Making OSHA Inspections More Effective: Alternatives for Improved Inspection Targeting In the Construction Industry

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June 2004

 This research was made possible by the Center to Protect Workers' Rights (CPWR) as part of a cooperative agreement with the National Institute for Occupational Safety and Health, NIOSH (NIOSH grant CCU317202). The research is solely the responsibility of the authors and does not necessarily represent the official views of NIOSH. CPWR – a research, development, and training arm of the Building and Construction Trades Department, AFL-CIO – is uniquely situated to serve workers, contractors, and the scientific community. A major CPWR activity is to improve safety and health in the U.S. construction industry. CPWR, Suite 1000, 8484 Georgia Ave., Silver Spring, MD 20910, 301-578-8500, www.cpwr.com

Acknowledgments

Funds for this study were provided by a grant from the Center to Protect Workers' Rights (CPWR). I am grateful to Pete Stafford and James Platner of CPWR for their interest in this project, which builds directly on a prior study of OSHA enforcement also supported by CPWR, and to Jane Seegal for her assistance in editing this manuscript. Thanks also to Bruce Swanson, H. Berrien Zettler, and Richard Rinehart of the OSHA Directorate of Construction for their input and access to OSHA personnel, to Joseph DuBois of OSHA's Office of Statistics, and to the OSHA Construction Targeting Task Force for provision of survey data. Dr. William Schriver of the Construction Industry Research and Policy Center at the University of Tennessee generously provided me access to data as well as insight into the Dodge/CRA system. Don Cotchen and Anita Gryan of F.W. Dodge Inc. were extremely helpful in providing information on the Dodge system and feedback on issues in the proposal. Finally, I am grateful to Alison Morantz and Marcus Stanley for comments at early stages of the project and to Nao Valentino for her ongoing research support. The analysis and conclusions of this paper reflect my own views and not those of any of the above individuals or institutions.

Abbreviations

CM	Construction manager
CRA	Construction Resources Analysts (now Construction Industry Research and Policy Center)
GC	General contractor
IMIS	Integrated Management Information System (OSHA)
LEP	Local emphasis program (OSHA)
OSHA	U.S. Occupational Safety and Health Administration

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Background

The problem of targeting in construction

Construction job sites are some of the most dangerous workplaces in the United States. In 2002, there were 1,153 deaths from injuries in construction – more than in any other industry – and 163,700 injuries and illnesses involving days away from work[1](Bureau of Labor Statistics 2004a, 2004b). Although the rate of reported injuries fell substantially over the past decade, the rate for construction remains well above that for the private sector as a whole.

Efforts by the U.S. Occupational Safety and Health Administration (OSHA) to improve workplace safety on construction work sites are complicated by features of the construction industry. The construction work site is dynamic by nature: the "manufacturing" process for construction requires the physical transformation of the workplace itself and, therefore, working conditions. Each new phase of a construction project entails different materials, building technologies, work processes, and exposures to external and internal environmental conditions. For example, the risk of falls – one of the major causes of deaths and injuries in construction – alternately increases and declines over the course of a multi-story construction project. On the other hand, in most residential construction, the largest risk from falls occurs during one relatively brief period, during roofing (Nelson and others 1997). As a result, the composition and nature of safety and health risks shift throughout a project.

The set of workers at a site also varies as a project progresses. Crews with different skills and abilities operate at each stage of a project. Management by individual contractors changes over time, also, as different subcontractors arrive at and leave a site, making the role of the prime construction manager particularly decisive, because of its continuity throughout a project. As the levels of skill and experience of workers and managers on a site vary over time, and as tasks shift, worker exposures to safety and health risks change.

These characteristics of the construction work site create a very different safety and health regulatory problem than in a fixed manufacturing location. Yet the underlying regulatory model applied to construction is the same as that applied to factories, banks, or other fixed facilities: sites are selected, inspections conducted, penalties assessed, and follow-up inspections undertaken to ensure abatement. Given the difficulties of ensuring safety at a construction site, however, OSHA recently has been reviewing how it targets enforcement in construction.[2]

This study proposes some alternative methods to improve enforcement by OSHA in the construction industry, with the goal of providing a basis for discussion of future public policy in this area

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[1]Illnesses make up only about 2% of the figure for construction.

[2] The OSHA Directorate of Construction has commissioned several evaluations of targeting, including the study by Ringen in 1999. In late 2002, the Assistant Secretary of Labor for OSHA, John Henshaw, appointed a Construction Targeting Task Force to study this problem. The author has worked in consultation with Richard Rinehart, chair of the task force, in the present study and has used data generated by their work. The views and recommendations found in this report reflect only my conclusions and not those of the task force or OSHA.

Construction targeting procedures and the *Barlow's* decision

There are millions of active construction projects at any time. In 2002, OSHA had 1,123 inspectors at the federal level, devoting roughly 40% of their time monitoring safety and health conditions in the construction sector. ("OSHA" throughout this report refers to the federal agency, whose jurisdiction includes 29 states; the 21 other states have separate state OSHA plans.) Given the limited number of inspectors, selecting sites for inspection is an enormously difficult task for OSHA, but remains critical to the agency's ability in carrying out the intent of the Occupational Safety and Health Act (OSH Act) of 1971 to improve workplace safety and health.

Ideally, OSHA would focus its resources on those projects that subject the largest number of workers to the most severe safety and health risks. However, with limited information about schedules for construction activity in a given region and about safety and health conditions in construction, scheduling inspections remains a major problem. Worker complaints and referral inspections can provide some information about risks on current work sites, but this information is not systematic.[3] OSHA inspections triggered by a workplace death or major accident can provide information on major problems that may have value for targeting, but the information is not often used for this purpose.

When the agency began, in the early 1970s, OSHA offices used a variety of formal and informal methods for targeting inspections, ranging from reliance on complaints, to use of information available from local permitting and public agencies regarding construction activity, to drawing on the knowledge of area-office OSHA compliance officers about upcoming construction. The targeting system now used by OSHA arose from a Supreme Court ruling in *Marshall v. Barlow's Inc.* (429 U.S. 1347, 97 S. Ct. 776) in 1977. In that decision, the Supreme Court required that OSHA use an objective and documented basis for selecting targets for inspections. Specifically, in selecting workplaces for programmed (planned) inspections, OSHA needed to demonstrate use of "specific neutral criteria" to prevent arbitrary or abusive behavior by personnel of the agency. Though the definition of "specific neutral criteria" is complicated, it rests on the idea that all establishments within a defined universe of employers covered by OSHA bear similar chances of being inspected. As a result, the definition of the relevant universe of employers becomes critical to the targeting mechanism. Subsequent to the ruling, OSHA formally adopted in its *Field Operations Manual* a procedure for targeting construction work sites:

> A list of all known construction worksites that are or will be active during the forthcoming scheduling period shall be prepared…using…sources such as Dodge reports, local building permits, and CSHO [compliance safety and health officer] sightings of construction activity…
>
> – *Field Operations Manual,* Chapter II.E.2.b(2)(a), cited in U.S. Department of Labor 1987

[3] Workers exercise their rights under OSHA unevenly. Because many workers are uninformed about their rights under the OSH Act or fear discrimination, many workers (such as immigrants, younger workers, and those working on nonunion, smaller sites) do not complain even when faced with dangerous conditions (*see* Weil 1992 and 2001).

A 1987 audit by the Office of the Inspector General of the U.S. Department of Labor concluded that several OSHA area offices had not come into adequate compliance with the *Barlow's* decision requirements on establishing a neutral and documented system of construction targeting. The Inspector General noted 6 of 8 area offices audited failed to have documented lists of all potential construction sites for the area (U.S. Department of Labor 1987, pp. 45-46). Coinciding with the Inspector General's investigation, OSHA initiated a project to create a computer-based targeting system to be introduced the following year in order to automate the process of selecting projects from a universe of all potential sites.

The targeting procedure created in response to *Barlow's* and the Inspector General report uses construction permitting data collected by F.W. Dodge Inc. and statistical models that predict construction starts and estimated durations to establish the universe of active construction projects for a given geographic area corresponding to each OSHA area office. For each OSHA area office, a list of projects is randomly selected from the estimated universe of active construction projects. The OSHA area office must then inspect contractors and subcontractors on all sites provided on the list during the course of the month (or carried over to the next month if there is insufficient time for completion). In this way *employers* (contractors and subcontractors) are identified on the basis of *project-level* activity. As a by-product of the unique structure of construction, this procedure of employer identification therefore differs markedly from the fixed-site/fixed employer model that OSHA generally uses.

Crafting alternative policies for targeting in construction

The current construction targeting system's ability to help OSHA achieve its central mission of improving workplace safety and health has been a topic of debate since the system was instituted in the late 1980s. Proponents of the system argue that it fulfills the *Barlow's* requirement of a neutral and documented method for identifying construction sites, drawing upon arguably the most comprehensive data available nationally regarding construction activity.

Critics have countered that the system frequently sends OSHA personnel to work sites that have not yet been started or are substantially completed and that the targeted projects – and contractors on those projects – are often not those with whom major problems reside. Instead, the system leads OSHA to focus its attention on segments of the industry that employ some of the best – rather than worst – actors in terms of workplace safety and health. Through a series of interviews, Ringen (1999) found evidence of positive and negative views of the targeting system among area office personnel:

> Almost all area offices expressed the view that the planned programmed inspections gives a presence at sites where the Agency would otherwise not go. However, a number of field managers expressed strong dislikes for the current system because it is too resource intensive and not sufficiently flexible. It produces "too little bang for the buck."

The OSHA Directorate of Construction which oversees industry enforcement and safety and health policy for federal programs, faces two seemingly competing forces in dealing with the limitations of the existing system. On one hand, the *Barlow's* decision and the subsequent Inspector General report of 1987 require OSHA to provide a clear and non-arbitrary method for targeting construction inspections. This forces the agency to find a way of defining a universe of potential targets and selecting sites based on transparent and documented procedures.

On the other hand, the existing system may be hampered, by definition, because it directs a major portion of OSHA's programmed inspection resources to "round up the usual suspects" rather than allocating those scare enforcement resources toward segments of construction – or phases of construction projects – that are potentially the most hazardous, in terms of injuries, illnesses, and deaths. The challenge for OSHA policy is therefore to find a means to identify projects in a documented and non-arbitrary fashion and draw on the best sources of information available regarding construction activity, yet do so in ways that focus OSHA resources on risk factors rather than on the largest projects that tend to be easy to locate.

Current Targeting Practice and Performance

Operation of the Dodge/CRA system

The performance of the current targeting system is a function in part of the method that has been employed to create a representative universe of construction required by *Marshall v. Barlow's, Inc.* F.W. Dodge Inc. (a division of McGraw-Hill Companies) employs a network of field reporters across the country to collect information from local permitting agencies, public bidding systems, companies, and end users regarding planned construction activity. Information on planned activity is used to create a comprehensive database (Dodge reports) on planned construction projects, which includes commercial projects valued at more than $100,000. Contractors, subcontractors, and other construction material and service providers planning to bid for private and public work are the primary users of Dodge reports. Beginning in 1988, OSHA contracted with Dodge and a group of researchers at the University of Tennessee – Construction Resources Analysts (CRA) – to use these data to generate a universe of construction activity for geographic areas across the country.[4] The resulting construction universe created by the Dodge/CRA system serves as the basis for selecting construction sites for OSHA inspection on the "neutral basis" required by *Barlow's*.[5]

In the first week of each month, Dodge sends CRA a list of all construction project starts from its master database.[6] The list includes a statistical record for projects with only an abbreviated set of all potential project information available from Dodge. Based on econometric models and using the list supplied by Dodge, CRA then forecasts an active-site list. From this universe, a random sample of worksites is selected for each area office to use in its programmed inspection activity. CRA then sends the Dodge report numbers for those projects selected back to Dodge which, in turn, provides a

[4] Construction Resources Analysts (CRA) has been headed since its inception by William R. Schriver, PhD. Although the group recently changed its name to the Construction Industry Research and Policy Center, it is referred to as CRA throughout this report.

[5] The focus of targeting procedures discussed here are OSHA programs, which are under the jurisdiction of federal OSHA. Although state-administered programs often draw on Dodge data that are provided to them at no charge, states that administer their own OSHA programs – 18(b) states – can establish their own targeting procedures and protocols.

[6] The Dodge system remains the most comprehensive national database on construction available in the United States. Its coverage of construction activity is extensive for projects above $100,000 in most sectors outside of residential construction. The logic of using this database as the underpinning of targeting therefore is strong. *See* Meridian Research 1992 and Ringen 1999 for earlier assessments of the adequacy of the Dodge data

current and detailed file for each listed project with additional information including the location. This information for each area office is posted on an OSHA intranet site. These electronic lists designate the targeted sites for programmed inspections in the next month.[7]

Although the targeting procedure is based at the project level, OSHA enforcement activity in all other respects is focused on the contractor(s) active on each site at the time of an inspection. That is, OSHA personnel record, track, and report on inspection activity on the basis of contractors, rather than projects, inspected. Thus, two projects of equal scale would be counted differently if only one contractor was present at the time of one inspection and eight on another. Because the number of inspections conducted is an important metric for OSHA, both in terms of its internal procedures and its reporting to the White House, Congress, and the public, the incentives for the agency have always pushed toward visiting construction projects with a large number of contractors present.

Thus, area offices can provide CRA with project characteristics (called "deletion criteria") that limit the universe from which random sites are selected. The most common form of these is specifying a minimum project size (measured in dollar value) for inclusion in the list. In order to maximize the number of contractors inspected during a visit to a site, area offices tend to pre-specify that only larger construction sites are included in the sampling universe.[8] Because most area and regional OSHA offices provide minimum dollar volumes in their deletion criteria, the resulting lists are biased toward larger projects. Because of this emphasis on larger work sites, OSHA enforcement for programmed inspection tends to be skewed toward monitoring the safety and health activities of large construction contractors and subcontractors, with annual revenues well above $5 million.

The effects of current targeting procedures

The targeting procedure developed in response to *Barlow's,* which was biased toward large sites, made sense in OSHA's first few decades of operation when it was reasonable for the agency to try to move as many contractors as possible toward compliance in a world of widespread noncompliance with newly promulgated safety and health standards. Studies of the effects of OSHA inspections in the early period of regulation show a high level of responsiveness to enforcement and therefore the rationality of an approach focused on larger employers (Bartel and Thomas 1985; Scholz and Gray 1990; Gray and Mendeloff 2001; Jones and Gray 1991; Stanley 2000; Weil 1996, 2001).

A previous study by this author investigated the effects of OSHA enforcement on safety and health among the large contractors typically selected through the Dodge/CRA targeting procedure. Using a panel of data on OSHA enforcement activity for the 2,060 largest contractors in the United States in 1987-93, the study revealed that large contractors traditionally exhibit higher levels of compliance with safety and health standards than other segments of the industry that receive far less regulatory attention (Weil 2000, 2001).

[7] *Barlow's* does not apply to all OSHA inspection activity in construction. Only programmed inspection activity is germane, rather than inspections initiated by a complaint, death or major accident, or by inspector referral. Planned programmed activity is governed by a systematic and neutral selection procedure that usually falls into one of two categories – scheduled inspection using the Dodge/CRA system or a national or local emphasis program where a different procedure has been developed that is directed at a particular problem (falls) or sector (bridges).

[8] The universe of potential targets can be modified by general criteria selected by the area office, although offices are obligated to then inspect all those randomly selected from that list in order to comply with the *Barlow*'s standards (as interpreted by OSHA practice).

The tendency for larger projects to have better safety and health performance can be vividly seen in comparisons of the incidence of violations of a subset of core OSHA standards relating to physical hazards between the sample of major national contractors inspected by OSHA and all other construction inspections conducted during this period (fig. 1). Large national contractors had a lower percentage of inspections with violations compared to inspections conducted at all other construction establishments. In 1993, for instance, while 51% of the inspections of large national contractors found at least one violation, almost 69% of the inspections conducted at all other construction establishments found violations.[9] The percentage of inspections with serious violations shows a similar gap between the two groups that grew from 5.6% in 1987 to 16% in 1993 (Weil 2001).

In addition to maintaining higher levels of compliance, large contractors tend not to improve compliance further, even though their projects receive a great deal of scrutiny. In the national contractor sample of 2,060 firms, the average number of inspections per contractor was 19.4 over the 6 years studied, with some contractors receiving more than 100 inspections during the period. This meant that these large contractors had about a 50-50 chance of receiving an inspection on at least one project in any given year. Yet the study found that repeated inspections did relatively little to improve compliance.

Figure 2 displays the impact of site- and contractor-level inspections on predicted levels of OSHA compliance.[10] The upper line displays the effect of sequential inspections of a contractor by OSHA on one site; the lower line indicates the effect of sequential inspections on predicted compliance given inspections conducted on *any* site where the contractor was active. The upper line shows that contractors started on a given site at high states of compliance (74% in compliance at the time of the first site inspection) and changed little, even given repeated inspection on the same site. Even after *eight* inspections of a contractor at the same site, predicted compliance rose only to 80.5%. Similarly, contractors responded more, but still modestly, to the effects of inspections conducted on any of their project sites, with predicted compliance rising from 61% on any site at the time of the first inspection in the time period to 76.6% at the time of the eighth inspection on any site.

Figure 3 underscores these modest enforcement effects on large contractors by focusing on the effect of an additional inspection conducted within one year on compliance behavior.[11] One would imagine that recent contractor inspections are more likely to result in changes in compliance behavior. Yet even when limiting the predicted effects to more recent inspections, large contractors showed limited responsiveness to OSHA.

There are several explanations for the recalcitrant behavior of large contractors. Large contractors tend to begin in and maintain relatively higher states of compliance (fig.1) than other, smaller contractors targeted by OSHA. This lack of response to OSHA enforcement implies that contractors have decided on some level of safety and health activities and practices – factoring in the risk (and cost) of being inspected and penalized – and choose not to alter them. The behavior might

[9] The percentage of all inspections where any violation was cited is used as a broad measure of compliance in these comparisons. Figure 1 includes violations of any OSHA standard for both groups, including but not limited to the subset of standards used in the rest of the 2001 Weil study for examining compliance. Serious violations of standards include those classified as "serious," "willful," or "repeat" by inspectors.

[10] Compliance is defined here as not violating any of a set of 100 core OSHA standards associated with physical hazards. The methodology and results are discussed in detail in Weil 2001.

[11] Compliance is measured in figure 3 in two ways: the lower line measures compliance as a contractor not violating a key OSHA standard – regardless of severity; the upper line measures compliance as a contractor not being cited for a serious violation of standards.

imply also that contractors cannot make the changes required to come in full compliance with standards, despite repeat inspections, because the changes would require responses of other parties at the construction site, including those involved in overall project management activities.

Ringen (1999) discovered related problems in his study of OSHA enforcement targeting procedures:

> There is a tradeoff between neutrality and inspection effectiveness as measured in terms of violations and penalties. The planned programmed inspections, based on neutral selection of inspection targets, are bound to produce “less inspection bang” than the unprogrammed inspections that are based on cause.(pp. iii-iv)

Ringen focused on the fact that inspections triggered by worker complaints or death/accident investigations are more likely to result in violations than any programmed procedure not directly linked to potential problems.

The view of targeting performance from OSHA area offices

In spring 2003, the OSHA Targeting Task Force undertook a survey of federal OSHA offices regarding targeting practices. The survey was distributed to all federal area offices and to California, which has a state OSHA plan. The task force received 69 responses, including some from 3 regional offices and 4 federal area offices in state plan states. Eleven of the responses from the California agency, CalOSHA, were not included in the analysis, however, because of systemic differences between the California system and others. The OSHA Targeting Task Force provided the survey data for review for this study.

The area offices responding to the survey reported widespread use of the Dodge/CRA system. Eighteen (31%) of 58 area offices responded that they use the Dodge/CRA system exclusively, and 34 (58%) reported using it for “some” scheduled inspections. Only 6 (11%) reported that they do not use the Dodge system at all.[12] Thirty-three of the area offices (57% of respondents) have done some form of in-house training; 23 (40%) are self-taught or have received no training. Only 2 (3%) have had formal training by CRA, although 44 (75%) indicated an interest in receiving training on the system.

Although the vast majority of area offices seems to be drawing on Dodge/CRA lists either partially or exclusively, the survey also identified significant use of local emphasis programs (LEPs) that target construction sites on the basis of specific construction safety and health problems defined at the regional or local level, such as fall protection. In general, these programs were more favorably rated in terms of perceived performance by OSHA staff than those based on Dodge/CRA, although this could arise in part from the fact that the LEPs are devised and implemented by the survey respondents.

The overall evaluation of the targeting system arising from the survey is generally similar to that reported by Ringen in his interviews with area office staff in 1999, with the problems and limitations cited by survey respondents. Perhaps not surprisingly, given its nature, the Dodge/CRA system receives its best marks regarding identification of sites with a large number of employers (fig. 4).

[12] Of the 40 using an alternative system – either in part or in lieu of Dodge – more than half, 23, say the alternative system is very useful.

The problem of the Dodge/CRA system most commonly cited by survey respondents concerned the level of construction activity found on sites at the time of inspections (fig.5). Despite the efforts of CRA to improve prediction of project start times and durations, half of the respondents partially or completely agreed with the statement "construction sites are either already completed or not yet started at the time of inspection." One-third of respondents agreed with, "the same contractors are selected over and over again." About the same percentage agree with the statement that construction sites on the Dodge/CRA lists "…cannot be found or do not exist." Few area offices view the mix of project types – that is, their end uses (such as factories or hotels) – identified in the lists as a problem, while only 13% of respondents agreed with the statement that "the site selected are not representative of the work in the area.

Implications for future targeting efforts

Results of the OSHA Targeting Task Force survey suggest that the system adopted in response to *Barlow's* has been substantially adopted in federal OSHA offices. Yet the problems just discussed are widely recognized.

There remains significant discontent among the area offices with the current system's ability to identify construction projects at their peak activity level. Any targeting system – whether it targets on the basis of overall construction activity as under the present system or uses some other criteria – will face the problem of accurately predicting the current stage of construction, given limited information on start dates. CRA has taken this criticism seriously over the years and modified construction duration models a number of times to improve performance.[13] These refinements should continue, but represent a separate problem from improving the system's overall ability to focus resources on the major safety and health problems in a construction market.

The Dodge/CRA system created in the wake of the *Barlow's* decision was a reasonable response to the demands of that ruling, particularly when OSHA was a relatively young agency. However, this targeting philosophy makes far less sense in OSHA's fourth decade of operation.

Targeting Alternatives: Principles

If one began with a blank slate to design a policy for allocating OSHA resources across the construction industry, it would reflect that the work process is inherently dynamic because the geographic location of work changes over time, the conditions on any given site are shaped by multiple employers, and working conditions are in constant flux as a project proceeds. An ideal targeting policy would follow three major principles that derive from these characteristics (each one will be discussed in detail below):

- **Focus targeting at the project level:** Much of what drives safety and health in construction arises at the project level, because the interaction of contractors and their coordination through a general contractor/construction manager has a major bearing on

[13] CRA has undertaken a series of studies and revisions of techniques to forecast construction starts since the beginning of its contract with OSHA and the Department of Labor. These include studies and modification of procedures in 1989, 1992 and 1997. *See* Schriver (1997) for a discussion of the most recent analysis of estimation of construction starts.

the risks faced by workers. Enforcement targeting should therefore shift from its current focus on the contractor and instead be oriented to the construction project (site level).

- **Focus on prospective risk to workers:** Enforcement policy should be based on the *prospective* risks facing workers on construction sites. Because risks arise from the interaction of multiple contractors and workforces, one cannot rely on a single contractor's past injury rates to predict future safety and health performance on a project.
- **Consider efficacy in choosing inspection targets:** Enforcement policy should consider the chance that OSHA intervention will change the choices made by contractors individually and collectively. This includes taking into account whether other mechanisms outside of enforcement might be more effective in improving safety and health performance of certain contractors or on certain types of projects.

The reality of course is that OSHA is not starting with a blank slate, but is bound by legal, organizational, and practical constraints. The key question is, Can a system be devised that incorporates the three principles, but still conforms to the requirements of *Barlow's* and the reality that the Dodge/CRA system remains the most comprehensive source of information about construction activity?

Data used for this section

This section, Targeting Alternatives, draws on a unique data set created by the OSHA Office of Statistics for analysis by William Schriver, the director of CRA (*see* Schriver 2003). The data set combines information from the F.W. Dodge system regarding project-level characteristics (used for assembling targeting lists) and from OSHA's Integrated Management Information System (IMIS) on inspections of companies operating on those projects.

IMIS contains the complete histories for all inspections undertaken by OSHA in federal and state-plan states since 1987 (and since the early 1970s for federal programs and some state-plan states). IMIS data are kept on a contractor-, rather than project-level, basis, making analysis of project-level information difficult. Fortunately, in 1999 OSHA started to append the Dodge project identification number on each file, making it possible to link all contractors inspected at a given site. [14]

The analysis presented here pulled IMIS inspection records for fiscal years 1999-2001, where Dodge numbers were provided.[15] The IMIS records were then matched with a file from the Dodge records kept by OSHA. Thus, the data linked information on the overall site inspection (such as, violations found and number of contractors inspected) with project-level information from Dodge, including value of the project, end-use type, and characteristics of

[14] Prior to the incorporation of Dodge project IDs, the only way to group contractors together on a common site was to use other identifiers in the IMIS system – address, zip codes, dates – to link the contractor files back to a common project location. This method was both extremely time consuming and prone to errors, for example because a single construction site might be listed under multiple street addresses.

[15] Unfortunately the Dodge project identification number is not yet uniformly provided in IMIS. Some inspection files might not include the Dodge number because the inspection was non-programmed (that is, triggered by a complaint, accident, or referral). In other cases, OSHA personnel might not have provided the data for programmed activities. I was not provided with an estimate of the number of contractor records that were excluded from the sample because of a missing Dodge identifier, nor characteristics of the excluded records.

construction. A total of 9,312 projects was identified by this approach and used in the data analysis that follows.[16] To my knowledge, this represents the first comprehensive data set to provide this merged Dodge/CRA/IMIS information.

The projects analyzed were large, with an average value of $7.1 million (table 1). That average masks the scale of many of the projects inspected by OSHA, with almost 10% of the projects having a value above $15 million and the largest project in the sample an estimated value of $373 million. In contrast, less than 5% of the projects had a value below $500,000. By region, the average value of projects ranged from a low of about $5.0 million in region 10 to a high of $8.5 million in region 1 (table 2).

The number of contractors inspected on projects varied widely in the sample. The average number of contractors on a project was 1.4, with the largest number of contractors inspected at a single site at 26. Only one contractor was inspected at 74% of the projects (table 3). A considerable percentage of this group might reflect cases where inspection records did not contain Dodge record identifiers and could therefore not be linked to a project for the analysis. However, the cases where there was only one contractor inspected per project may also reflect the ongoing problem of accurately predicting peak construction activity at sites (identified in the OSHA Targeting Task Force survey as a major problem).[17]

Project-level targeting

A project-level focus for OSHA activity makes sense given the central role that coordination plays on most construction sites. A construction project of any size requires synchronization between many separate business enterprises and workers, with varied responsibilities, skills, and roles. It is therefore not surprising that the industrial organization and industrial relations/human resource systems in construction are extremely complex, as well as decentralized (*see* Dunlop 1961 for a classic discussion of this issue).

Organization of the sector has changed with the transition from the use of general contractors to construction managers (fig. 6) to coordinate projects. Driving the construction project are owners who are the end users, public or private players interested in putting up a structure(s). The owners' interest might be extremely short term – as in the case of developers seeking to build and then lease or sell a building – or longer term, as in the case of private companies building for their own use or government organizations providing some type of public good (for instance, a federal office building housing many different agencies).

The owner, in turn, typically hires a firm to coordinate construction. Historically, this

[16] The results presented here represent my own analysis of the data and all conclusions are solely my own and not intended to represent those of William Schriver, CRA, or OSHA.

[17] Unfortunately, it is impossible, given the present data, to estimate the portion of cases involving a failure to match Dodge identifiers with IMIS records from the case where only one contractor was inspected on a project. However, comparing construction industry classifications (SIC code) of contractors receiving inspections on projects with only one contractor inspected versus multiple contractors inspected provides a glimpse into the prevalence of the problem of timing on construction sites. If the projects where only one contractor has been inspected represent a case where the Dodge/CRA system led an inspector to a site too early or too late in the construction cycle, one would expect those sites to have a relatively high prevalence of subcontractors rather than general contractors at the time of the single inspection. A review of 250 records in the data set found that 38% of projects with only one contractor inspected consisted of employers classified as subcontractors versus 22% for projects where multiple contractors were inspected.

role was filled by a general contractor (GC) who served two functions: managing the construction project and being the direct employer of the occupations that tend to remain throughout a construction project (the "basic trades," laborers, carpenters, and operating engineers). The general contractor would be responsible also for overseeing and coordinating the work of subcontractors associated with specialty trades, such as electrical, plumbing, sheet metal, roofing, and other contractors. The larger and/or more complex the project, the more subcontractors typically would be on a job.

More recently, the construction manager (CM) has emerged, often replacing the GC in its traditional role.[18] A construction manager works for the owner/developer, and coordinates with architects and engineers. Unlike the general contractor, however, a construction manager does not directly employ workers on the site. Instead, the construction manager contracts basic trades, for instance, much in the same way as it employs specialty trades.

Whether a project is led by a GC or a CM, the construction coordinator is critical in determining project costs, financing, pace, delays, and completion dates. Because each of these outcomes affects project safety and health, project-level characteristics should be considered when fashioning OSHA policies. For example, a CM managing the construction of a commercial office space for developers may have high incentives to complete the building quickly so that the developer in terms can sell or lease the property recouping the investment. This may create dynamics on the project to minimize construction time, cut corners, and finish that may, in turn, have deleterious safety and health consequences. On the other hand, a general contractor working for an end user that intends to use the property itself upon completion (for example as a research facility) may face pressure to achieve quality standards in building the project to the owner's specifications that might, in turn, provide an atmosphere more conducive to project safety and health. Characteristics of both the ownership structure and management of a project are therefore linked to safety and health outcomes.

Although projects come and go and employers remain – and one enforcement goal must be to keep track of so-called bad actors – focusing on project dynamics can buttress efforts to improve safety and health in construction.

Fortunately, because the Dodge/CRA system operates at the project level – and project-level identifiers are now being included in OSHA inspection records – one could modify the existing targeting system in several ways to take far greater advantage of its project-level roots.

One illustration of the benefits of integrating the Dodge and IMIS data sets is examining the cross-section of projects that OSHA inspects by their end-use characteristics (*see* table 4).[19] Of the 9,312 inspection reports analyzed for this study, the largest end-use type was schools /colleges and universities, followed by offices and financial buildings, and apartments and small homes. If these project types – or the GCs, CMs, or end users who managed or controlled the sites – can be correlated with risk levels, one could redirect targeting procedures in a fundamental manner.

[18] See Weil 2003 for a more detailed discussion of these changes in industry structure and their implications.

[19] The Dodge system uses a more-detailed system of classification consisting of 109 individual project types. To simplify this system, I have followed a project end-use classification system developed by Schriver in his recent analysis that aggregates these into the 36 categories listed in table 4.

Risk-based targeting

What is the proper measure of risk for construction?

The notion of targeting construction projects on the basis of risk seems self-evident: If a construction site has a higher potential level of injuries and deaths than another, one would want to direct OSHA enforcement there. OSHA has over the years drawn on this notion generally in targeting industries (including construction) with higher reported injury and illness rates. Various efforts have also been made to do so at the establishment level within industries, particularly in the manufacturing sector (GAO 2002).[20]

Once again, construction has turned out to be a more difficult area in which to apply targeting principles. For risk-based targeting, because any given construction site has a finite length of operation, it is difficult to assign it an overall injury rate (unless it is of a sufficient scale and duration that such a rate could be calculated). Even if one wanted to track the injury and illness experience at the project level, one difficulty is in establishing what party should be linked to this information: the end user (owner/developer) or the GC/CM (*see* fig 6)? Administratively, even if one could resolve this dilemma, the reality is that injury and illness rates computed by the Bureau of Labor Statistics for construction are based on contractor-level information.

This would suggest focusing risk information at the employer (contractor) level and measuring injury performance over a number of different projects. For example, many contractors (particularly larger and older contractors) have workers' compensation experience modification rates based on their past injury experience that are used to calculate workers' compensation premiums. In principle, experience modification rates could be used as a predictor of future behavior on new sites.

Several problems immediately arise around collecting contractor-level information about injury rates. Administratively, experience modification rates collected for construction employers are notoriously problematic for several reasons. First, workers' compensation systems in general tend to be imperfectly experience rated, making injury rate estimates at the high and low ends unreliable (Thomason, Schmidle, and Burton 2001). This problem is exacerbated in construction. Second, many states have separate workers' compensation structures dealing with the peculiarities of construction; those structures place employers in larger risk pools, making assessment of company-level injury-rates impossible. Third, because of the high expense of workers' compensation premiums in construction, misclassification of workers and misreporting into workers' compensation remains a widespread problem (GAO 1989, 1996, Planmatics 2000).[21]

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[20] The GAO (2002) indicates that, even in manufacturing, there have been a number of difficulties in implementing enforcement procedures that draw on establishment-level injury data for targeting.

[21] Other studies point to a related problem of relying on administrative information involving self-reporting of injury-related outcome. Ruser and Smith (1988) found consistent evidence that inspection targeting based on firm-reported injury rates (the "record check" method used by OSHA during the Reagan administration) not surprisingly leads firms to under-report injuries. This means that any system relied on for risk information must draw on data where the incentives to understate risk are low or kept in check by countervailing procedures.

Even if one could wave a magic wand and obtain accurate injury-rate information for contractors, it is still not clear that this would provide the best prospective measure. One reason is the differing interactions of contractors with one another and with the GC/CM and project owner on a given project. Anecdotal information suggests that one construction company can act differently on two separate projects. Once again, the complexity of construction project organization becomes important (fig. 6). Is the best predictor of future behavior on any site the average past performance of the contractor on a range of completed projects or the contractor's performance on sites with comparable construction management or other characteristics? This is a particularly tricky issue because significant lost-workday injuries and especially deaths from injuries often occur after a breakdown in a system of factors involving multiple parties rather than failure of a single player. Major accidents generally occur when a complex system has been pushed too far and several failures occur simultaneously (Perrow 1999).

A final, related problem is that prospective safety and health risk is not synonymous with past death, injury, and illness experience. Studies examining the relationship between past and future injury experience raise a number of issues about the usefulness of injury rates as a leading indicator for workplace risk in construction. Scholz and Gray (1990) found evidence that high injury rates in one period were negatively correlated with high rates in subsequent periods. In a study more focused on recidivism, Ruser (1995) found that establishments having injury rates exceeding the industry averages in one period tend to exhibit declining rates in the ensuing period. This is particularly true in the case of small establishments (more typical in construction), while in larger establishments a rate at one point tends to predict the future rate. Although both studies were based on data from manufacturing, the findings suggest that injury-based targeting may be more effective in some firms but not in others.

One explanation for the recidivism results is that employers use a "fire-fighting" model where an injury rate spike in one period leads management to identify a problem that has been ignored in the past. Once an injury rate has spiked, the employer provides attention to the problem until it declines, leading to a decline in injury rates after a period of high rates.[22] This implies that waiting for injury rates to identify bad players (as opposed to signals of future injury problems) may lead to shutting the gate after the animals have escaped.

An alternative method for assessing prospective risk

Given the myriad of substantive and administrative problems regarding injury and illness rates as risk predictors, what other measures of potential risk could be applied in setting regulatory targets in construction?

[22] There are other explanations for these results as well. One is that they reflect the phenomenon known as "regression to the mean" that arises in statistical processes involving sampling. An observation that is significantly above the mean in one period will tend to fall back toward the mean subsequently. Another explanation offered by Ruser for his findings is the presence of unobservable characteristics associated with injury rates. The more one knows these correlates, the better the characteristic is as a targeting instrument. The flip side is that studies like Ruser's indicate that the "hidden" covariates may be hard to find, particularly *a priori.*

One potential resource is OSHA's Integrated Management Information System, with its historical record of programmed, complaint, accident, and referral-based inspection reports. IMIS cannot, however, be treated as a scientific, random sample of workplaces.

Nonetheless, the inspection-level data could provide new insight into patterns of construction risks at the project level because Dodge and IMIS files can be linked. An alternative measure for gauging risk, then, can be constructed by linking data on contractor compliance with OSHA standards to information from Dodge on project characteristics.

Compliance can only be observed at the time of an OSHA inspection, when OSHA personnel survey a construction site. The inspector issues citations for activities at the site that do not comply with OSHA standards and then rates the violations according to their severity. Violations of standards do not always lead to injuries or illnesses. However, the number and severity of safety and health standard violations cited during an inspection provide a basis for measuring the risk to which a contractor might subject its workforce on future sites. A practical virtue of this information is that it is readily available in the IMIS system.

The standards applying to a construction contractor comprise almost 900 printed pages in the Code of Federal Regulations. Using standards as an indicator of risk only makes sense if there is an association between regulatory compliance and safety and health outcomes. Compliance with safety and health standards only affects the "bottom line" of OSHA performance if those standards relate to the real causes of workplace injuries or illnesses. Rather than looking at all construction standards, one would focus on contractor compliance with a subset of carefully chosen key safety and health standards.

OSHA should use two criteria to create "leading indicators" of risk to workers, in order to select the standards. The first should be that a standard has been consistently enforced in the past by OSHA. These should thus reflect past behavior (rather than be artifacts of particular program emphases of national, regional, or area offices). Second, a standard should be closely linked to underlying physical hazards that are, in turn, associated with injuries and illnesses. That is, the selected standards should approximate factors leading to injury and/or illness outcomes. One example of this approach is a subset of 100 safety and health standards identified by OSHA related to physical hazards at the work site (OSHA 1993).[23]

A final step would be to aggregate information across all contractors inspected on a given construction site to derive project-level measures of risk. Once again, this approach is feasible because of the recent ability to merge IMIS and Dodge-level data.

Correlating project characteristics and risk levels

A revised targeting process that uses prospective risk to workers as a criterion for selecting projects requires connecting construction project characteristics with risk measures. The project-level data set described earlier (pg.9) provides a method for doing so by using OSHA inspection-based measures of risk from IMIS and information on project characteristics from the Dodge database.

[23] This method was used as the basis for analysis of OSHA enforcement performance in Weil 2001 and described in this report, in Current Targeting Practice and Performance, above.

Methodology: For each project identified in the data set, the total violations found across all contractors on that project are tabulated. Although we do not construct the more refined measures of key standards described above, the methodology and analysis that follow could be easily applied to a more refined measure of violations. Here, we create a standardized measure of violation rate equal to the total violations found on the project as a whole divided by the total number of contractors inspected (average number of violations per contractors per project). For the whole sample, the average value for this variable was 1.3, varying from 0 to a high of 34 violations per contractor per project.

Given this outcome measure, I compare violation rates across different types of projects and characteristics of those projects. I compare the full sample of all projects as well as a subsample of projects where more than one contractor was inspected (tables 4-6). The subsample is examined because of the large number of projects where only one contractor inspection could be matched with the Dodge identification number. I also present the results of statistical modeling of the effects of a variety of different project-level factors on violation rates. This analysis is to illustrate the possibilities of using Dodge/IMIS data to identify project-level factors for use in targeting. The results are not intended to be a definitive analysis of the factors of importance.[24]

Results: Figure 7 compares violation rates (number of violations per contractor per project) for the 15 project end-use types with the highest levels of violation rates. For each project type, it presents the average violation rate for a subset of the sample consisting of only projects where more than one contractor was inspected (upper, darker bar) and for the sample as a whole (lower bar). The analysis shows that there is significant variation in the violation rate across project types. For both the subsample of projects with more than one contractor inspected and the sample as a whole, the highest violation rates are found in the auditorium/community building and shoreline maintenance/dock categories. These averages are significantly higher than the overall average violation rates for the subsample and full sample.

Figure 8 looks at the 15 project types with the lowest violation rates, again for both the subsample of projects with multiple contractor inspections and the sample as a whole. In this case, the lowest rates for the full sample are somewhat different (passenger terminals and radio towers at 0.5 and 0.7 violations per contractor, respectively) than for the multiple contractor subsample (post office buildings and radio towers at 0.6 and 0.8). Once again, there is significant variation in violation rates across the end uses with low overall rates.

A regression model was used to show the relation of multiple project characteristics and violation rates (table 5). Along with project end-use types, it also includes the dollar value of projects, the number of contractors on the project, whether the project is a single- or multistory structure, whether the end user was a public or private party, and the OSHA region where the project was located. In each case, the model estimates the effect of the project-related factor on

[24] For example, one problem in this analysis is the large number of projects where only one contractor has been identified as having had an OSHA inspection. Because we cannot assess how often other contractors were not linked to the site because of a failure to include the Dodge identification number in the IMIS file, it is not possible to estimate how representative the sample used here is of the population of project types. We discuss this problem further below.

the violation rate.[25] The statistically significant (.05 level) variable coefficients are in boldface type.

A number of results from the model command attention. First, the dollar value of the project is negatively (and significantly) related to the violation rate – that is, as the value of the project increases, the estimated violation rate decreases, holding other factors constant. This is consistent with the notion that larger projects tend to have better overall safety and health practices than smaller practices. A second variable that measures the squared value of projects is included to determine if the size/violation rate effect changes with scale. The positive and significant value of that variable implies that the size effect diminishes as projects become very large (that is, the size effect on violation rates becomes less negative as project size becomes very large), but the magnitude of this effect is quite small. Several different estimation techniques affected other variables, but the negative relation of project size and violation rates remained in most models.

The results indicate also that the private projects – projects with an end user that is entirely in the private sector – have significantly lower overall violation rates than projects with a public end user (or where public money from the state or federal level has been used).[26]

Technical features related to a project (such as, the type of structural materials used or whether the project had single or multiple stories) did not have strong relations to violation rates in the models used here, although Schriver (2003) found relationships of particular combinations of technical project characteristics.

There were significant differences across OSHA regions in average project violation rates, with regions 1 and 5 having significantly higher rates of violations than the omitted regional category (regions 8 and 10) and region 7 with significantly lower rates. This type of finding is consistent with other OSHA studies which show similar variation in violation rates arising in part from different enforcement procedures across regions as well as from variation in unmeasured project characteristics also associated with location.

Finally, table 5 shows that certain end-use types have higher violation rates than others, even after controlling for other characteristics of a project. For example, in the full sample, shoreline and dock facilities, sewage treatment plants, chemical and water tanks, military facilities, police stations, religious buildings, hotels, apartments/small homes, and auditorium/community buildings all have higher violation rates than the omitted categories, even after controlling for other factors.

Nothing inherently would suggest that one end-use type would tend to have higher or lower rates than others, and it is also possible that rankings would vary across time and localities. One need not have strong theoretical predispositions regarding the relative hazards of certain types of projects of end uses for results to be useful from a targeting perspective. The

[25] The estimates are based on a Tobit regression model. A Tobit model is used for estimation purposes because of the large number of projects where there were zero violations cited by OSHA. Because the value of the dependent variable cannot go below 0 and there are a large number of these observations, the dependent variable is left-censored leading to biased estimates for the independent variable using ordinary least squares procedure. In the Schriver (2003) study of the same data, he models violation rates as a dichotomous (0/1) variable, where the outcome is defined as the presence or absence of any violations. The results might not hold in a changed analysis.

[26] Results are available from the author.

information on the association of end-use type and violation rates, as well as other project characteristics, can be used as tools to redirect targeting efforts toward particular sectors, led by past history of the associations.

Other potential project factors might be associated with violation rates in future analyses, once merged samples like the one used here have been assembled and analyzed. One factor of particular potential use is the association between certain project managers (GCs and CMs) and end users (public or private) in a region and violation rates. It is possible in principle to create project-level variables for ownership type or project managers in a region (for example, classifying public projects by the type of bidding procedure used to allot work or private users by whether a project was intended for their own use or for resale/leasing) and gauge their relation with violation rates. Or, it might be possible in certain regions to even capture the relation between a particularly dominant end user or project manager and violation rates on projects owned or managed by that party. Given the importance of coordination, examining these relationships could provide further insight into prospective project risks, based on past experience, and would rely on data already captured in the Dodge and IMIS systems.

Efficacy-based targeting

The final targeting principle focuses on the willingness of contractors to change behavior once they have been targeted for inspection. Measures that capture regulatory efficacy address the question that, once a problem has been identified in an industry or with an employer, exactly how much resistance would OSHA face in trying to solve it?

As discussed above (page 6), there is evidence that many of the large, nationally based contractors targeted by the existing system appear to be unwilling to change behavior, even given repeat inspections across several projects or even within one project. This result has been found elsewhere among large employers who tend to be at higher states of compliance with workplace regulations and, having attained these high rates of compliance (*see* Morantz 2001; Stanley 2000; Gray and Mendeloff 2001), seem reluctant to improve behavior. Regulatory efficacy also raises the question of the characteristics of employers or projects that might lead them to be more responsive to regulatory intervention. Faced with two projects with comparable levels of risk, where intervention in one was more likely to lead contractors to clean up their act compared with another where the players would be unwilling to change, a prudent regulator would select the former project over the latter.

Evidence from the regulatory literature provides some guidance on company characteristics that might be related to efficacy. Studies on OSHA, for example, indicate that employers who have not been inspected and tend to think about themselves as flying under the radar screen are very responsive to enforcement once they are found. This "bolt from the blue" effect can be a powerful mechanism to shift safety and health behavior (Weil 1996, 2001; Morantz 2001; Stanley 2000). Yet, the survey by the OSHA Targeting Task Force found that area offices were particularly critical of the Dodge/CRA system because it rarely led to inspections of "new firms" which, by extension, mutes the potential bolt-from-the-blue effect (*see* figs. 4 & 5).

Project-, rather than contractor-level focus, is another factor that is important in terms of efficacy. Because a project owner, GC, or CM can set the overall tone and incentive structure on a construction site, finding out more about their responsiveness to OSHA interventions specifically and the factors that influence their decisions more generally is key to trying to reduce site-level risks. Just as one needs to characterize the overall level of risk by project type, as illustrated above, one similarly needs to develop a better understanding of the relation between project and project-manager characteristics and responsiveness to regulatory pressure and other instruments of intervention.

A final class of employers should be cited in crafting efficacy-based targeting systems. A 2003 *New York Times/Frontline* series profiling widespread, pervasive, and willful violations of OSHA standards, as well as other workplace and environmental regulations, by McWane Inc.– a major producer of industrial pipe – which highlighted the existence of U.S. firms that continue to flaunt even basic workplace protections and whose behavior will change only given protracted and intense pressure from regulators.[27] In response to the McWane revelations, OSHA has instituted new policies (including the construction sector) seeking to identify such extreme cases and bring significant regulatory pressure on them. A final aspect of an efficacy-based targeting policy would be to explicitly incorporate information on the presence of bad offenders into targeting protocols (*see* below).

Targeting Inside and Outside the Existing System

Alternatives using an amended Dodge/CRA system

Any realistic modification to the existing targeting system must do so with the recognition that the Dodge/CRA universe will remain the starting point for the foreseeable future. As a result, any procedure for targeting must draw on information that can be found *prior to* identification of projects for inspection and using criteria that could be identified using project-level fields available in the Dodge system.

The previous sections imply that, by combining historic information from IMIS with information on projects from the Dodge system, there are ways to identify factors related to overall construction management, risk exposure, and efficacy of inspections that could move the system away from its present focus on project scale. This might be achieved by modifying OSHA's current system in four ways.

Project-type targeting. OSHA could undertake region-based analyses based on data collected over the preceding 2 to 3 years that would associate different end-use types with violation rates of key OSHA standards (using a framework similar to the foregoing analysis). The OSHA analysis would be used to identify a subset of project types in a given region that have had higher rates of violations than others for the past few years. We illustrate this type of analysis using regression results for regions 2 and 3 (table 6). The analysis shows both project characteristics that are commonly associated with violation rates (such as, the significant and

[27] *See* PBS *Frontline,* A Dangerous Business, January 2003 (www.pbs.org/wgbh/pages/frontline/shows/workplace/). *See also* David Barstow and Lowell Bergman, At a Texas Foundry, An Indifference to Life, *The New York Times*, January 8, 2003, p. A1, www.nytimes.com.

negative relation of project size and violation rate) and those that differ across regions (for instance, end-use types with significantly positive associations with violation rates). On the basis of regional models like those in table 6, the Dodge /CRA system could create a universe that over-sampled for those end-use sectors most problematic for a region.

Size-based targeting. Studies conducted using a variety of data sets (including the analysis presented in this section) suggest that large projects tend to have lower safety and health risks. Large projects remain an area of concern for OSHA because of the large numbers of workers in each of those projects. Yet the evidence strongly indicates that some type of reverse weighting procedure that would raise the probabilities of project selection for smaller projects seems appropriate. Dodge/CRA could therefore experiment with a project weighting scheme that incorporates some form of inverse weighting based on size (within the Dodge sample).[28]

Targeting by type of management or end user. The Dodge/IMIS data could be analyzed further to explore using certain common features of project management and project ownership as factors in targeting. This approach might include more-refined classification of end users in terms of their status as developer or ultimate user of building projects; classification of project managers in terms of their status as general contractors or construction managers; and public end users according to the type of bidding procedure used to award work. On a regional basis, analysis should be undertaken to find possible correlations between specific developers/construction managers/general contractors in an area and violation rates. Information on end users or CMs or GCs with particularly high or low rates of violations on jobs could then be used with other criteria to create the inspection universe.

Worst-offender targeting: In keeping with concerns about particularly egregious violators, OSHA could identify construction managers, general contractors, or end users associated with major accidents/deaths over the previous 5 to 8 years. This effort would require use of the Bureau of Labor Statistics Census of Fatal Occupational Injuries (CFOI) or OSHA's fatality database (part of IMIS) to find the list of "worst offenders." Once created, the worst-offenders list could be incorporated by Dodge/CRA while creating targeting lists for area offices. The targeting could specify that all projects owned by or employing worst-case offenders would be included on the targeting lists.

Combining targeting methods: The above four methods could be combined in different groupings as the basis for modified procedures for targeting in different area offices. Part of the groupings could be done on the basis of available information (that is, the current ability to undertake the requisite analysis might be more or less feasible given the reliability of IMIS data – in particular the use of Dodge identification numbers in reports – in regions). More importantly, they could be combined in different ways to allow systematic evaluation on their ability to improve targeting outcomes over the present system (*see* Designing a Pilot Study, below).

[28] Ringen advocated a similar modification based on his analysis of regional data in 1999.

Alternatives outside of the Dodge/CRA system

There are several additional ways to change the targeting system to better attain the principles of targeting described at the outset. As these methods involve the use of systems outside of Dodge/CRA, they are probably not feasible in the short term. Nonetheless they should be considered as alternative procedures to Dodge/CRA (or as adjuncts to that system) in the longer term.

Targeting of residential housing

Starts of single-family homes reached 1.27 million in 2001, amounting to a total value of $206 billion (Joint Center for Housing Studies 2002). The scale and extent of the residential housing sector and OSHA's historic lack of attention to it have been an area of concern in and out of the agency. An effort mediated by the late John T. Dunlop and involving OSHA, the National Association of Home Builders, and the Building and Construction Trades Dept, AFL-CIO, identified OSHA standards and training programs applicable to residential construction (Coulton 2003). The current programmed inspection procedure, however, virtually ignores the sector in establishing inspection priorities. This, in part, arises from the spotty inclusion of the residential sector in the Dodge system, as well as the difficulty in efficiently inspecting residential projects from the point of view of OSHA.

OSHA has tried using local emphasis programs to identify and target residential construction. In addition, other sources of data regarding residential sector activity in particular areas of large-scale activity (residential developments) should be carefully evaluated.

The home building sector is undergoing considerable regional consolidation (Roth 2003). Because of this trend and the lack of sustained OSHA enforcement in the sector to date, a pilot targeting effort could initially focus on large-scale homebuilders (similar to the logic underlying the current system in its early days). Undoubtedly, early efforts would require developing models to ensure that timing of OSHA inspection would coincide with selected construction activity, given that homebuilding involves different scheduling than that followed by other types of projects.

Targeting based on project stage

As noted, different stages of construction entail different risk levels. An alternative method for setting regulatory targets would be to focus enforcement activity at those stages of a given construction project when safety and health risk exposures are highest. For example, this would be when roofing activities are being undertaken in residential work or steel erection in multi-story, commercial building. The OSHA project-level data provide some information relating to correlates of technical aspects of construction and the number of violations found during contractor inspections. Using information from the Dodge/CRA system on project start dates and OSHA/IMIS data regarding when inspections were conducted, some evaluation could be done to find correlations between violation rates and different stages of construction. This analysis could be done for end uses consistently associated with higher rates of violations.

The difficulty of predicting true construction start dates and projecting construction phases might hamper this approach. As noted, CRA has developed methods to improve the accuracy of predicted start times (Construction Resources Analysis 1997). Despite the use of more-refined models, OSHA area office respondents in the 2003 Targeting Task Force survey continued to report that lists included sites that had not yet started construction. Even with more-accurate prediction of start times, many factors – particularly weather – would make construction phase targeting difficult to implement without some type of follow-up data on actual progress.

Given these limitations, project stage-based targeting, although desirable, is not likely to be used in the near future. Conducting further research on the association of different stages of project construction and safety and health risk, however, should be pursued so that this method might be used if better models to predict construction project progress could be created.

Using local emphasis programs for targeting

A wide range of local emphasis programs in OSHA area offices are attempting to use other means outside of the Dodge/CRA system for identifying safety and health problems in construction (*see* Current Targeting Practice and Performance, above). The 2003 survey found that area offices using a variety of LEPs have found them a useful supplement – and in some cases a substitute for Dodge/CRA. As such, LEPs bear further scrutiny and evaluation (*see* pg. 7, above). The OSHA Targeting Task Force is cataloging local emphasis programs in use. OSHA should consider expanding successful LEP approaches to other areas and regions as part of a larger evaluation of new methods of undertaking construction enforcement targeting.

Implementing the targeting options

The three potential alternative methods for targeting inspections, with some additional analytic work, could be incorporated into the existing system of inspection targeting. Other targeting alternatives focusing on homebuilding and on particular phases of construction projects could be developed in the medium-to-long term. In all cases, these alternative forms of targeting could be tested against the existing system as part of a systematic evaluation process.

Designing a Pilot Study to Evaluate Targeting Alternatives

Rationale for pilot studies

The desirability of alternative methods for targeting construction inspections rests on their ability to improve safety and health at construction work sites relative to the present system. At issue is, How might OSHA design pilot studies that could assess the performance of different methods of targeting programmed OSHA inspections?

Classic experimental design

Experimental designs are most commonly used in medical research where they are used to evaluate the performance of new drugs, treatments, and other interventions on health outcomes (for instance, Cook and Campbell 1979; Boniface 1995; Selwyn 1996). The classic experimental design is a double-blind clinical trial. In this design, the effects of a treatment (for instance, a new pharmaceutical product) are assessed by testing it on a sample of patients, representative of the population that would ultimately use the drug. In the sample, patients are randomly assigned to a treatment group or a control group. The treatment group receives the drug during the experiment, while the control group receives a placebo that looks identical to the treatment but has neutral medicinal value (such as a sugar pill). Random assignment to control and treatment groups is critical so there is no interaction between who receives the treatment and who does not that might influence the health outcome.

Classical experimental design is dubbed “double-blind” because neither the patient nor treatment administrators know who receives the true treatment and who receives the placebo. This further ensures that the measured treatment effect truly measures the treatment rather than unmeasured effects (even inadvertent ones) of those administering the experiment on the treatment or control subjects. Once the experiment ends and the code regarding who received the true treatment is revealed, relevant measures of health status are tabulated and compared to health at the beginning of the trial for both groups. The difference between the change in health status for those receiving the drug and those in the control group can then be calculated. The difference between the treatment and control groups’ changes in health can then be attributed to the treatment itself, because all other confounding factors (such as, the individual physiology of patients and the natural change in health observed over time) have been held constant by the experiment’s design.

Can an effective experimental design be applied to the evaluation of a regulatory intervention like inspection targeting? The idea of an experimental design is attractive because it allows one to isolate the effects of a change in regulatory policy from other factors that also can influence safety and health. However, the context of regulatory policy is far different than medical research, making it difficult to recreate the controlled circumstances possible in medical science.[29] Different areas of public policy research have used experimental design (or modified versions) to test welfare policies, Head Start programs, job training, and, most recently, school vouchers.[30] Still, applying experimental design to the regulatory arena would be novel.

[29] Even in medical research, conducting true double-blind clinical trials has proven difficult, partly because of the costs involved and because of ethical controversy regarding random assignment of individuals to control and treatment groups.

[30]There are many examples of using randomized experiments to test social programs. Examples include welfare-to-work and job subsidy efforts (such as, Dubin and Rivers 1993; Katz, Kling, and Liebman 2001; Bloom, Hill and Riccio 2003), job training (LaLonde 1986; Bloom and others 1997), and educational vouchers (Howell and Peterson 2004).

A proposed experimental design for evaluating targeting

The focus for pilot studies would be OSHA area offices. Rather than simply piloting new methods of targeting inspections in any area office that chooses to apply them, an experimental design would set up the pilot efforts in such a way that the effects of the new methods could be compared to the existing system. The "treatment" would be the new types of targeting methods described in the previous section, particularly new methods of using the Dodge/CRA system. The "control" group would be area offices using the existing Dodge/CRA targeting system.

For institutional and practical reasons, of course, a "pure" experimental design could not be put in place in the pilot study. But it might be possible to emulate many of the aspects of experimental design and therefore achieve many of the benefits of such an approach.

Selection of area offices

The first problem that arises in applying an experimental design structure to pilot efforts involves the choice of area offices. The survey results described earlier indicate that most area offices use the Dodge/CRA system at least as a component of programmed inspection planning. Only about 11% reported not using the system in any way. On the basis of discussions with OSHA staff in area offices and in Washington, D.C., it is evident that gaining the upfront cooperation of area officials and staff would be crucial to any pilot effort; thus there might be a bias in the relative enthusiasm of offices that agree to participate. While the group of survey respondents might not be representative of the population of area offices, they can be thought of as the sample frame for the pilot effort.[31] For control and treatment groups, one could use the area offices that indicated that they use the Dodge/CRA system in some form, if they were willing to participate in the pilot effort.

Treatment groups

Dodge/CRA list treatments

The treatment groups for the study would fall into two categories. First would be offices that are currently using the Dodge /CRA system and would continue to do so, albeit in a modified form. That is, this group would continue to receive their Dodge lists as under the present system, but would use a targeting method drawing on one or more of the procedures described above. Ideally, area offices would not be able to detect whether selection criteria used in generating their lists had been altered. By masking the method used to generate monthly inspection lists, the pilot would more closely conform to the "double-blind" structure of experimental design.

[31] It is likely that area offices that responded to the Construction Targeting Task Force survey were more interested in the targeting issue (as shown by their willingness to fill out the survey) and therefore more likely to use the existing system.

Depending on the number of area offices and the length of the pilot efforts, the study could use a number of combinations of targeting criteria (discussed earlier).

- Project-focused targeting, based on area- or regional office experience
- Size-based targeting (weighting larger projects less than medium and smaller projects)
- General contractor-based targeting, based on prior GC/CM performance
- Worst-offender targeting (worst-case GC/CM and contractor behavior).

It seems unlikely, however, that there would be enough area offices resources to test all relevant combinations. An alternative would be to select "bundles" of alternative targeting methods as treatments. For example:

- Project-type targeting: Combine project-weighted targeting and size-based targeting
- Project-type and management targeting: Combine all four criteria in compiling lists.
- GC/CM-focused targeting: Combine "worst offender" and GC/CM performance targeting

Other treatment groups

The other type of treatment would use methods for selecting projects outside of the present Dodge/CRA system. One set of treatments are some local emphasis programs already under way that target on the basis of specific sectors (such as, residential), contractors, or types of problems (for instance, falls). The LEPs chosen for the pilot evaluation might be established rather than newly instigated LEPs in participating area offices. By using LEPs that have already been in place for some time, the pilot evaluation would capture effects related to the protocol rather than start-up or learning-curve effects.

A related set of treatments would use new methods to target specific sectors or stages of construction. The section, Targeting Inside and Outside the Existing System (above), outlined uses of Dodge information to target the residential sector and to target by project stage. In the former, Dodge and CRA might seek to create a procedure similar to the existing system but directed specifically at the residential sector – particularly the larger end of that industry to begin. In the latter, Dodge and CRA would refine the prediction methods to emphasize certain phases of construction, based on assessment of risk profiles. The stage during which to concentrate inspection activity would differ by project type.[32]

Other targeting procedures not tied to the Dodge/CRA system (for example, lists that target smaller residential construction projects not usually listed by Dodge) could also be used as treatments. Obviously it would be impossible to mask the use of these targeting methods from the area offices employing them, but such an effort could still provide insights.

[32] As noted, targeting based on project phase is the most speculative form of targeting at this time and would require further evaluation of both the relationship between worker risks and construction phase by project type as well as refinement of CRA estimation methods of project completion. As a result, this type of targeting effort might not be tractable in the near term, but could be tested at some future time using similar procedures.

Treatment procedure

The area offices chosen as treatment sites would follow existing Dodge/CRA or LEP protocols throughout the pilot period. These offices – and those in the control groups – would not use their own deletion criteria, such as projects below a given dollar value, during the pilot study. Following the existing protocols would ensure a common basis of comparison and once again mask for those using Dodge/CRA lists their status as either a treatment or control group area office participant.

Control groups

The control groups for the pilot effort would be some area offices that have already been using the Dodge/CRA system for programmed targeting. These offices would continue to receive periodic Dodge lists, although they would not know whether those lists had been altered by some of the new targeting methods – and thus whether they were control or experimental groups. They would therefore continue to conduct programmed inspections as in the past.

The only change for the control groups would be the need to create standard selection criteria across the participating area offices. In particular, a common project size cutoff would need to be established across the groups, because of the importance of these size cutoffs to the types of projects included.

Outcome measures

Given OSHA's purpose – to improve workplace safety and health – it would seem that injury/illness rates should be used as an outcome measure for the pilot study. Changes in injury and illness incidence could be charted for the projects inspected, and the effects of different targeting methods on injury and illness incidence charted.

However, injury and illness measures are not advocated for this pilot study for several reasons. First, the pilot studies will necessarily be of limited duration. Because of the highly random nature of injuries and the longterm nature of occupational illnesses, the time frames for the study and the number of workers covered likely would be far too small to pick up measurable effects on these rates. Second, optimal targeting policy should not only affect the projects that are directly subjected to OSHA inspection; it should also affect the incentives for compliance on non-inspected projects through deterrence effects. The relevant area to gauge change in behavior arising from inspection activity is therefore the area rather than only inspected sites. Outcome measures must therefore be taken for a representative sample of projects for the region as a whole. Although one could take examine injury and illness logs from a representative cross-section of sites for the study period, the relatively short time horizon of the pilot study would once again make it difficult to discern program effects.

A wide variety of workplace conditions and practices affects the probability of injuries and illnesses. Rather than focusing on cases where the risk of injury has resulted in an actual injury – a difficult connection to establish – one might measure the risk level itself. That is, one could devise measures of the proximate causes of injury and illnesses, particularly those that are most directly influenced by OSHA. One way to do this would be to measure project-level compliance with a similar subset of OSHA safety and health standards most closely related to physical hazards and injuries and to occupational illnesses that were discussed in regard to risk-based targeting (above). Rather than measuring the incidence of injuries, the outcome measure of interest would be the average incidence of violations of key standards on representative projects in a given area.[33]

Creating this measure to gauge the performance of alternative methods of targeting would require two components. First, a sample of representative construction projects would need to be identified, separately from the construction targeting protocols. These would be sites selected to gauge the level of safety and health risk at a representative cross-section for the area office. The procedure to identify these project sites would be the Dodge/CRA system.

Second, sites selected for gauging compliance would receive an OSHA inspection focused on a small number of carefully chosen construction standards closely related to physical hazards and occupational illnesses. As in the Dodge/CRA general protocols, the inspection would occur at the peak of construction activity for the given project. The inspection would be limited to assessing the incidence of key standard violations across the contractors at the site at that time. The incidence of violations (violations divided by some standardized measure of project scale) would be gathered for a set of identified projects at the beginning of the pilot period and again at the end of the period.

The Wage and Hour Division of the U.S. Department of Labor has been using a related approach to gauging program success in efforts to improve compliance with minimum wage, overtime, and child labor standards in the apparel industry. In that effort, the Wage and Hour Division since 1997 has been undertaking inspection-based surveys of randomly selected contractors in New York City and Southern California. The surveys assess compliance with the Fair Labor Standards Act for a limited time – far less than in normal investigations undertaken by Wage and Hour investigators – as a means of getting an independent measure of typical employer compliance with those laws. Like the outcome measurement process advocated above, this requires randomly selecting a representative set of contractors from the population of covered employers in the area, and then administering focused surveys of those contractors.[34]

Evaluating program success

Using outcome measures from the inspection-based surveys, OSHA could calculate the average incidence of violations of key construction standards on projects in area offices in the various treatment groups and in the control area offices. As noted, incidence levels would be measured at the beginning and the end of the trial period for participating offices. Program effect would be measured as the change in incidence in treatment groups relative to change in incidence among controls.

[33] This is related to the approach taken to measuring the impact of construction inspections retrospectively in my prior studies of OSHA enforcement (Weil 2000, 2001).

[34] Contractors found in violations of the Fair Labor Standards Act during these inspections are still subjected to penalties and additional follow-up by Wage and Hour. However, the inspection-based surveys are administered and tracked separately from the main enforcement program (Wage and Hour Division 2001).

In those cases where the treatment consists of inspections focused on particular sectors (such as, residential), treatment and control-group measures would be taken for a representative sample of those types of construction projects only. Nonetheless, cross-project comparisons could be made based on percentage rather than absolute reductions in incidence over the study period.

By evaluating performance at the area office or regional level (rather than only at sites that have been inspected) the trial would be measuring the direct and indirect effects of OSHA on injury and illness risk exposure. This is important because a well-designed inspection targeting system should provide incentives to construction contractors and project coordinators to not only reduce safety and health risks retrospectively (via direct inspection impacts) but more importantly prospectively (through deterrent effects).

The results of the proposed study would need to be evaluated carefully in terms of their application to non-participating area offices, particularly those that have resisted use of the present Dodge system. The pilot design described above uses the subset of OSHA offices currently participating in a Dodge or LEP program for targeting. Although the results might be applicable to other offices that have shown such an interest, OSHA would need to understand that study results might be less applicable to offices that are unwilling to use even the existing system. The agency would need to overcome institutional resistance and barriers that go beyond the scope of an experimental pilot program.

Costs and benefits of the pilot experiment approach

An experimental approach to pilot targeting programs can reap benefits. Through careful assignment of area offices to treatment and control groups, the effects of different forms of targeting on outcomes can be discerned from other factors that might influence safety and health outcomes, but are unrelated to targeting. The experimental approach would therefore provide much more clear guidance on which targeting methods are most desirable on a national level than would be available from simply piloting different methods without an overarching experimental design.

Because the pilot study would be testing several treatments/protocols, the program results might also point to the usefulness of different targeting protocols, given different circumstances. This information would allow OSHA to better direct its limited enforcement and consultation resources across area offices more efficiently and allow it to ensure that inspections move toward construction workplaces having greater safety and health risks.

The experimental design approach to pilot efforts is consistent with the growing emphasis on performance-based assessment, planning, and budgeting arising from requirements of the Government Performance and Results Act passed by Congress in 1993 and more recent initiatives from the Office of Management and Budget. Both congressional and executive office efforts (that began in the Clinton administration and continue in the current administration) emphasize the need to connect regulatory inputs and performance outcomes.

There are added costs of using an experimental approach relative to simply piloting new methods outside of such a structure. Under the experimental approach, it would be essential for the trials to be carried out for a sufficient period of time to ensure that treatment effects (if any) could be discerned – even with the use of intermediate risk-exposure measures described above rather than injury and illness rates. The experiment would require a firm commitment from those area offices that are using the Dodge system or LEPs to participate for a prescribed period of time.

The experiment would require additional resources for the supplemental “inspection-based ” monitoring surveys to be conducted. Inspection-based surveys require allocating inspector time toward an activity related to, but different from, normal inspection activity. This additional requirement might meet resistance from both OSHA compliance officers and area- and regional-office leadership already facing tight constraints on their resources. The effort would require careful consideration, as well, of the relation between inspection-based survey activity and subsequent enforcement action and targeting.

Concluding Thoughts

Given the prevalence of severe injuries and deaths in the construction sector, improving safety and health in the construction industry must be an important component of future efforts to address workplace conditions in the United States. OSHA policy is only part of the overall system that produces safety and health outcomes. Yet this study argues that, for its part, OSHA could contribute more by addressing its procedures for selecting work sites and targeting its limited resources.

This study framed policy options to improve the present system. But rather than generating alternatives without acknowledging real-world conditions, This analysis has tried to fashion alternatives that could operate within the boundaries set by significant and persistent legal constraints, data limitations, and organizational realities. Like it or not, *Marshall v. Barlow’s* will remain the guiding principle of acceptable targeting protocols, although we have argued that a “neutral and documented” system can include a highly modified use of Dodge/CRA. Like it or not, data limitations will continue to make the Dodge lists and CRA-projected construction start dates the basis of generating inspection universes, although those data could be augmented and used to better focus OSHA resources on sites that have the most pressing problems. And like it or not, OSHA will internally and externally continue to be judged (and judge itself) on the basis of a regulatory model designed for the manufacturing sector, although reform could be introduced that would move that model closer to the realities of twenty-first century construction.

An opportunity exists to advance safety and health policy in construction in a way that allows experimentation and learning alongside improvements in safety and health outcomes. In following this path, OSHA could not only set an example for new ways to undertake its mission within the agency, but also forge a new way of exploring regulatory alternatives more generally.

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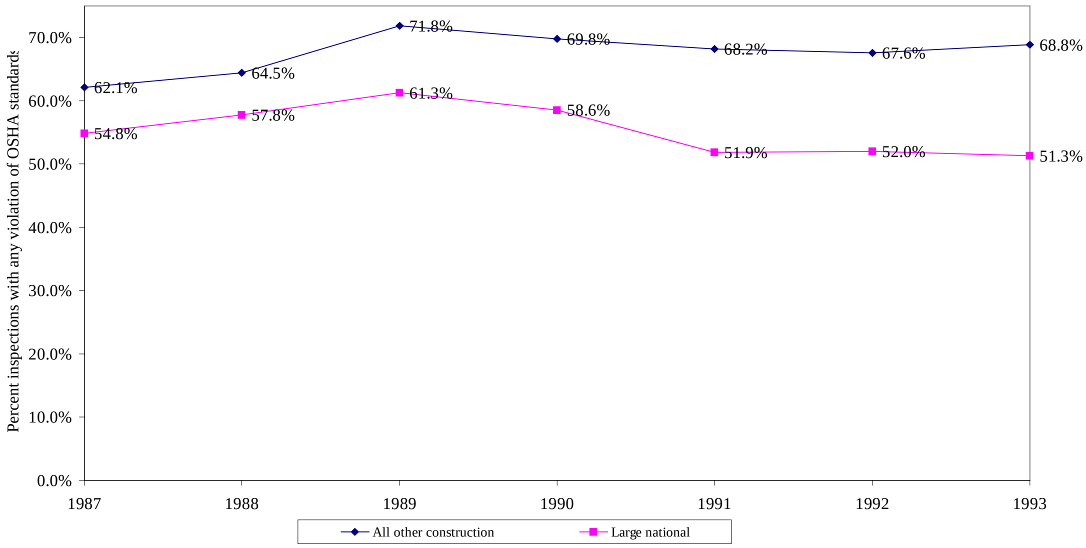
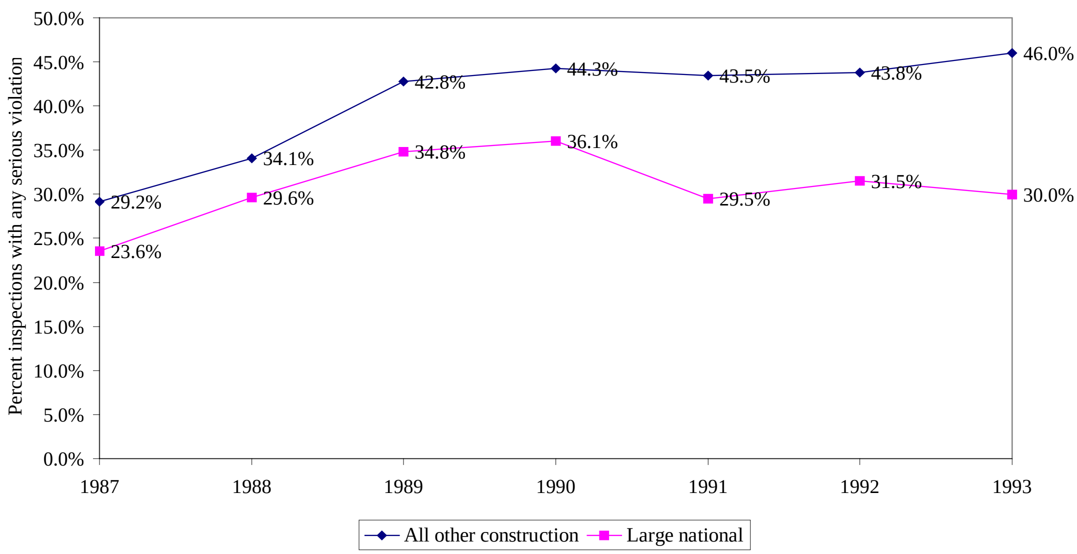
Figure 1: Percentage of inspections with violations of OSHA standards

Percent of OSHA Inspections with Any Violations of OSHA Standards:
Large national contractor sample vs. all other construction inspections, 1987-1993



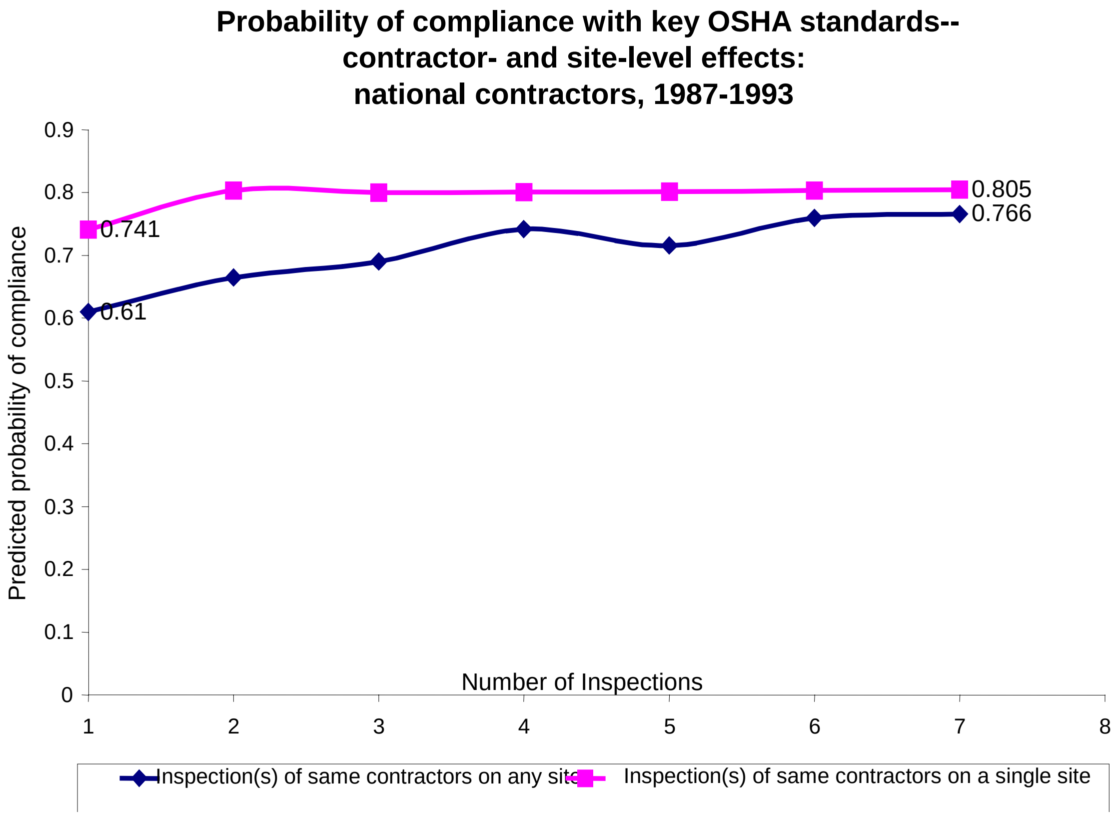
Note: Figure compares all OSHA inspections less national sample with the national sample

Percent of Inspections with any Serious Violations:
Large national contractor sample vs. all other construction inspections, 1987-1993



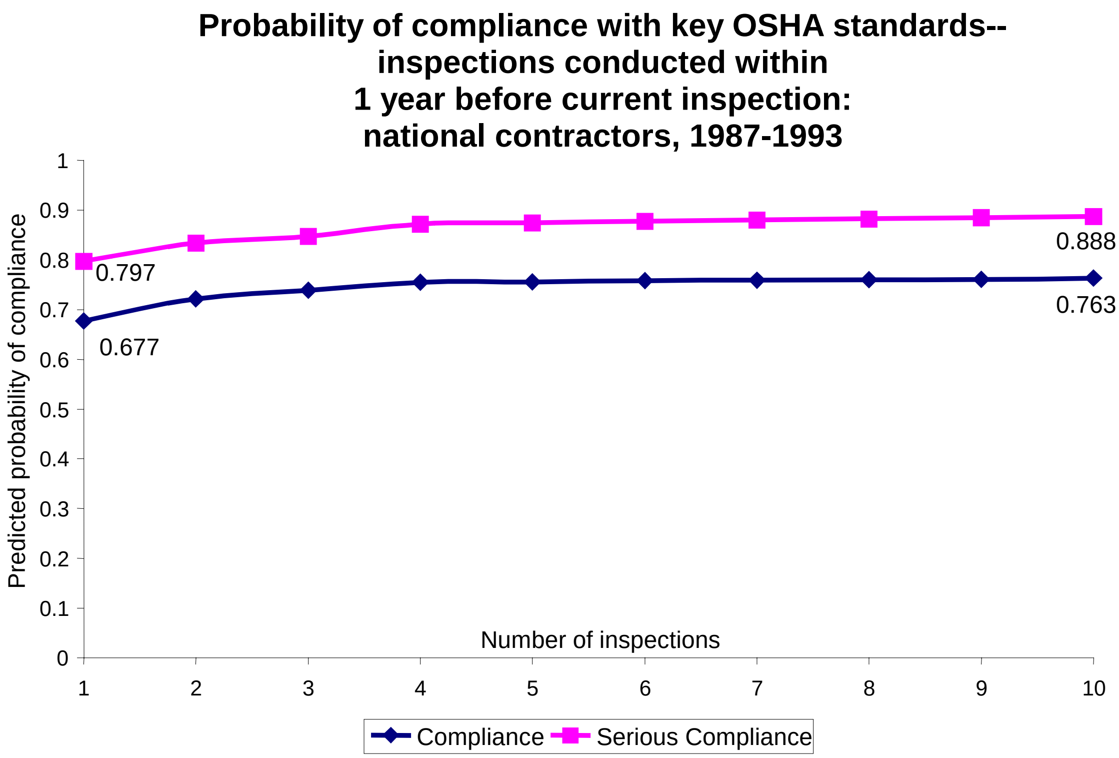
Note: Figure compares all OSHA inspections less national sample with the national sample

Figure 2: Effects of site- and contractor-level inspections on predicted compliance with key construction safety and health standards, 1987-93



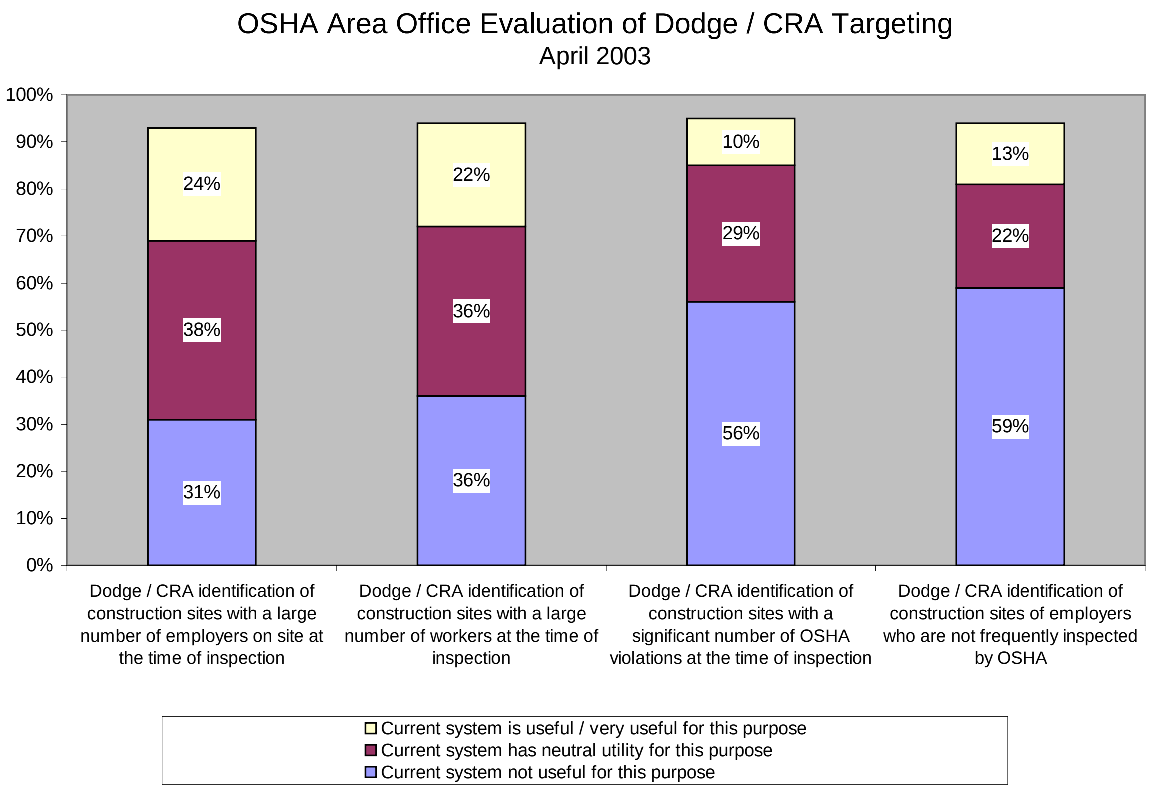
N= 2,060 contractors.
Note: Compliance defined as no violation of any key OSHA standard.
Source: Based on estimates in Weil 2001.

Figure 3: Effects of recent contractor-level inspections on predicted compliance with key construction safety and health standards, 1987-93



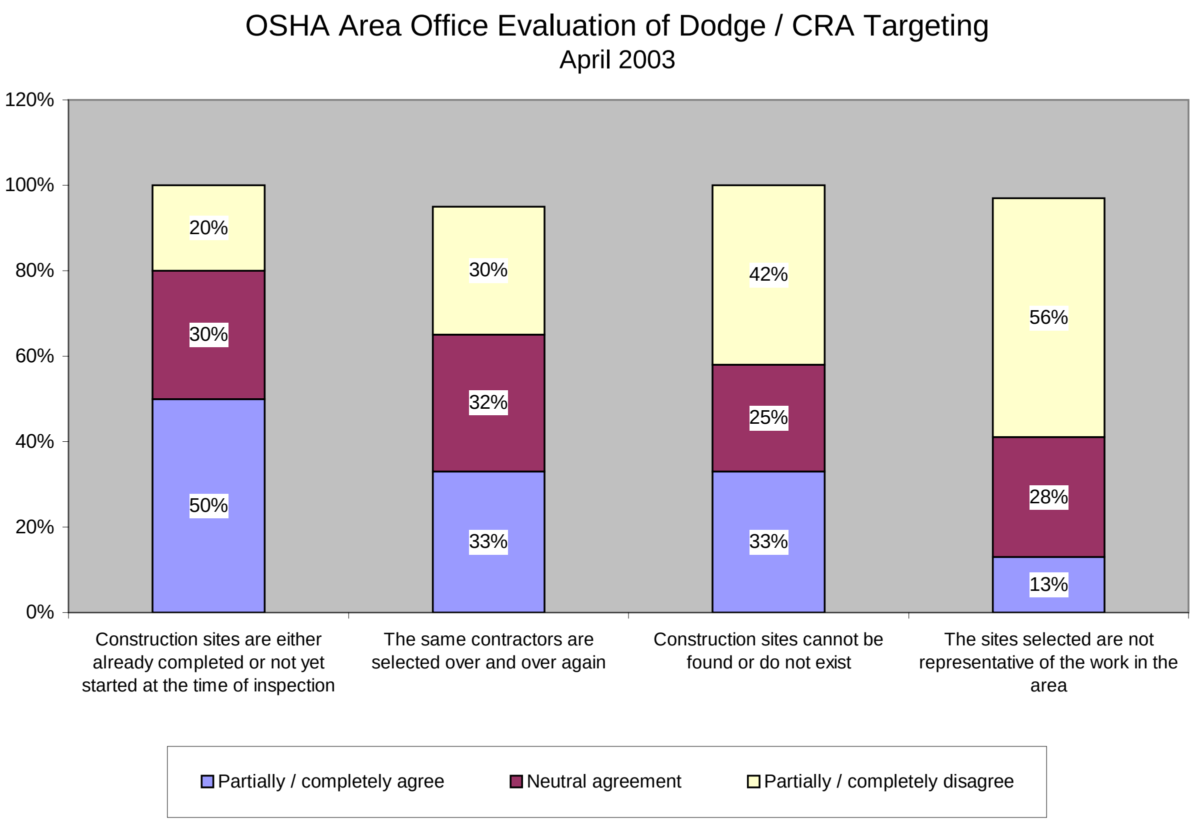
N = 2,060 contractors.
Note: Compliance defined as no violation of any key OSHA standard; serious compliance defined as no serious violation of any key OSHA standard.
Source: Based on estimates in Weil 2001.

Figure 4: Evaluation of Dodge/CRA Targeting Methods



Note: Percentages do not add up to 100 where some respondents answered "not applicable" or were unable to answer a question.
Source: OSHA Targeting Task Force survey of area offices, April 2003; data provided to the author by permission of OSHA.

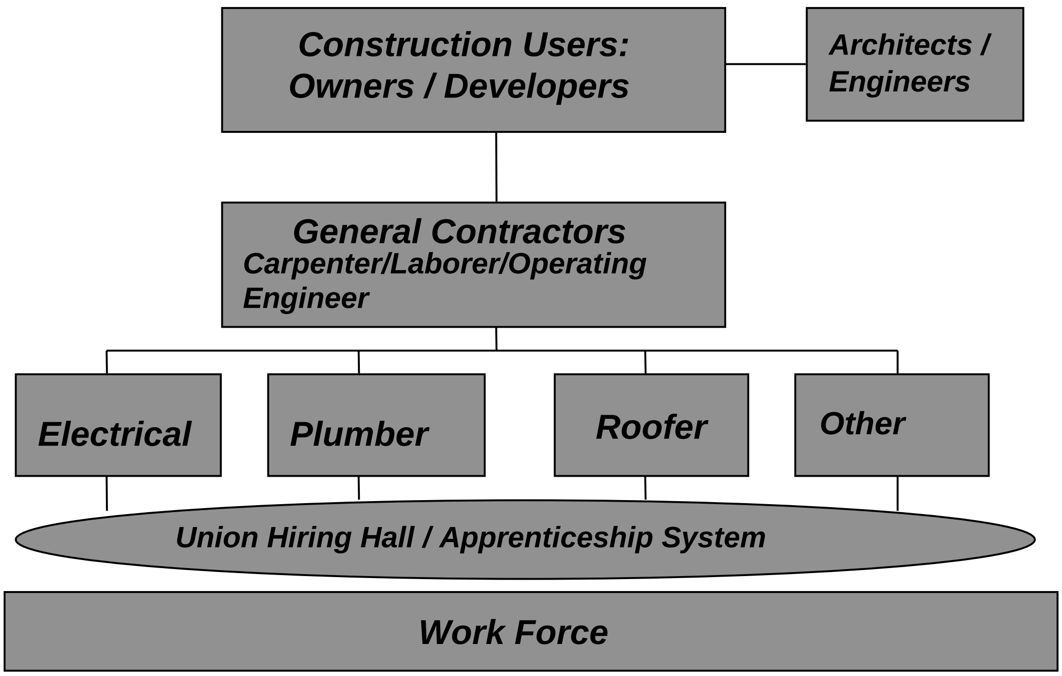
Figure 5: Cited Problems of Dodge/CRA Targeting Methods



Note: Percentages do not add up to 100, because some respondents answered "not applicable" or were unable to answer a question.
Source: OSHA Construction Targeting Task Force survey of area offices, April 2003; data provided to the author by permission of OSHA.

Figure 6: Organization of construction projects—General contractor versus construction manager

General contractor coordination



Construction manager coordination

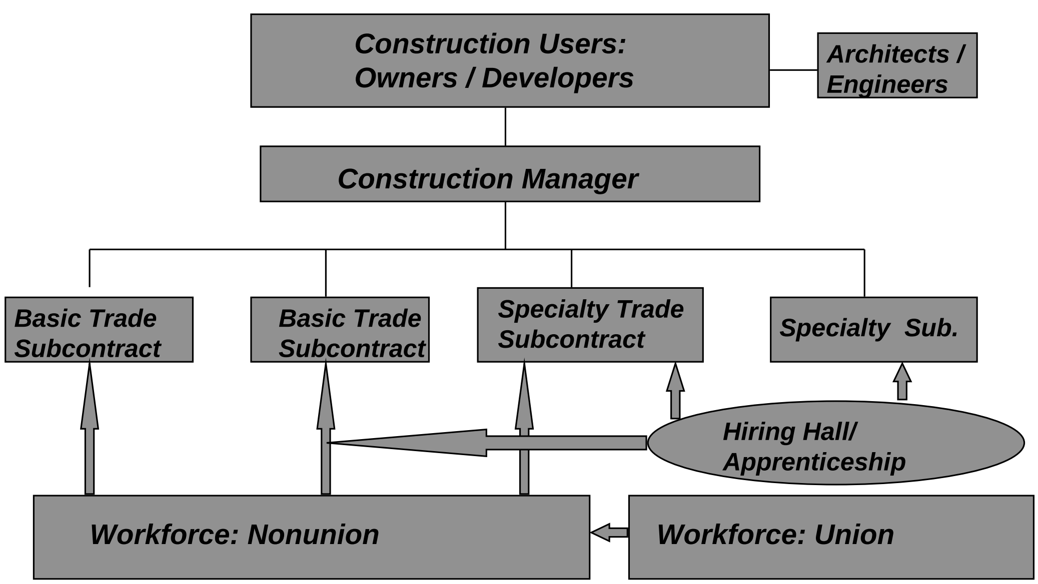
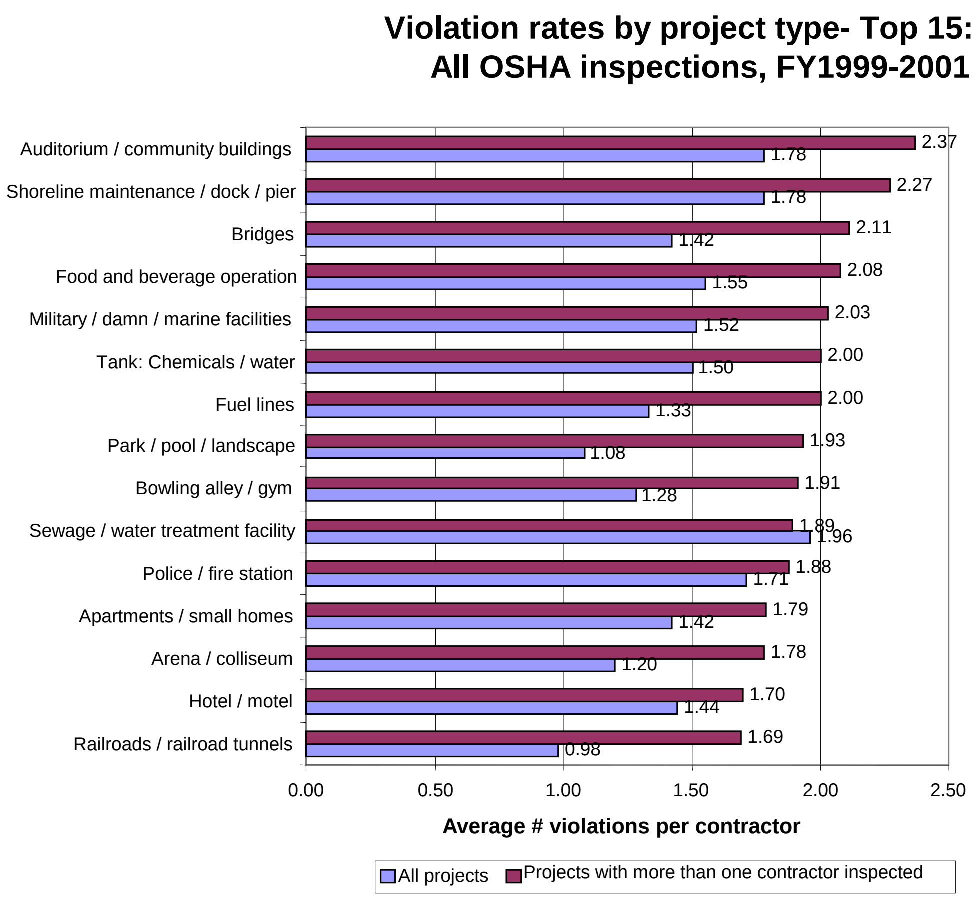
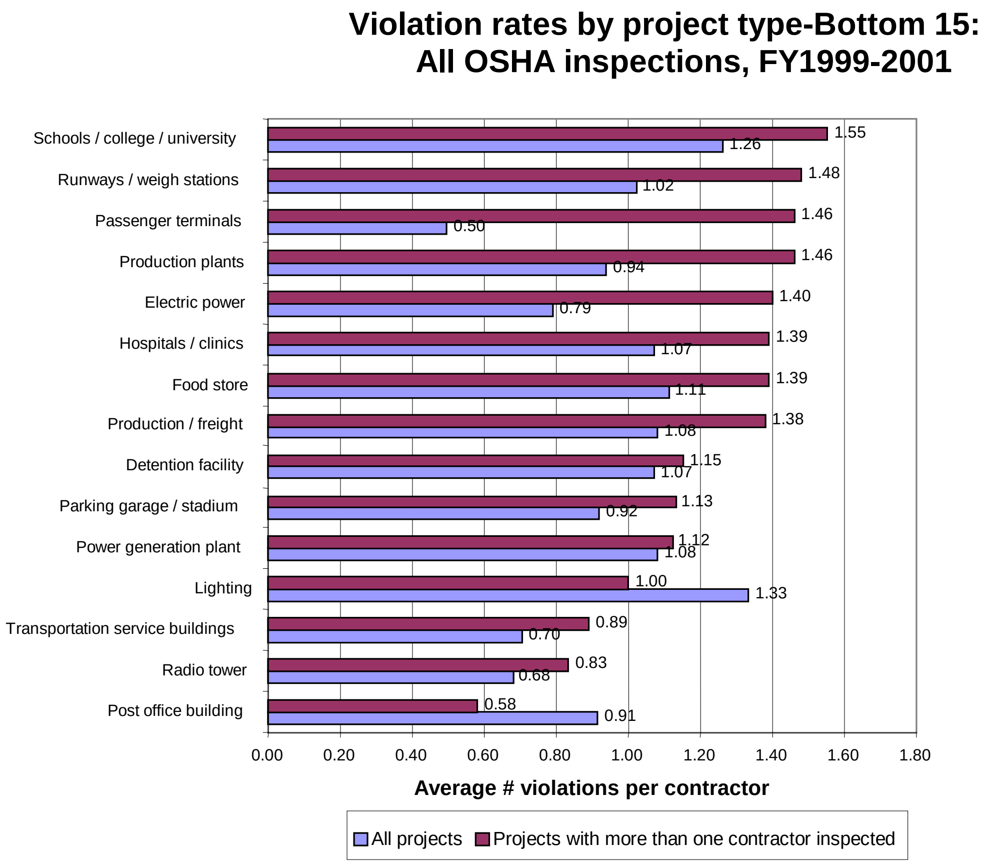


Figure 7: Top 15 violation rates per contractor by major project type



N= 9,312 projects.
Source: Analysis by the author of OSHA IMIS data at the project level; based on data provided by William Schriver, June 2003.

Figure 8: Bottom 15 violation rates per contractor by major project type



N= 9,312 projects.
Source: Analysis by the author of OSHA IMIS data at the project level; based on data provided by William Schriver, June 2003.

Table 1: Project characteristics in Dodge/OSHA IMIS combined sample, FY1999-2001

Variable	Mean (average)	Standard Deviation	Minimum	Maximum
Value of project ($ 000s)	7121.9	15889.7	50	373,070
Number of contractors on project	1.68	1.63	1	26
Number of stories of project	1.43	2.04	0	40
Total violations cited on project	2.28	4.14	0	83
Average number of violations per contractor per project	1.27	1.88	0	34

N=9,312 projects.
Source: Analysis by the author of OSHA IMIS data at the project level; based on data provided by William Schriver, June 2003.

Table 2: Value of projects by region, Dodge/OSHA IMIS combined sample, FY1999-2001

OSHA Region	Number of observations	Mean ($000s)	Standard Deviation	Maximum ($000s)
Region 1	501	8506.244	17601.08	260,000
Region 2	1518	6637.01	13746.43	373,070
Region 3	2278	7416.783	15532.1	260,000
Region 4	1272	8061.035	17189.93	290,000
Region 5	1060	7266.012	10975.94	175,000
Region 6	1211	7369.742	23960.86	346,875
Region 7	909	5710.721	11210.19	196,900
Region 8	411	5489.81	9374.651	100,000
Region 10	152	4994.579	6136.855	47,512

N=9,312 projects.
Note: No projects could be identified in the OSHA IMIS data using Dodge identifiers in Region 9.
Source: Analysis by the author of OSHA IMIS data at the project level; based on data provided by William Schriver, June 2003.

Table 3: Number of contractors on projects in Dodge/OSHA IMIS combined sample, FY1999-2001

Number of contractors inspected by OSHA on project	Frequency (Total number)	Percentage of all projects
1	6,876	73.8%
2	1,031	11.1%
3	542	5.8%
4	330	3.5%
5	179	1.9%
6	119	1.3%
7	74	0.8%
8	51	0.5%
9	33	0.4%
10	22	0.2%
11	20	0.2%
12	9	0.1%
13	12	0.1%
14	8	0.1%
15	1	0.0%
16	2	0.0%
18	1	0.0%
19	1	0.0%
26	1	0.0%
Total	9,312	100.0%

Source: Analysis by the author of OSHA IMIS data at the project level; based on data provided by William Schriver, June 2003.

Table 4: Major project types in Dodge/OSHA IMIS combined sample, FY1999-2001

Project End Use Type	**Frequency**	**Percentage**
Food store	522	5.6%
Food and beverage operation	82	0.9%
Offices / financial	910	9.8%
Auto service	74	0.8%
Schools / college / university	1,985	21.3%
Detention facility	128	1.4%
Post office building	60	0.6%
Police / fire station	114	1.2%
Religious / funerary	374	4.0%
Arena / coliseum	51	0.5%
Clubs / lodge / exhibit hall	359	3.9%
Bowling alley / gym	98	1.1%
Hotel / motel	294	3.2%
Apartments / small homes	845	9.1%
Hospitals / clinics	817	8.8%
Capitol buildings / court houses	131	1.4%
Metal plant	102	1.1%
Production / freight	350	3.8%
Production plants	169	1.8%
Runways / weigh stations	306	3.3%
Bridges	243	2.6%
Shoreline maintenance / dock / pier	94	1.0%
Park / pool / landscape	71	0.8%
Power generation plant	43	0.5%
Sewage / water treatment facility	384	4.1%
Fuel lines	181	1.9%
Railroads / railroad tunnels	24	0.3%
Tank: Chemicals / water	38	0.4%
Lighting	9	0.1%
Military / damn / marine facilities	220	2.4%
Electric power	18	0.2%
Passenger terminals	32	0.3%
Transportation service buildings	36	0.4%
Parking garage / stadium	112	1.2%
Radio tower	14	0.2%
Auditorium / community building / YWCA / YMCA	22	0.2%
TOTAL	**9,312**	**100.0%**

Source: Analysis by the author of OSHA IMIS data at the project level; based on data provided by William Schriver, June 2003.

Table 5: Correlates of violation rates by project characteristics, FY1999-2001

Variable	***Coefficient***	***Standard Error***	***t Statistic***
Dependent variable: Average violations per contractor on project—Mean	1.27	1.88	--
Value of project ($ million)	**-0.0340**	0.004	-7.94
Value of project^2	**1.160E-07**	1.790E-08	6.49
Number of contractors on project	**0.26**	0.019	13.6
Multistory structure	0.00	0.079	0.03
Region 1	**1.07**	0.185	5.8
Region 2	-0.21	0.154	-1.34
Region 3	0.21	0.145	1.47
Region 4	0.24	0.156	1.55
Region 5	**0.80**	0.159	5.05
Region 6	0.03	0.157	0.16
Region 7	**-0.73**	0.168	-4.36
Private project	**-0.22**	0.095	-2.31
Food store	0.61	0.517	1.19
Food and beverage operation	**1.23**	0.595	2.07
Offices / financial	0.57	0.508	1.13
Auto service	0.61	0.610	0.99
Schools / college / university	0.74	0.498	1.48
Detention facility	0.73	0.555	1.32
Post office building	0.07	0.639	0.1
Police / fire station	**1.14**	0.566	2.01
Religious / funerary	**1.47**	0.523	2.81
Arena / coliseum	0.72	0.656	1.09
Clubs / lodge / exhibit hall	0.53	0.520	1.03
Bowling alley / gym	0.64	0.582	1.1
Hotel / motel	**1.13**	0.531	2.13
Apartments / small homes	**1.11**	0.508	2.18
Hospitals / clinics	0.53	0.508	1.04
Capitol buildings / court houses	0.89	0.559	1.59
Metal plant	0.84	0.583	1.45
Production / freight	0.54	0.523	1.03
Production plants	0.12	0.556	0.21
Runways / weigh stations	0.06	0.528	0.12
Bridges	0.87	0.531	1.63

Table 5: Correlates of violation rates by project characteristics, FY1999-2001 (continued)

Variable	*Coefficient*	*Standard Error*	*t Statistic*
Shoreline maintenance / dock / pier	**1.55**	0.581	2.66
Park / pool / landscape	0.29	0.616	0.47
Power generation plant	0.71	0.725	0.98
Sewage / water treatment facility	**1.64**	0.514	3.2
Fuel lines	0.55	0.545	1
Railroads / railroad tunnels	0.54	0.801	0.68
Tank: Chemicals / water	**1.43**	0.687	2.08
Lighting	1.76	0.911	1.93
Military / damn facilities / marine facilities	**1.12**	0.534	2.09
Electric power	-1.16	0.940	-1.24
Passenger terminals	-1.14	0.807	-1.42
Parking garage / stadium	0.24	0.575	0.41
Radio tower	-1.61	0.958	-1.68
Auditorium / community building / YWCA / YMCA	**1.66**	0.797	2.09
Constant	-0.71	0.511	-1.38
Number of observations	9312		
Log likelihood	-15829.0		
LR chi 2	612.0		
Prob > chi2	0.000		

N=9,312 projects

Note: Based on Tobit regressions of data. Omitted category for project type is transportation service buildings. Bolded coefficients statistically significant at the 0.05 level. Complete results available from the author.

Source: Analysis by the author of OSHA IMIS data at the project level; based on data provided by William Schriver, June 2003.

Table 6: Violation rate correlates with project characteristics and types with high violation rates: Region 2 vs. Region 3, FY1999-2001

	Region 2		***Region 3***	
Variable	***Coefficient***	***t Statistic***	***Coefficient***	***t Statistic***
Dependent variable: Average violations per contractor on project—Mean (s.d.)	1.05 (1.55)	--	1.29 (1.96)	--
Value of project ($ million)	**-0.031**	-2.78	**-0.029**	-3.13
Value of project^2	3.98E-08	0.71	9.10E-08	1.8
Number of contractors on project	**0.359**	6.36	**0.358**	8.32
Multistory structure	-0.199	-1.09	-0.041	-0.27
Private project	-0.259	-1.19	-0.222	-1.22
Hotel / motel	**1.031**	2.1	**0.815**	1.94
Apartments / small homes	**0.631**	2.03	**0.563**	2.12
Bridges	0.417	0.83	**1.167**	2.7
Shoreline maintenance / dock / pier	**1.637**	2.31	**1.550**	2.54
Sewage / water treatment facility	0.017	0.03	**1.744**	5.23
Military / damn facilities / marine facilities	**1.099**	2.01	0.806	1.83
Constant	-0.274	-0.99	-0.284	-1.23
_se	2.567051		2.837096	
Number of observations	1518		2278	
Log likelihood	-2305.6		-3959.0	
LR chi 2	101.3		152.9	
Prob > chi2	0.000		0.000	

N=9,312 projects.
Note: Based on Tobit regressions of data. Omitted category for project type is transportation service buildings. Bolded coefficients statistically significant at the 0.05 level. Complete results available from the author. Region 2 consists of New Jersey, New York, Puerto Rico, and the Virgin Islands; region 3 is made up of Delaware, the District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia.
Source: Analysis by the author of OSHA IMIS data at the project level; based on data provided by William Schriver, June 2003.