reason was that they utilized data sources that OSHA and the BLS discontinued in the late 1980s. One of these, labeled Work Injury Reports, came from a program that followed-back a sample of injured workers to learn more about events related to their injuries. The Department of Labor should consider restoring this program or find other methods for obtaining better data. One method that might be considered would be to “piggy-back” a team of analysts onto 1 or 2 state WC data programs. OSHA could identify a set of hazards that it was thinking of setting new standards for. The analysts would review injury reports related to those hazards. Specifically, they might follow-back (by telephone or through visits) to learn the details of the injuries--e.g., the specific equipment involved, the level of training, the use of personal protective equipment--in order to develop better estimates of the likely effects of the new standards.

The importance of developing better sources of data and devoting resources to analyzing them deserves a high priority. OSHA and other safety agencies face difficult analytic challenges in projecting what the consequences of new rules will be.

Some of the limitations of this study must be emphasized. First, we did not include standards where OSHA had predicted that only a small number of fatalities would be prevented. The pattern in those cases might be different. Second, our evaluation designs are usually not strong enough to make precise estimates. For example, when we find no evidence of a decline, it seems reasonable to rule out a 70% decline, but not necessarily a 10% or 20% decline. Third, although we made some effort to look at other factors affecting changes in the number of deaths, we generally did not fully examine developments in the affected industries that might have influenced outcomes.

Although our findings are relevant to examining the number of deaths, if any, prevented by the OSHA standards, it should also be kept in mind that this is not the topic of our study. Rather, our topics have been whether OSHA's projections of the impact of its standards have been accurate, the reasons for errors, and possible remedies.

We should emphasize that these standards may well be justified on economic grounds even if the number of deaths prevented is much lower than projected. In recent standards, the Environmental Protection Agency has been using a valuation of over \$6 million per death prevented and the Department of Transportation, \$3 million.<sup>9</sup> At these rates, even a small number of deaths prevented could justify many of the standards we review here.

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<sup>9</sup> Personal communication from John F. Morrall, III, Office of Information and Regulatory Analysis, U.S. Office of Management and Budget, June 16, 2003.

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**Table I. Safety Standards Promulgated Since 1990**

| Date of Federal Register | Title  | Effective date                                 |
|--------------------------|--|--|
| 8/6/1990                 | Electrical safety related work practices   | 12/4/1990<br>(with exception 8/6/1991)         |
| 11/14/1990               | Safety standards for stairways and ladders used in the construction industry               | 1/14/1991                                      |
| 2/24/1991                | Process safety management of highly hazardous chemicals; explosives and blasting agents    | 5/26/1992                                      |
| 1/14/1993                | Permit-required confined spaces  | 4/15/1993                                      |
| 1/31/1994                | Electric power generation, transmission, and distribution; electrical protective equipment | 5/31/94<br>(with exception 1/31/95)            |
| 8/9/1994                 | Safety standards for fall protection in the construction industry                          | 2/6/1995                                       |
| 10/12/1994               | Logging operation  | 2/9/1995                                       |
| 8/30/1996                | Safety standards for scaffolds used in the construction industry                           | 11/29/1996<br>(except with OMB Control number) |
| 7/25/1997                | Longshoring and marine terminals   | 1/21/1998                                      |
| 12/1/1998                | Permit-required confined spaces modification   | 2/1/1999                                       |
| 12/1/1998                | Powered industrial truck operator training   | 4/27/1999                                      |

**Table II. Costs and Effects of the Standards in this Study**

| Title of the standard  | Affected Industry   | Cost estimate   | Estimate of Effects   |   |   |
|--|---|---|---|---|---|
|  |   |   | Baseline  | Fatalities prevented  | Injuries prevented  |
| Electrical safety related work practices   | General industry  | \$ 90.8 million annually  | 235 fatalities and 7682 non-fatal injuries  | 97 (41.4 %)   | 1691 non fatal (22.7 %)   |
| Process safety management of highly hazardous chemicals; explosives and blasting agents    | General Industry except in 3 states                         | First 5 years, annually \$888.7 mil and 6-10 year, annually \$405.8 mil             | 1983 -90: 330 fatalities and 1,918 injuries/illness per year (excluding CA, NJ, and DE) | Annually, first 5 years 132 (40 %) and next 5 years 264 (80%) | Annually, first 5 years 767 with 250 LWDIs (40 %) and next 5 years 1,534 with 500 LWDIs (80%) |
| Permit-required confined spaces  | General industry (less 6 states)                            | \$ 202.4 million annually   | 63 fatalities; 5931 LWDIs; 6951 Non-LWDIs   | 54 (85 %)   | 5041 LWDIs and 5908 Non-LWDIs (85 %)  |
| Electric power generation, transmission, and distribution; electrical protective equipment | Mainly, electric utility industry (SIC 491 and part of 493) | \$ 40.9 million for the first year \$ 21.7 million annual cost after the first year | 85.5 fatalities; 12,976.5 LWDIs   | 61 (69%)  | 1633 LWDIs (12.6%)  |
| Logging operation  | SIC 241 (less in 6 states)                                  | \$ 14 million for the first year and \$ 12.5 million annually                       | 158 fatalities & 10,568 injuries (6798 LWDIs; 3770 Non-LWDIs)                           | 111 (70%)   | 7398 injuries: 4759 LWDIs; 2639 Non-LWDIs (70%)   |
| Safety standards for scaffolds used in the construction industry                           | SICs 15, 16, and 17   | \$ 12.62 million annually   | 79 fatalities; 9750 injuries  | 47 (60%)  | 4455 (45.7%)  |

Source: Regulatory Impact Analysis Documents

**Table III. The Accuracy of the Projections of Deaths Prevented by New OSHA Safety Standards**

| <b>Standard</b>  | <b>Accuracy of Baseline Number</b> | <b>Accuracy of Prevention Factor</b> | <b>Accuracy of Projection of Deaths Prevented</b> |
|--|------------------------------------|--------------------------------------|---|
| Electrical safety related work practices   | Overestimated                      | Overestimated                        | Overestimated                                     |
| Process safety management of highly hazardous chemicals; explosives and blasting agents    | Overestimated                      | Overestimated                        | Overestimated                                     |
| Permit-required confined spaces  | Probably Accurate                  | Somewhat Overestimated               | Somewhat Overestimated                            |
| Electric power generation, transmission, and distribution; electrical protective equipment | Accurate                           | Overestimated                        | Overestimated                                     |
| Logging operation  | Accurate                           | Greatly Overestimated                | Greatly Overestimated                             |
| Safety standards for scaffolds used in the construction industry                           | Accurate                           | Overestimated                        | Overestimated                                     |

Figure 1. Electrical Safety - Fatalities in General Industry

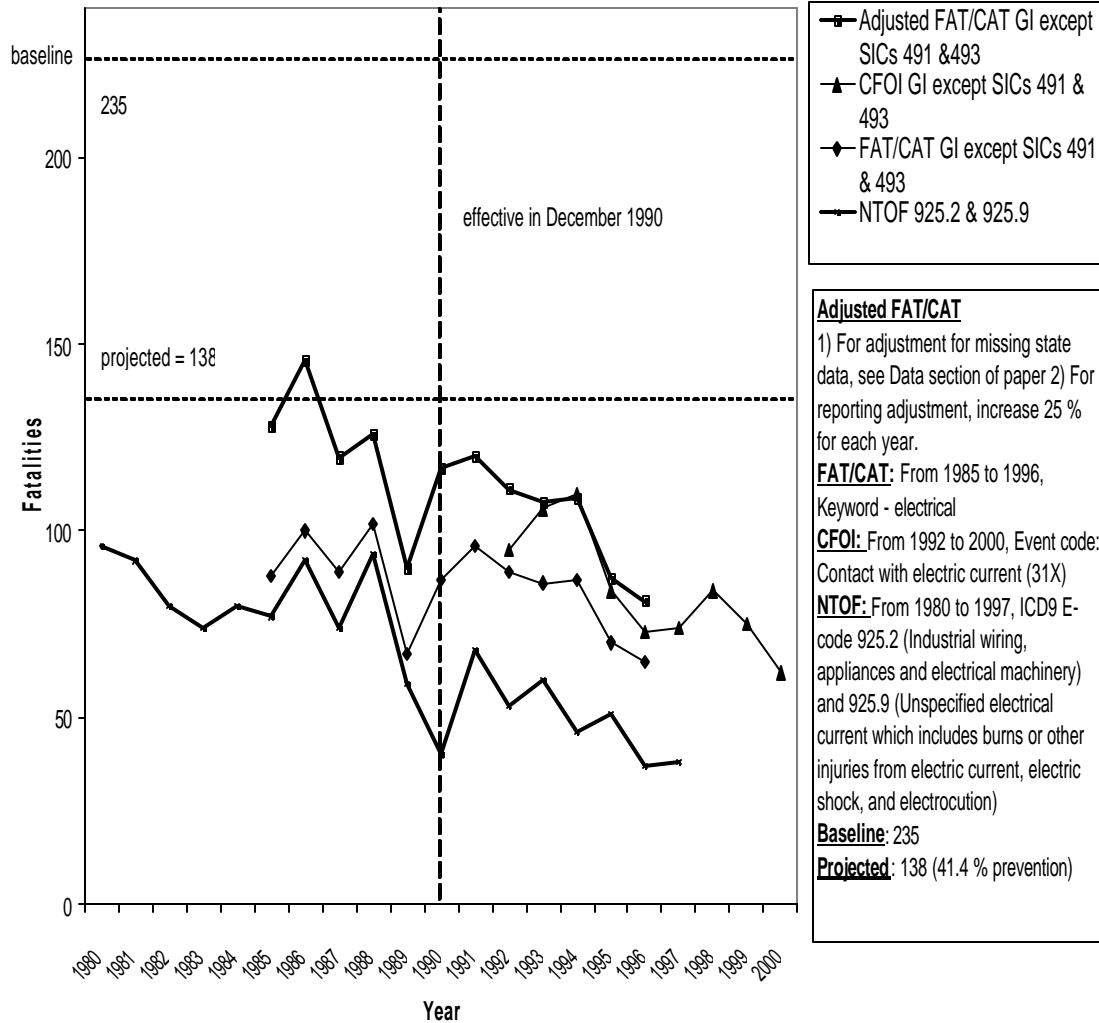


Figure 2. Process Safety Management - Fatalities

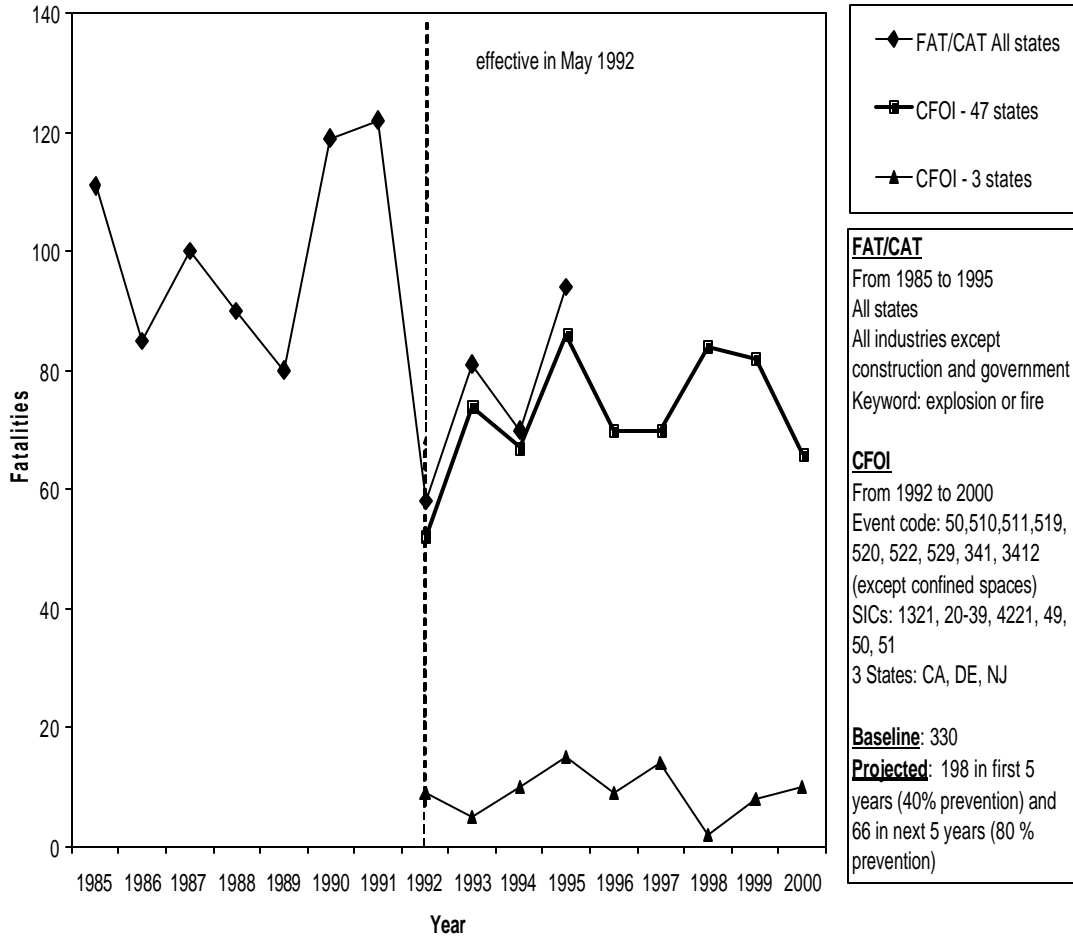


Figure 3. Confined Spaces - Fatalities in General Industry

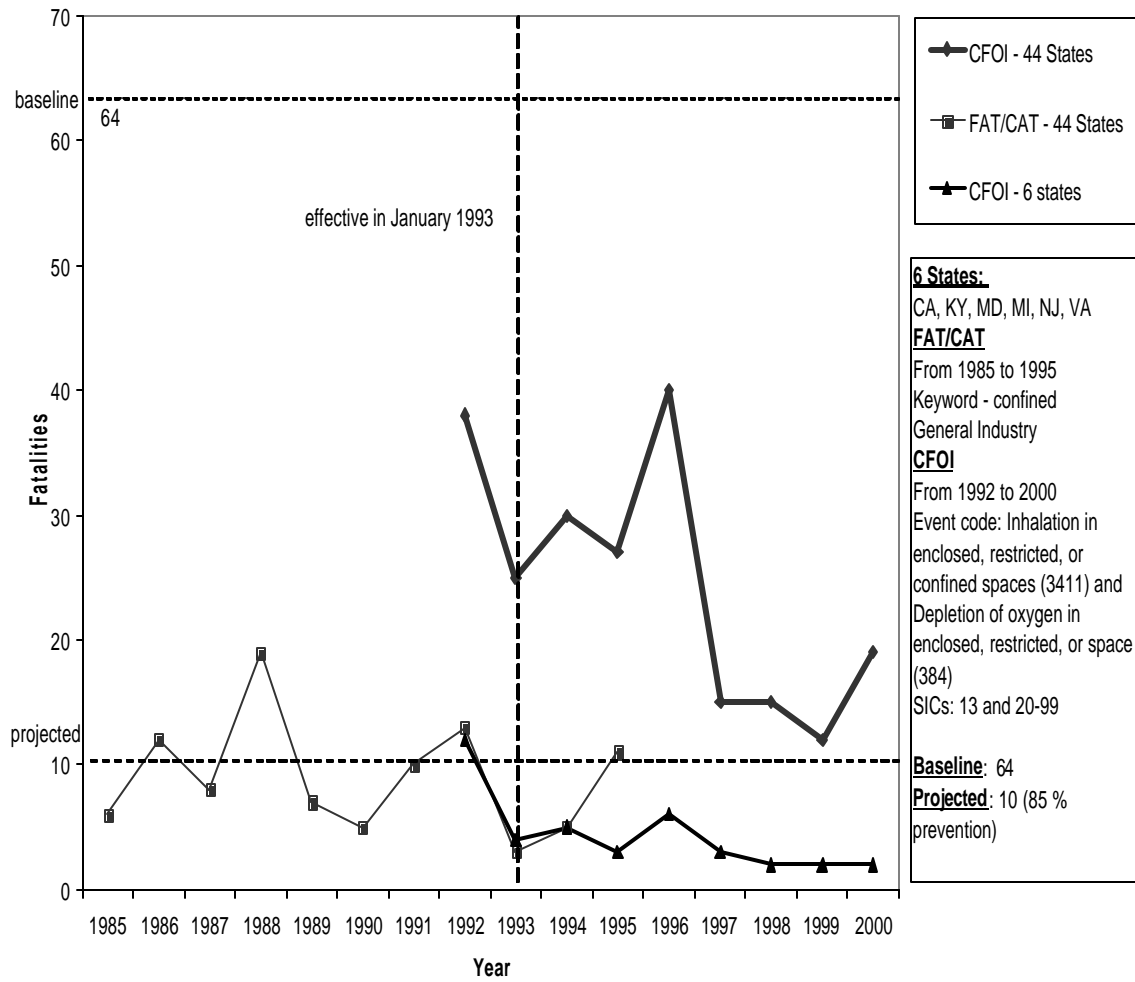
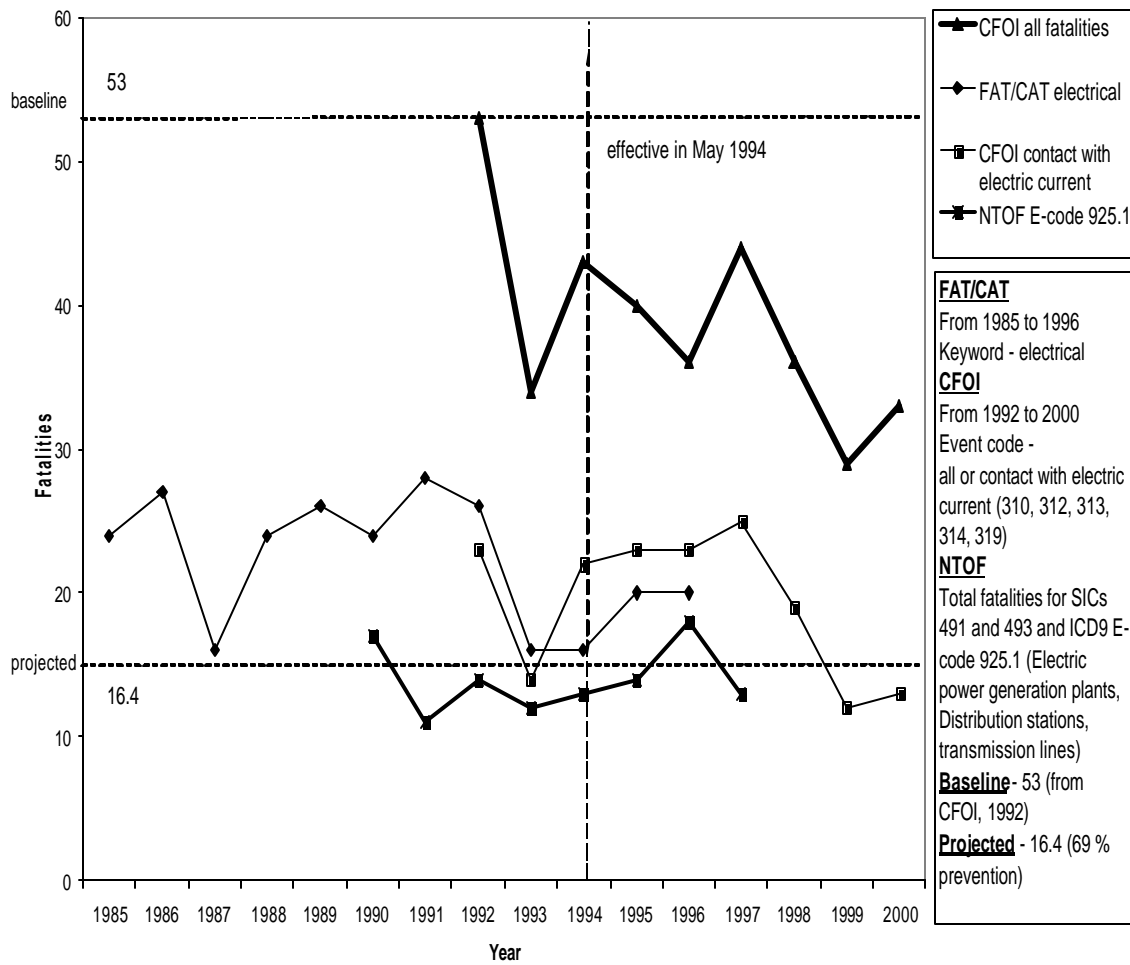


Figure 4. Electric Power Generation - Fatalities in SICs 491 & 493



**Figure 5. Electric Power Generation - Fatality Rate per Million Employees in SICs 491 & 493**

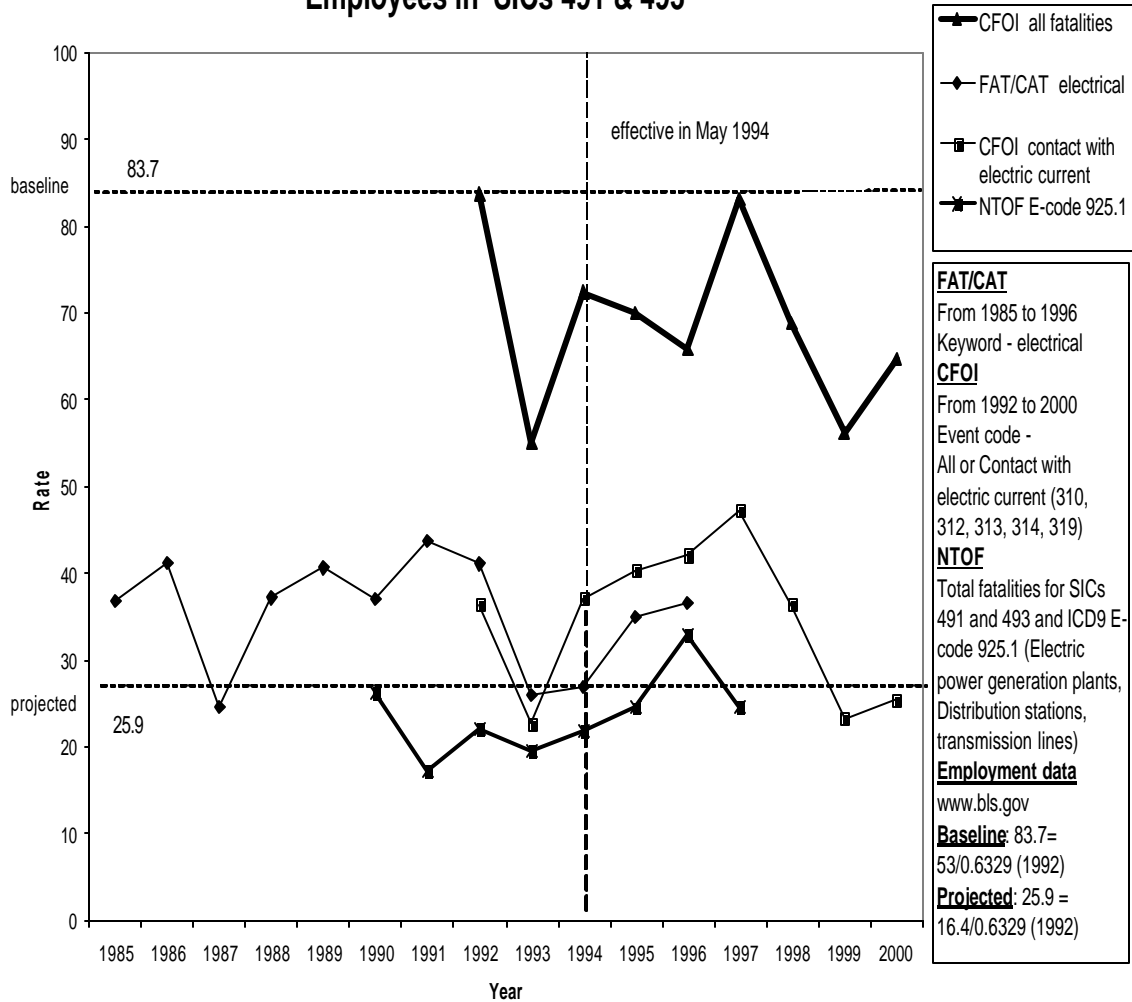


Figure 6. Fatalities in Logging Industry

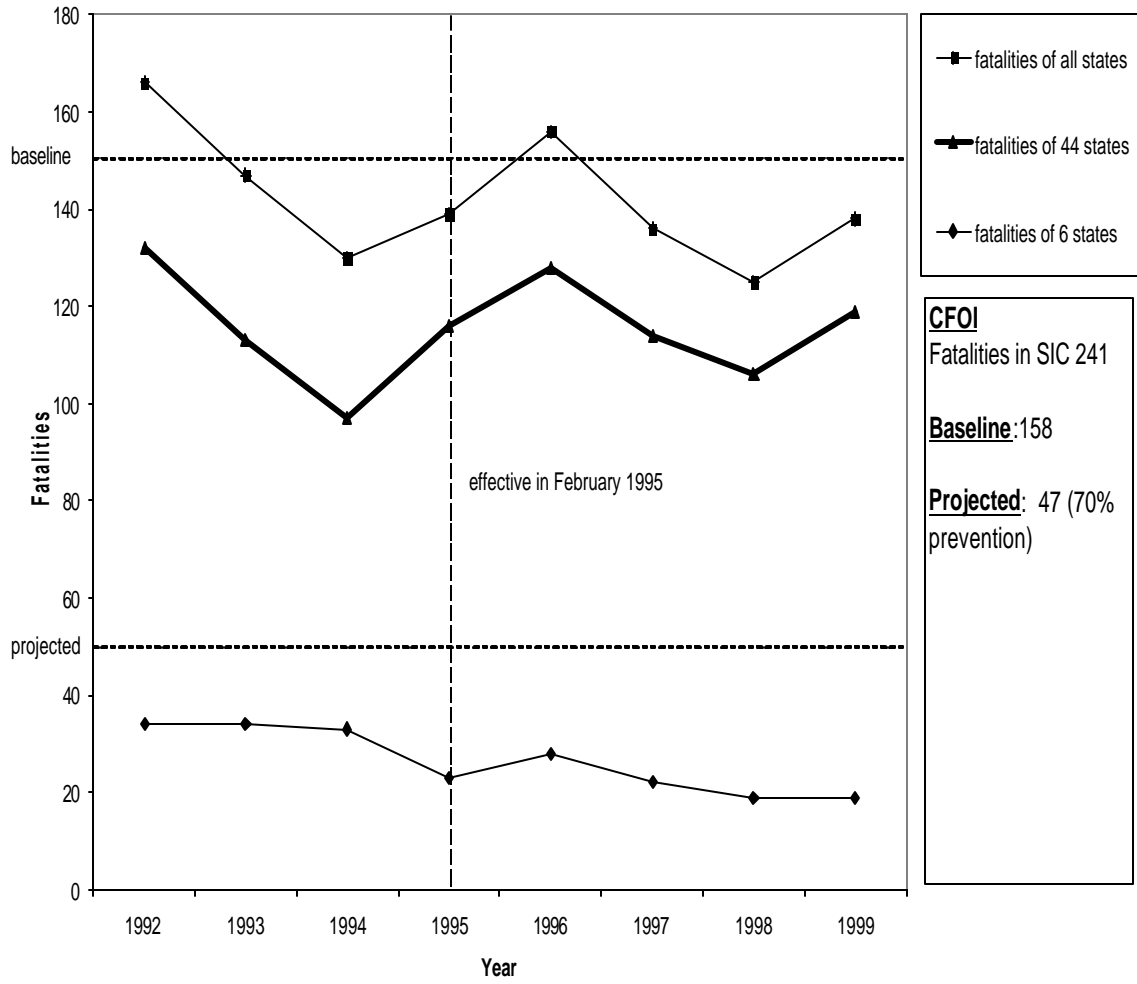


Figure 7. Fatality Rate per 1000 Employees in Logging Industry

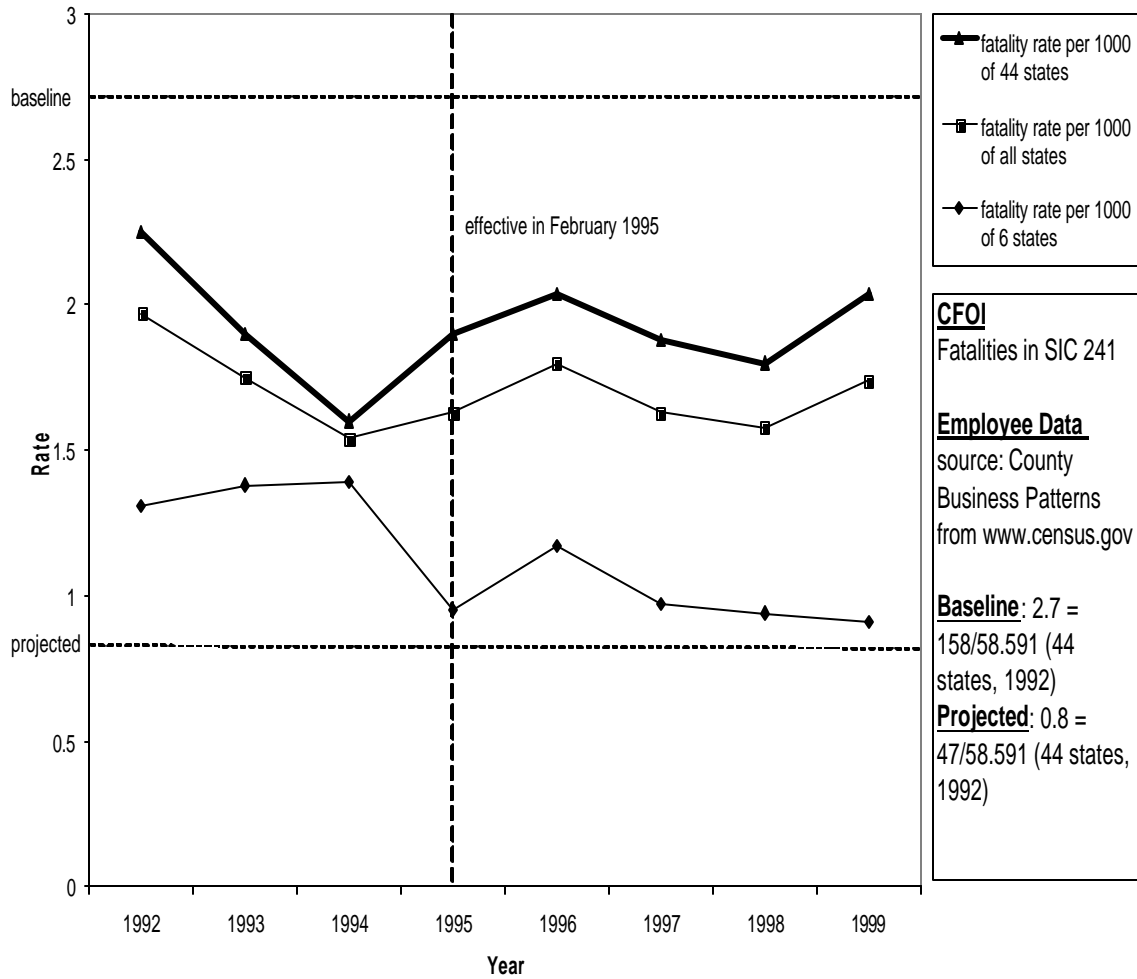
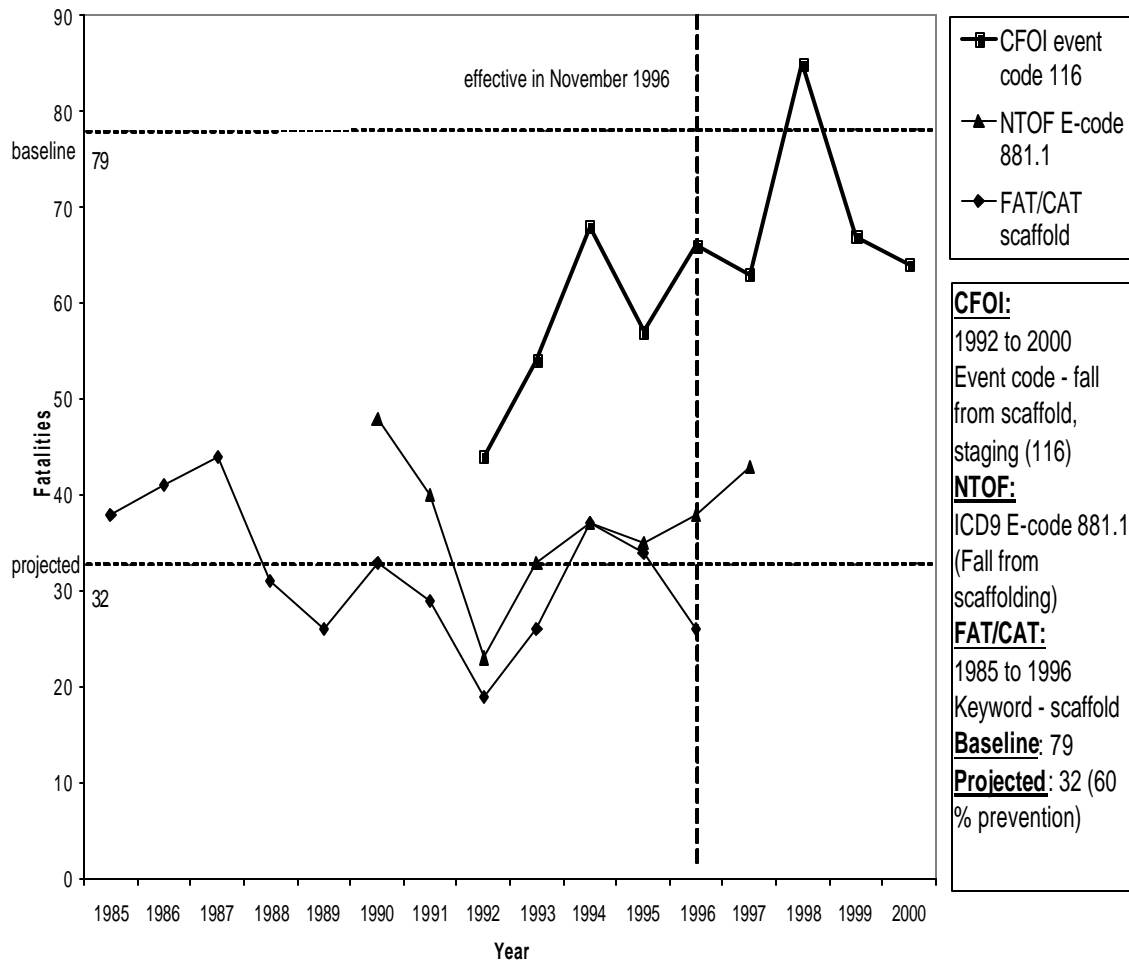


Figure 8. Scaffold - Fatalities in Construction Industry



**Figure 9. Scaffold - Fatality Rate per Million Employees in Construction Industry**

