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An Analysis of DoN Mishap Rates

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Summary

The Secretary of Defense has asked each of the services to achieve a 50-percent reduction in safety mishap rates over the next 5 years. Similar gains were achieved during the 1990s. However, it is unclear to what extent those improvements were the result of safety efforts or the consequence of other factors such as changes in workforce demographics. In general, the safety community has made little effort to look systematically at the effectiveness of its programs. With limited understanding of what has driven past mishap rates, there is little basis for establishing well-reasoned targets for future reductions. The objective of this study is to explore the improvement in mishap rates that occurred in the 1990s, determine the variety of factors that explain the decline in mishap rates, and develop a sound basis for projecting possible future reductions in mishap rates.

Tasking and study approach

We addressed the following tasks:

- Assess the factors that have driven past trends in DoN civilian mishap rates
- Determine the extent to which past improvements in mishap rates can be attributed to safety efforts
- Identify differences in effectiveness across safety programs
- Assess the potential for reducing mishap rates in the future.

To address these tasks, we built a data set covering Department of Navy (DoN) civilian personnel who reported mishaps between July 1988 and June 1998. Federal workers' compensation (FECA) claims are the source for mishap data. We incorporated demographic information from personnel records. Our analysis is based on disaggregating mishap data by demographic categories (by job and age, for example). Doing so allows us to correct for differences in the compo-

sition of the workforce over time and across organizations. By separating out the effects of demographic change, we can identify a residual improvement in mishap rates attributed to safety. We show where safety improvements have occurred and project the potential for reducing mishaps in the future.

Summary of study findings

We summarize our results as follows:

- Almost half of apparent improvement in DoN mishap rates over the 1990s can be explained by demographic factors.
  - — Much of the apparent improvement was due to the declining size of the DoN's industrial workforce.
- Although the overall reduction in mishap rates attributable to safety in the 1990s may be less than the 40 percent that is sometimes cited, the savings that resulted were still substantial.
  - — We find that safety improvements led to 2,600 fewer mishaps in 1998. Such annual gains equate to lifetime savings of $43 million in workers' compensation costs.[1]
- There were substantial safety improvements within a number of occupations and organizations.
  - — Among occupations, the greatest reduction in mishaps (attributed to safety) occurred among sheet metal mechanics, welders, and pipefitters.
  - — Among the activities considered,[2] the greatest reductions in mishaps occurred at Puget Sound Naval Shipyard and Naval Aviation Depot Jacksonville.

1. Savings estimates are based on an earlier CNA study [1] of workers' compensation costs.
2. In our analysis, we look in detail at 27 major activities that account for 36 percent of the DoN workforce and 56 percent of the mishaps.

- The pattern of improvements in the 1990s points to catch-up as the primary identifiable driver of mishap reductions.
  - — Most of the substantial gains were achieved by activities that still did not match the average DoN mishap rate in the occupations where gains occurred.
  - — We could see no indication of gains that could be clearly associated with the introduction of specific safety innovations.
- As of 1998, there remained substantial differences in mishap rates for similar jobs across organizations. These differences suggest obvious opportunities for improvement.
  - — We estimate that a 56-percent reduction in overall mishaps could be achieved if lagging activities improved enough to match the best-in-class performance among similar activities.
  - — The 56-percent reduction in annual mishaps results in lifetime savings of $81 million in workers' compensation costs.

Organization of this report

In the first section, we present an overview of the data sources and a look at some of the demographic factors behind the trends in mishap rates during the 1990s. In the second section, we describe our analysis and results.

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Mishaps rates and demographic trends

Our focus is on work-related mishaps among the DoN civilian workforce. In this section, we present information on our data sources. In addition, we provide summary information on DoN mishap rates for 1989 through 1998, along with information on demographic trends that might have influenced mishap rates. The information we present here previews some of the concerns that we will explore in greater detail later.

Data

The Office of Workers' Compensation Programs (OWCP), Department of Labor, keeps records on Federal Employment Compensation Act (FECA) claims. OWCP provides annual tapes that cover claims that show financial or administrative activity during the preceding year (the FECA year runs from July 1 through June 30). We relied on two databases developed for the DoN to access annual OWCP records.

OSHSYS is a database developed for the DoN's safety program. It associates DoN FECA claims back to the year of injury. To perform a safety study, it is essential to have data that are organized by date of incident. However, building these records from the annual OWCP files is not an easy task. The first challenge is related to the fact that claims may not be activated until some time (occasionally years) after the date of the triggering incident. The second challenge is to screen out those claims that will later be rejected. To get a reasonably complete and accurate picture of the annual number of mishaps from OWCP records requires merging data from files one or two years ahead. OSHSYS was last updated with 1998 OWCP records. We rebuilt the database to include information from FECA years 1999 and 2000. To do so, we used data drawn from FECAMIS, a database that NAVSEA maintains to store information on annual DoN OWCP claims activity. The result is a database that covers mishaps from July

1989 through June 1998 (those mishaps that resulted in valid workers' compensation claims). We can distinguish mishaps that resulted in lost workdays. We do so by identifying claims approved for continuation of pay or disability compensation (remaining claims include those with covered medical expenses but no lost workdays).

The workers' compensation data offered little of the demographic information we needed. For basic demographic and workforce data, we drew on Naval Civilian Personnel Data System (NCPDS) records for the years 1988 through 1998. These records gave us an annual snapshot of employment by occupational series and activity. We used these data to calculate mishap rates. The data also provided us with basic demographic characteristics for individuals (birth date, sex, and occupation, for example). By merging the demographic data with the mishap data, we were able to look at differences in mishap rates across demographic groups.

Statistics on mishaps and the demographic trends

Mishap rates

Figure 1 shows overall mishap rates and lost-time mishap rates for the period 1989 through 1998. There was a general downward trend over the decade such that by 1998 both mishap rates were at 63 percent of the levels observed in 1989. (We describe this as a 37-percent improvement in mishap rates). Since 1998, DoN mishap rates have been essentially flat. The turnaround causes us to question what really happened in the 1990s. There were a number of demographic trends in the earlier period that could have led to a decline in mishap rates. We look at some of these trends next.

A smaller blue collar workforce

The 1990s were a period of base closures and reduction in the DoN civilian workforce. Figure 2 shows the steady decline in the DoN's industrial workforce that was associated with these changes. It should be no surprise that the relative decline in the blue collar workforce would lead to a reduction in overall lower mishaps rates. Mishap rates for blue collar workers are substantially higher than those for white

collar workers. The mishap rates are shown in figure 3. Blue collar rates exceeded 10 percent in this period; white collar rates were closer to 2 percent.[3]

Figure 1. DoN mishap rates, 1989–1998

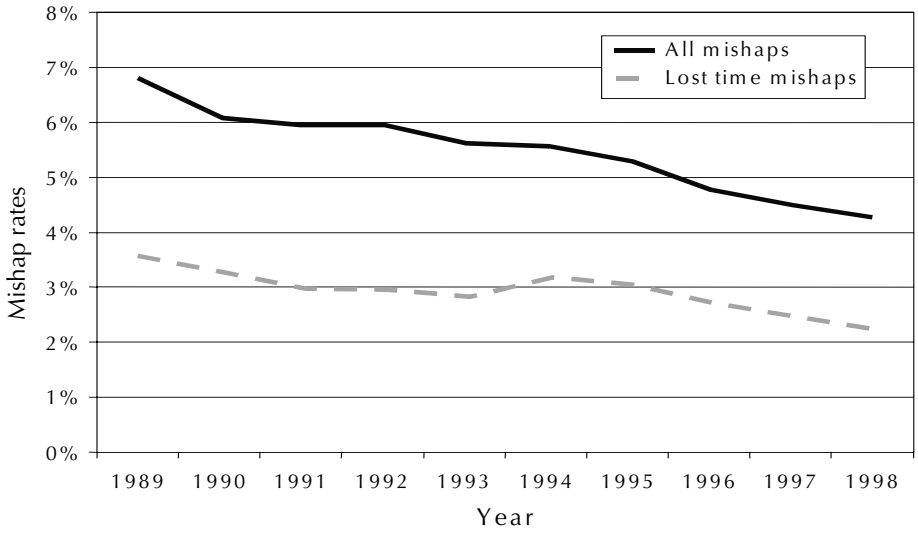
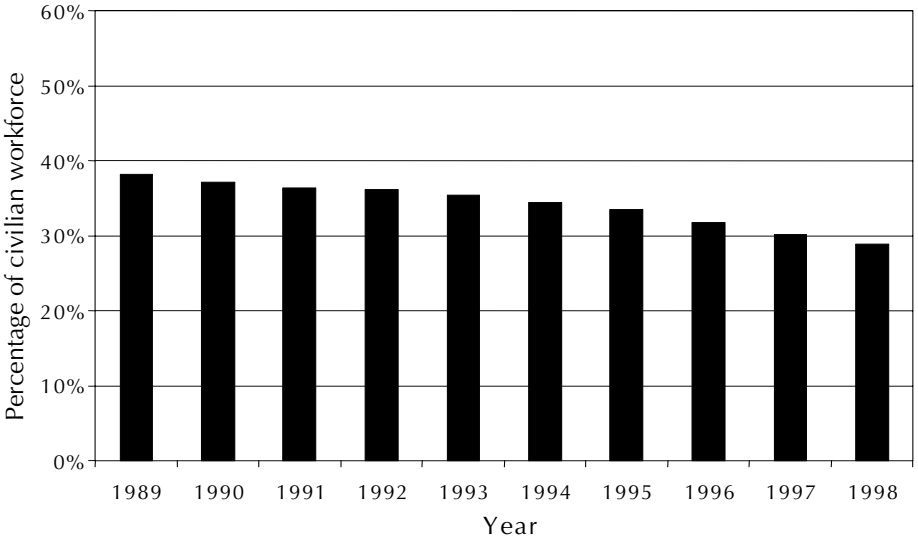
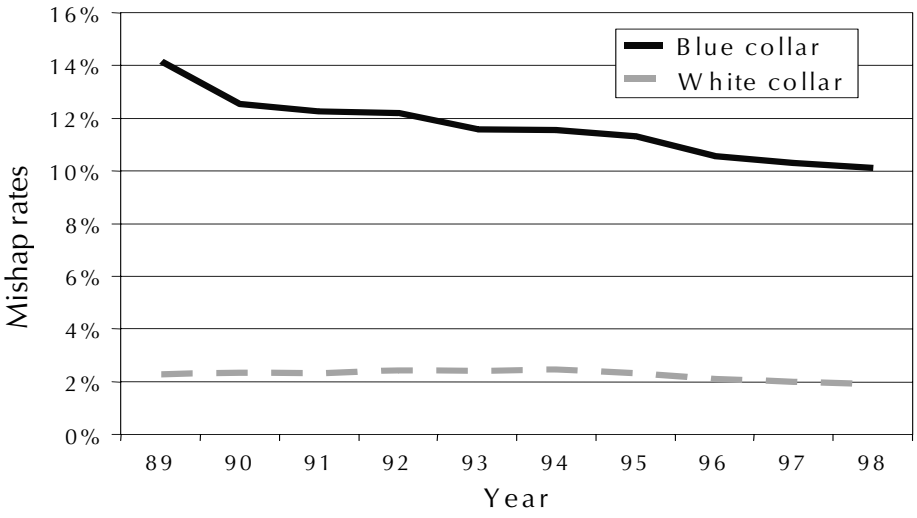


Figure 2. Trend in the DoN blue collar workforce, 1989–1998



3. We define blue collar workers as Federal Wage System [2] jobs, shipboard occupations, and police and firemen (included because their mishap rates are most comparable to those of industrial workers).

Figure 3. Blue collar and white collar mishap rates, 1989–1998



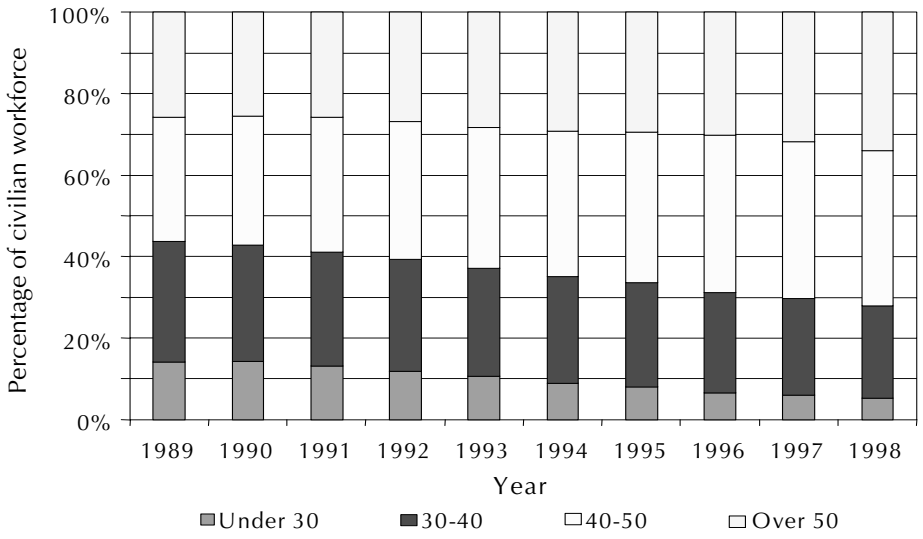
There was a 29-percent improvement in blue collar mishap rates and a 13-percent improvement in white collar rates over the decade. This means that neither group improved at the 37-percent rate that was reported for DoN as a whole. This is a clear indication of the fact that the decline in the overall mishap rate must be a reflection of the increasingly white collar workforce.

It is easy to correct for the effects of a changing workforce. We calculate that overall mishap rates would have declined by only 25 percent had the workforce been constant at 1998 proportions over the entire time period. This leads us to conclude that the changing occupational composition of the workforce is an important factor. Later, we will take a more detailed look at the effects of the changing occupational mix.

An aging workforce

Over the period 1989 to 1998, the DoN civilian workforce declined steadily from about 300,000 to 200,000 workers. A direct effect of this reduction in force was the loss of younger workers. Figure 4 shows the decline in the share of the workforce under 40 (which fell from 44 percent to 28 percent). Although it is not shown in the figure, the decline in younger age groups among blue collar workers was even more striking (43 percent to 22 percent).

Figure 4. Changes in age mix of the workforce, 1989–1998

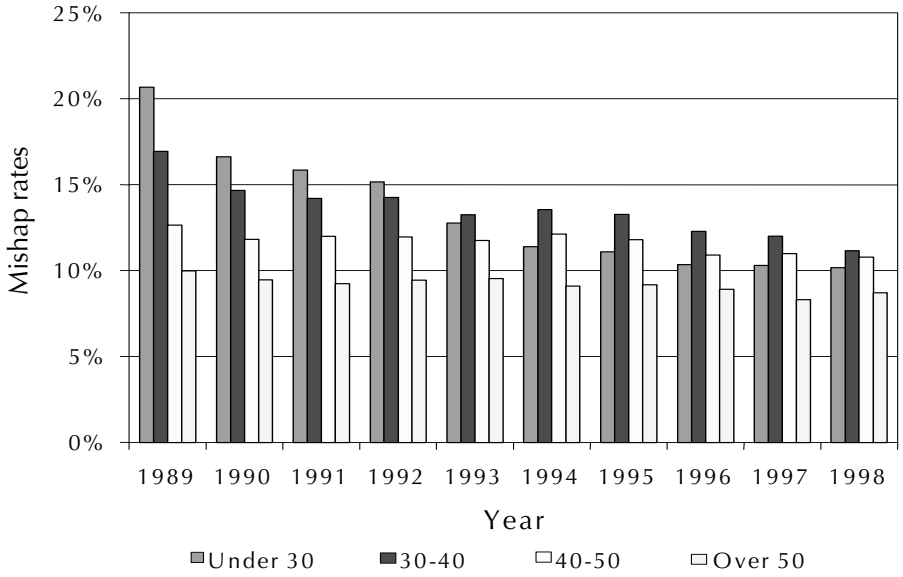


It is not immediately clear how such changes in the age mix would affect mishap rates. Certainly, if younger workers were more prone to accidents, the declining share would have contributed to lower mishap rates. This turns out to be true, to an extent.

Figure 5 shows mishap rates, by age, for blue collar workers. In general, the younger age groups do show higher mishap rates. This was most apparent in the early years of the decade. Note that the decline in blue collar mishap rates came almost entirely from the younger age groups. Among white collar workers, however, mishap rates are, in general, higher for older worker. Apparently, experience and the benefits of seniority contribute more to safety for blue collar workers.

We can correct for the changing distribution of age groups by applying historical mishap rates to a workforce held constant at the 1998 mix. By doing so, we find that the changing age mix might explain another 5 percentage points of the overall reduction in mishap rates. That is, overall mishap rates would have declined by only 20 percent had the workforce been constant at 1998 proportions (correcting for both the age and blue collar mix). However, despite this apparent indication that the age factor may be significant, there is considerable ambiguity concerning the effect of age on mishap rates.

Figure 5. Blue collar mishap rates by age group, 1989–1998



It is likely that with age and seniority, industrial workers would typically move to physically less demanding jobs. This would help explain the lower mishap rates of older workers. However, as the proportion of younger workers declined, it must have been increasingly difficult for older workers to avoid the more challenging jobs. Thus, the slow decline in mishap rates that we observe among older workers may be the result of the changing workforce. Correcting for that endogenous effect would tend to negate some of our measured impact. Given the uncertainty and complexity of the relationship between mishap rates and age, we do not address age in our later analysis.

A workforce that is increasingly female?

The final factor we looked at was the possibility that changes in the proportion of women in the workforce might have had an effect on mishap rates.

Figure 6 shows mishap rates for men and women, in both blue collar and white collar occupations. There are systematic differences in mishap rates, with women having consistently higher rates. Given these differences, had there been a noticeable shift in the male/female composition of the workforce, we might have considered this factor further. However, the proportion of women in the

workforce changed very little in the 1990s. Over the decade, the share of women in the DoN workforce increased only 2 percent. When we look separately at the blue collar and white collar groupings, we find that the female share within each category actually declined slightly (see figure 7). Still, we conclude there was too little change for this factor to have influenced mishap rates.

Figure 6. Male and female mishap rates, 1989–1998

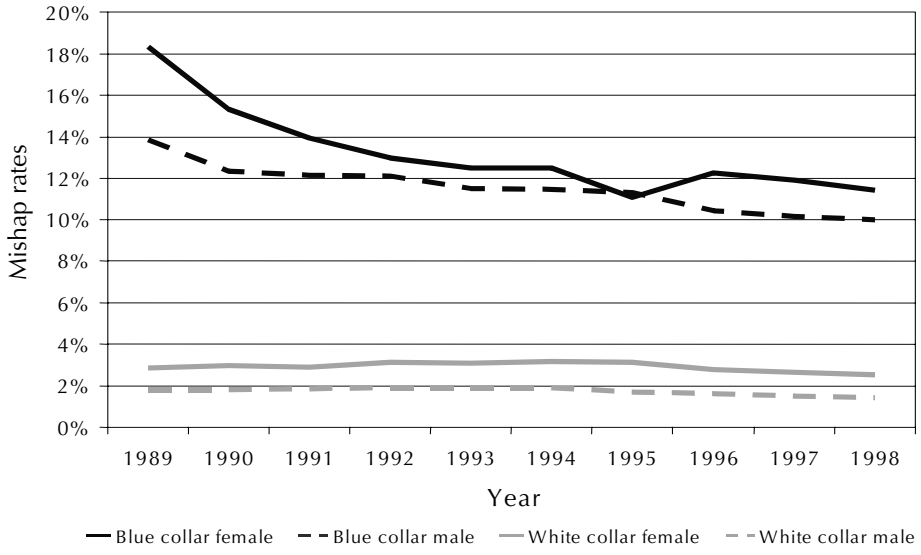
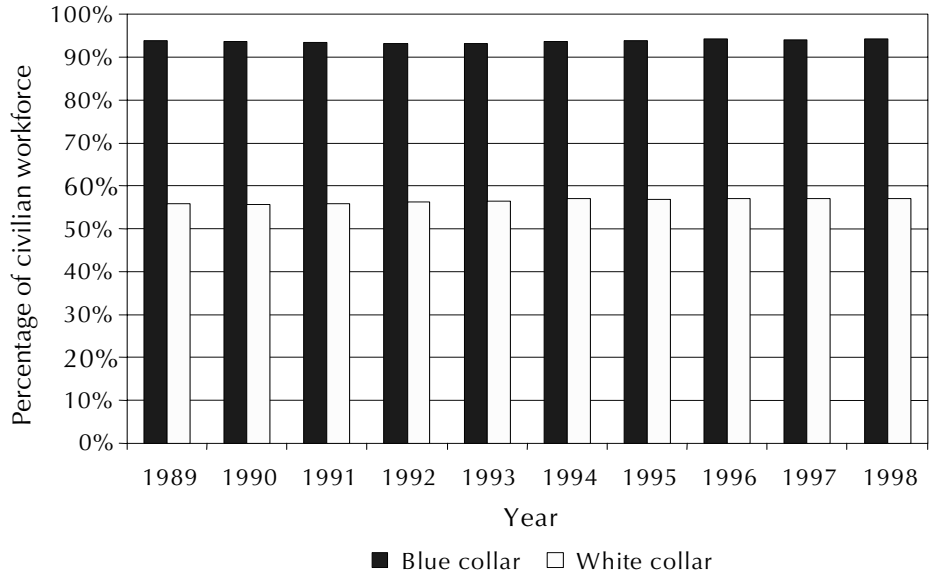


Figure 7. Males, as percentage of the workforce, 1989–1998



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Analysis of trends in mishap rates

The data and trends discussed in the previous section point to the changing occupational mix as a primary driver of the reduction in mishap rates in the 1990s. Our goal, however, was not to explain away the improvements of the 1990s but to identify where safety improvements occurred, identify the effective programs, and assess the potential to reduce mishap rates in the future.

Analytic approach

Overview

We have a data set of occupational injuries and illness for the period July 1988 through June 1998. Our analysis relies on disaggregating the mishap data by activity and occupational code within activities. Doing so allowed us to correct for the changing composition of the workforce over time and across organizations. By correcting for differences in the workforce, we could identify residual improvements that were attributable to safety. From these, we could see where the greatest safety improvements had occurred (by occupation and activity). We then looked for explanations for safety improvements. The only discernible pattern was one of catch-up. That is, reduction in mishaps often occurred among activities whose safety performance had been worse than average. This is the basis for our projection of potential reductions in the number of mishaps. We calculated the reductions that could be achieved if activities that lag in safety performance improve enough to the match the best among similar organizations.

The occupations

We consider 92 occupational categories (listed in appendix A), and investigate mishap rates within these. The categories are based on Of-

fice of Personnel Management occupational group and series codes [2]. We have used a combination of 2-digit groups and 4-digit occupational series. We separated jobs to the 4-digit level if there were a large number of workers and high mishap rates, and if the series seemed distinct from others in the group. When a 4-digit series is separately identified, the corresponding 2-digit group reflects remaining occupations within the group.

The activities

We investigated the safety performance of 27 activities. The activities are listed in appendix B along with some basic statistics on mishaps. Together, these activities account for 36 percent of the DoN workforce and 56 percent of mishaps. Our focus was on larger activities (particularly those with high numbers of mishaps) for which there were comparable activities. In the list provided in appendix B, lines separate the groups of activities. These groupings are relevant only to the projections; our estimates of potential reductions in mishaps are based on the best mishap rates among the comparable organizations.

Because the activities that we consider account for less than half of the DoN workforce, we needed a way to account for the remainder. We did this by combining the remaining activities and treating that aggregate as the equivalent of a single activity.

Calculating reduction in mishaps due to safety

We calculate the reduction in mishaps due to safety in the following manner. For each occupation, we calculated an average mishap rate for the initial two years (1989–1990) and the final two years (1997–1998).[4] We then calculate the reduction in mishaps, in each occupation, by multiplying the change in mishap rates by the number of people in the 1998 workforce. The sum over all occupations, repre-

4. We used average mishap rates because of the relatively small numbers within occupational groups. Further, we did not consider occupations with fewer than six employees.

sented by index `i,` gives us the total reduction in mishaps that is due to improvement in mishap rates

$$= \sum_{i} (89\ \text{Mishap Rate}_i\ -\ 98\ \text{Mishap Rate}_i) * 98\ \text{Workers}_i$$

In effect, we have adjusted the historical mishap numbers to account for changes in the workforce over time. We calculate savings separately for each activity.

Calculating job-corrected mishap rates

We can also correct the apparent trends in mishap rates to account for the changing occupational composition of the workforce over time. We do so by applying historical mishaps rates, by occupation, to the 1998 workforce. For example, the overall job-corrected 1989 mishap rate for an activity is

$$= \frac{\sum (89\ \text{Mishap Rate}_i * 98\ \text{Workers}_i)}{\sum 98\ \text{Workers}_i}$$

where the sum is over occupations (`i`). When we compare the job-corrected mishap rates to the 1998 mishap rates, we have a measure that removes the effects of workforce changes and more accurately reflects underlying safety improvements.

Predictions

For the 27 identified activities, our predictions are based on matching the best mishap rates observed within a group of comparable activities. Within each group, we identify the lowest 1998 mishap rate for each occupation.[5] For each activity, we then calculate the potential improvement in mishaps that would result from matching these best-in-class rates, by occupation. We report the potential reduction in mishaps and the resulting improvement in mishap rates. For the remaining activities (those not among the 27 specifically identified)

5. To be conservative in setting these benchmarks, we used 2-year average mishap rates and ignored rates that did not reflect at least 15 workers.

our predictions are based on their improving to meet at least the DoN's average mishap rate for each occupation.

Assumption and limitations

Here we discuss some of the assumptions and potential limitations of our data and analysis.

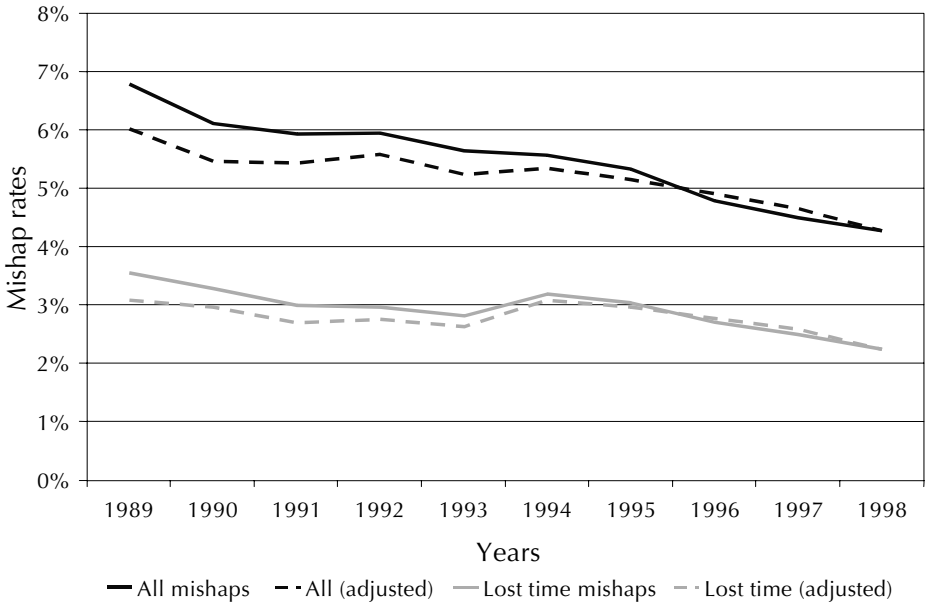
- Our key assumption is that it is appropriate to interpret the reduction in mishap rates within the individual occupational groups as attributable to safety improvement. This implies that we have adequately accounted for other relevant demographic changes. The assumption would not be appropriate for occupational groups that combine a variety of jobs with different degrees of risk, if the mix of these jobs changed over the decade.
- In selecting activities for this analysis, we focused primarily on the industrial workforce that is responsible for most mishaps. This may have left us with little to distinguish successful white collar safety programs:
- There are a number of issues related to the benchmarks rate we use for projecting potential improvement:
  - — The choice of grouping for activities affects the benchmark rate. The fewer the activities in a group, the less likely it is that a low benchmark rate will be observed.
  - — Problems arise if the jobs are not truly comparable across the activities we group.
  - — Clearly, it is not appropriate to make projections based on mishap rates that are calculated from only a few workers, but it is unclear just where to draw the line.
- More recent years of mishap data will systematically undercount the occupational illnesses that take several years to develop. Although the overall numbers may not be large, this issue might be of relevance to specific occupations where illnesses are more likely to occur.

Results

Corrected mishap rate trends

In figure 8, we show observed DoN mishap rates and corrected rates that account for changes in the workforce. The effect of the adjustments is to offset much of the apparent decline in mishap rates.

Figure 8. Trends in mishap rates, corrected for changes in occupational mix



Improvement in mishap rates

We have calculated corrected mishap rates for each individual activity. The results are shown in table 1. Column 3 shows the apparent improvement in mishap rates; column 4 shows the adjusted rate of improvement, corrected for job changes. Positive numbers denote an improvement in mishap rates. A few activities, such as FISC Pearl Harbor, have done better than the apparent improvement in mishap rates. This can happen if work has shifted toward higher risk jobs over the decade. On the other hand, several activities have not done as well as the apparent mishap rates suggest. Two examples are FISC San Diego and FISC Puget Sound.

Table 1. Activities and mishap rates

Activity name	(1) Mishap rate (89–90)[a]	(2) Mishap rate (97–98)[a]	(3) Percent change (apparent)[b]	(4) Percent change (adjusted)[b]	(5) Mishap reduction (total)[c]	(6) Mishap reduction (safety)[c]
MCB, Camp Lejeune	13.2%	16.2%	-22%	-12%	21	-29
MCB, Camp Pendleton	16.2%	9.5%	41%	33%	155	64
MCLB, Albany	6.5%	7.3%	-13%	-2%	6	3
MCLB, Barstow	16.1%	12.1%	25%	27%	118	67
FISC, Norfolk	6.0%	4.1%	33%	20%	125	22
FISC, Pearl Harbor	8.1%	4.5%	45%	47%	21	19
FISC, Puget Sound	9.1%	11.0%	-20%	-155%	-1	-9
FISC, San Diego	6.1%	3.3%	46%	16%	58	8
NAWC, Patuxent River	3.3%	2.4%	27%	17%	-6	19
NAWC, China Lake	4.6%	3.5%	25%	20%	65	29
NAWC, Pt Mugu	7.2%	3.7%	49%	43%	174	77
NSWC, Crane	3.0%	2.1%	31%	34%	24	39
NSWC, Indian Head	3.5%	2.6%	25%	-9%	37	-1
NSWC, Port Hueneme	2.2%	1.7%	26%	28%	9	10
NADEP, Cherry Pt	7.4%	6.0%	19%	18%	-26	50
NADEP, Jacksonville	8.9%	3.6%	59%	57%	122	195
NADEP, North Island	12.1%	8.9%	26%	23%	246	88
NSY, Norfolk	8.4%	5.8%	31%	18%	812	102
NSY, Pearl Harbor	11.4%	8.2%	28%	28%	549	87
NSY, Portsmouth	14.1%	9.8%	31%	33%	1,029	144
NSY, Puget Sound	19.5%	13.4%	31%	30%	1,462	546
Trident Refit, Bangor	8.6%	12.2%	-24%	-25%	-52	-27
Trident Refit, Kings Bay	10.4%	12.9%	-41%	16%	-54	4
PWC, Norfolk	12.0%	5.6%	54%	46%	111	148
PWC Pearl Harbor	11.6%	4.6%	61%	64%	103	92
PWC, Pensacola	6.8%	10.1%	-49%	-43%	-19	-20
PWC, San Diego	7.5%	8.1%	-9%	-11%	8	-10
Other activities	5.0%	3.0%	41%	19%	7,435	920
Totals	6.5%	4.4%	32%	22%	12,352	2,636

a. Mishap rates are averaged over 2-year periods (1989–1990 and 1997–1998).

b. Changes reflect improvement relative to the 1989–90 average rates, actual in (3) and job-corrected in (4).

c. Column (5) shows the total reduction in mishaps over the decade (positive numbers for a reduction). Column (6) shows the reduction attributable to improved mishap rates (i.e., corrected for changing workforce).

Reductions in mishaps due to safety

We have also calculated the reduction in the number of mishaps attributable to safety. Column 5 in table 1 shows the observed reduction in mishaps that occurred between 1989 and 1998. Column 6 adjusts for the changing workforce, and shows the reduction in 1998 mishaps that can be attributed to safety improvements (i.e., improved mishap rates).

For the most part, the safety improvements are less than the overall reduction in mishaps. That is to be expected given a generally smaller workforce. NADEP Jacksonville and a few others have safety-related gains that exceed the total reduction in mishaps. This means that the changes in the workforce would have led to increased mishaps had it not been for safety improvements. For other activities, such as NSWC Indian Head, we see apparently positive improvements turn negative once we adjust for the changing job mix.

Valuing the reduction in mishaps due to safety

We found that, over the decade, 1998 mishaps were reduced by 2,636 as a result of safety gains. In an earlier study, we estimated the lifetime cost of the average DoN worker's compensation claim to be about $16,500 [1]. Using this estimate, the reduction in 1998 mishaps due to safety should lead to lifetime savings of over $43 million.

Ranking safety performance by activity

In this section, we provide summary tables that rank safety performance by activity. Table 2 ranks activities in terms of mishap reductions. Both the top five and bottom five performers are identified. Keep in mind that we have ranked only the 27 activities that we have identified in our analysis. The greatest gains were at Puget Sound Shipyard; note, however, that its mishap rates remain high.

A ranking by the number of mishap reductions tends to be skewed in favor of larger organizations. Therefore, we have also ranked activities by the percentage improvement in mishaps rates over the decade. This may be a more relevant measure of safety performance.

Table 3 lists these rankings. NADEP Jacksonville and PWC Norfolk are notable in that they appear on both top five lists. The bottom five are consistent across both lists.

Table 2. Safety performance by activity, ranked by mishap reduction

	Mishap rate (89–90)	Mishap rate (97–98)	Percent change (adjusted)	Mishap reduction (total)	Mishap reduction (safety)
Top 5					
Naval Shipyard, Puget Sound	19.5%	13.4%	30%	1,462	546
Naval Aviation Depot, Jacksonville	8.9%	3.6%	57%	122	195
Public Works Center, Norfolk	12.0%	5.6%	46%	111	148
Naval Shipyard, Portsmouth	14.1%	9.8%	33%	1,029	144
Naval Shipyard, Norfolk	8.4%	5.8%	18%	812	102
Bottom 5					
Marine Corps Base, Camp Lejeune	13.2%	16.2%	-12%	21	-29
Trident Refit Facility, Bangor	8.6%	12.2%	-25%	-52	-27
Public Works Center, Pensacola	6.8%	10.1%	-43%	-19	-20
Public Works Center, San Diego	7.5%	8.1%	-11%	8	-10
FISC, Puget Sound	9.1%	11.0%	-155%	-1	-9

Table 3. Safety performance by activity, ranked by percent change (corrected for job mix)

	Mishap rate (89–90)	Mishap rate (97–98)	Percent change (adjusted)	Mishap reduction (total)	Mishap reduction (safety)
Top 5					
Public Works Center, Pearl Harbor	11.6%	4.6%	64%	103	92
Naval Aviation Depot, Jacksonville	8.9%	3.6%	57%	122	195
FISC, Pearl Harbor	8.1%	4.5%	47%	21	19
Public Works Center, Norfolk	12.0%	5.6%	46%	111	148
NAWC Weapons Div., Pt Mugu	8.4%	5.8%	43%	174	77
Bottom 5					
FISC, Puget Sound	9.1%	11.0%	-155%	-1	-9
Public Works Center, Pensacola	6.8%	10.1%	-43%	-19	-20
Trident Refit Facility, Bangor	8.6%	12.2%	-25%	-52	-27
Marine Corps Base, Camp Lejeune	13.2%	16.2%	-12%	21	-29
Public Works Center, San Diego	7.5%	8.1%	-11%	8	-10

Ranking safety performance by occupation

To assess the performance of activities, we had to evaluate mishap reductions within the individual occupations. Here we provide summary tables ranking safety performance by occupational category. Appendix A contains a complete list of the occupations.

In table 4, we rank the occupations by reduction in the number of mishaps attributed to safety. In table 5, we rank occupations by percentage of improvement in mishap rates. (Notice that the previous distinction between *apparent* and *adjusted* improvement in mishap rate is not meaningful within a single occupational category.) Some of the greatest gains were among sheet metal mechanics, welders, and pipefitters. Note that, in general, the more substantial improvements were in occupations that had high mishap rates initially. Education stands out among the poor performers.

Table 4. Safety performance by occupation, ranked by mishap reduction

	Mishap rate (89–90)	Mishap rate (97–98)	Percent change (actual)	Mishap reduction (safety)
Top 8				
Sheet metal mechanic (3806)	17.1%	10.5%	38%	200
Welding (3703)	23.1%	17.1%	26%	169
Pipefitting (4204)	17.1%	14.4%	16%	127
Shipfitting (3820)	24.8%	17.6%	29%	121
Gen. admin., clerical, office services (03xx)	2.5%	1.8%	26%	120
Heavy mobile equip. mechanics (5803)	20.0%	13.0%	35%	106
Insulating (3610)	22.0%	16.3%	26%	104
Electrician (2805)	12.8%	10.1%	21%	95
Bottom 5				
Education (17xx)	1.7%	3.7%	-120%	-76
Social science, psych., & welfare (01xx)	1.6%	2.1%	-35%	-14
Personnel, clerical (0203)	3.0%	3.5%	-15%	-10
Personnel mgnt. & industrial relations (02xx)	2.1%	2.4%	-14%	-10
Business and industry (11xx)	2.5%	2.6%	-5%	-8

Table 5. Safety performance byoccupation, ranked by percent change

	Mishap rate (89–90)	Mishap rate (97–98)	Percent change (actual)	Mishap reduction (safety)
Top 8				
General services and support work (35xx)	11.6%	4.6%	64%	92
Sandblasting (5423)	30.2%	16.6%	45%	-4
Boilermaking (3808)	20.8%	11.8%	43%	23
Laboring (3502)	14.2%	8.5%	40%	61
Pliable materials work (43xx)	19.8%	12.0%	39%	24
Metal processing (37xx)	17.7%	10.8%	39%	38
Sheet metal mechanic (3806)	17.1%	10.5%	38%	200
Aircraft overhaul (88xx)	8.5%	5.3%	37%	12
Bottom 5				
Education (17xx)	1.7%	3.7%	-120%	-76
Wire comm. equip. inst. & maint. (25xx)	3.9%	6.1%	-58%	-4
Miscellaneous occupations (52xx)	8.1%	11.8%	-45%	-3
Social science, psych., & welfare (01xx)	1.6%	2.1%	-35%	-14
Equipment, facilities, & services (16xx)	2.5%	3.0%	-19%	11

Exploring the safety improvements

We had hoped to identify a number of areas of consistent improvement and then investigate how these improvements came about. The reality is a little more complex. As we looked at where safety gains were found, it became clear that there were few areas of consistent improvement. Even in occupational areas with the greatest gains, we saw improvement for some activities but declines for others. More apparent was that many of the gains were not so much a reflection of safety innovation but of lagging programs catching up with leaders. The most obvious example is Puget Sound Shipyard. It was responsible for 546 safety-related mishap reductions, which was 20 percent of the overall gains that we show. But despite these improvements, it still had the highest mishap rate among shipyards. These findings suggest that the most obvious source of future gains is the lagging organizations working to catch up to current leaders. Table 6 illustrates the findings.

Table 6. Safety-related mishap reductions by activity, for occupations with the greatest gains

	General admin	Electrician	General services	Laboring	Insulating	Metal processing	Welding	Boilermaking	Sheet metal	Shipfitting	Painting	Pipefitting	Pliable materials	Woodwork	Sandblasting	Heavy mobile equip.	Material handling	Aircraft overhaul
MCLB Albany	-1	1		1		2	1		5		-4				0	-2	0	
MCLB Barstow	-1	-1		6			2				14	2		-1	0	42	5	
MCB Lejeune	-3	-3		-3			1		-2		0	-5		4		1	-1	
MCB Pendleton	2	3		2			4				-3	5		7		0	-2	
FISC Norfolk	0		5											-2			6	
FISC Pearl Harbor	1		3											0			13	
FISC Puget Sound	-1			2										1			-10	
FISC San Diego	1													0			7	
NAWC Pax R.	5								2					1			-1	
NAWC China Lake	3	1							-1		1	-1		2			1	
NAWC Pt Mugu	9	1							4					2			1	
NSWC Crane	9	0									-2	-1		0		0	0	
NSWC Indian Head.	0	-1										0		-1			0	
NSWC Pt. Hueneme	1																0	
NADEP Cherry Pt.	-1					7	4		15		6		0	2	-15			2
NADEP Jacksonville	5	-2				10	1		86		5	0	2	0	1		0	5
NADEP North Island	5	0				3	0		27		-5	-1	1	0	0			2
NSY Norfolk	-2	-1			11	-2	18	5	10	10	4	15		5	0	2		
NSY Pearl Harbor	2	6			3		15	3	7	12	2	10	0	1	7	8		
NSY Portsmouth NH	3	11			7		11		3	8	26	6	9	-1		4	2	
NSY Puget Sound	2	18	0	-1	74	18	79	4	20	67	29	46	9	6		19	5	
Trident Refit Bangor	1	0			0	-1	0		0	0	-2	-5	0				1	
Trident Refit Kings B.	-4	5															-4	
PWC Norfolk	1	24		1	2		2	2	11	-1	-1	12		8		3		
PWC Pearl Harbor	3	0		7			5		1		0	3		14		1	2	
PWC Pensacola	0	1			1				-4		-1	-3		-1		0	0	
PWC San Diego	2	-7					0		0		-3	7		-1		3	0	

In table 6, we list the 18 top-ranked occupations in terms of mishap rate improvement (top 8) or safety-related reductions in mishaps (greater than 75 improvement). For each activity, we show safety-related mishap reductions by occupation (positive numbers for a reduction). Gray shading marks the squares where an activity showed safety losses or the improvements still left it with an occupational mishap rate that was above the DoN average. Numbered elements without shading reflect improvements that left the activity with better than average mishap rates. So, even among these selected occupations where improvements were greatest, there were more instances (139) of catch-up or slipping backward (gray shading) than there were instances (102) of safety leadership. We should note the generally positive performance of a few activities, including NADEP Jacksonville and PWC Norfolk. Also, a few occupations, such as welding, do show fairly consistent gains.

Projecting future safety improvements

To estimate the potential for reducing future mishaps, we looked at what might happen if each activity could match the safety performance of the best among comparable activities. We did an assessment for each occupation and summed the results to determine the overall potential improvement for an activity. Note that the improvements shown for the "other activities" group is based on their meeting the best overall mishap rates in DoN.

The results are shown in table 7. Column 3 shows the potential reduction in mishap rates; column 4 shows the reduction in mishaps; and column 5 shows the percentage reduction in mishap rates that is possible. The results provide a clear indication of the best performers within each group.

Among shipyards, Norfolk has relatively little opportunity for further improvement whereas Puget Sound might be able to reduce mishaps by almost 60 percent. A comparison of potential mishap rates is interesting. We can see that Puget Sound performs inherently more risky work than Norfolk (with a 5.4-percent potential rate, as compared to 4.5 percent). Nevertheless, Puget Sound was far from meeting the potential as of 1998. Among the NADEPs, Jacksonville stands

out as the strong performer and North Island as the one with the most potential for improvement.

Table 7. Projecting potential safety improvements

Activity name	(1) Mishaps (1998)	(2) Mishap rate (97–98) [a]	(3) Potential mishap rate	(4) Potential reduction in mishaps	(5) Percent reduction in mishaps
MCB, Camp Lejeune	261	16.2%	6.6%	153	59%
MCB, Camp Pendleton	126	9.5%	4.7%	55	44%
MCLB, Albany	126	7.3%	4.1%	27	22%
MCLB, Barstow	198	12.1%	8.3%	61	31%
FISC, Norfolk	62	4.1%	2.7%	19	31%
FISC, Pearl Harbor	20	4.5%	2.1%	9	44%
FISC, Puget Sound	66	11.0%	2.6%	48	76%
FISC, San Diego	26	3.3%	1.4%	13	48%
NAWC, Patuxent River	90	2.4%	0.7%	60	67%
NAWC, China Lake	117	3.5%	0.9%	85	73%
NAWC, Pt Mugu	110	3.7%	1.1%	78	71%
NSWC, Crane	68	2.1%	1.1%	32	47%
NSWC, Indian Head	43	2.6%	1.4%	15	36%
NSWC, Port Hueneme	34	1.7%	0.2%	29	86%
NADEP, Cherry Pt	232	6.0%	3.3%	97	42%
NADEP, Jacksonville	141	3.6%	2.7%	28	20%
NADEP, North Island	330	8.9%	3.2%	216	65%
NSY, Norfolk	354	5.8%	4.5%	42	12%
NSY, Pearl Harbor	229	8.2%	5.0%	90	39%
NSY, Portsmouth	314	9.8%	4.7%	149	47%
NSY, Puget Sound	1,154	13.4%	5.4%	671	58%
Trident Refit, Bangor	162	12.2%	5.0%	103	63%
Trident Refit, Kings Bay	189	12.9%	4.9%	114	60%
PWC, Norfolk	158	5.6%	3.0%	62	39%
PWC Pearl Harbor	65	4.6%	2.7%	25	38%
PWC, Pensacola	75	10.1%	4.8%	42	56%
PWC, San Diego	182	8.1%	3.7%	91	50%
Other activities	3,803	3.0%	1.0%	2,498	66%
Totals	8,735	4.4%	1.9%	4,911	56%

Bounds on the potential safety improvements

To put some bounds on the potential for improvement, we looked at two alternative scenarios. For the more conservative scenario, we evaluated each activity as meeting the average DoN mishap rates in each occupation. The result is only a 17-percent overall reduction in mishaps. At the other extreme, we considered what might happen if every activity improved to meet the best overall mishap rates. That would have led to a 69-percent reduction in mishaps.

Appendix A: Occupational groups and series

Table 8. Occupational groups and series, mishap rates, and improvement in mishaps rates

Occupational group or series (codes) [a]	Mishap rate 89–90 [b]	Mishap rate 97–98 [b]	Mishap rate change [c]	Mishap reduction (safety) [d]
Fire, police, security (0081, 83, 85)	10.5%	9.4%	10%	68
Miscellaneous occupations (00xx)	3.7%	3.1%	15%	18
Social science, psychology, and welfare (01xx)	1.6%	2.1%	-35%	-14
Personnel management & industrial relations (02xx)	2.1%	2.4%	-14%	-10
Personnel, clerical (0203)	3.0%	3.5%	-15%	-10
Computer specialist (0334)	1.7%	1.5%	11%	24
General admin., clerical, & office services (03xx)	2.5%	1.8%	26%	120
Mail & file (0305)	5.2%	3.9%	25%	6
Misc. clerk & assistant (0303)	3.6%	3.4%	6%	27
Secretary (0318)	2.5%	2.0%	20%	31
Biological sciences (04xx)	4.4%	4.7%	-8%	1
Accounting and budget (05xx)	2.0%	1.6%	20%	29
Accounting technician (0525)	2.9%	2.2%	22%	14
Medical, hospital, dental, & public health (06xx)	3.5%	2.9%	16%	25
Electronics engineering, & technicians (0855,56)	1.5%	1.1%	23%	55
Engineering and architecture (08xx)	1.2%	0.8%	31%	65
Engineering technician (0802)	3.2%	2.6%	19%	32
Legal and kindred (09xx)	1.8%	1.8%	-1%	-1
Information and arts (10xx)	2.6%	2.2%	14%	5
Business and industry (11xx)	2.5%	2.6%	-5%	-8
Contract & procurement (1102)	1.4%	1.2%	16%	17
Procurement cler. & asst. (1106)	3.1%	2.1%	33%	12
Production control (1152)	4.2%	3.4%	17%	12
Physical science technicians (1311)	8.0%	6.9%	13%	19
Physical sciences (13xx)	1.6%	1.2%	24%	17
Library and archives (14xx)	2.7%	2.0%	27%	7
Mathematics and statistics (15xx)	0.9%	0.9%	3%	1
Equipment specialist (1670)	2.2%	2.1%	3%	-2
Equipment, facilities, & services (16xx)	2.5%	3.0%	-19%	11
Education (17xx)	1.7%	3.7%	-120%	-76
Investigation (18xx)	5.4%	4.0%	25%	14
Quality assurance, inspection, & grading (19xx)	3.3%	2.8%	16%	8
Supply (20xx)	1.8%	1.5%	13%	10

Occupational group or series (codes) [a]	Mishap rate 89–90 [b]	Mishap rate 97–98 [b]	Mishap rate change [c]	Mishap reduction (safety) [d]
Supply clerical & tech. (2005)	3.1%	3.0%	2%	-4
Transportation (21xx)	2.5%	1.8%	26%	14
Wire communications equip. inst. & maint. (25xx)	3.9%	6.1%	-58%	-4
Electronic equipment installation & maint. (26xx)	4.5%	5.1%	-14%	4
Electronics mechanic (2604)	5.9%	4.3%	26%	20
Electrical installation & maintenance (28xx)	9.4%	8.8%	6%	34
Electrician (2805)	12.8%	10.1%	21%	95
Fabric and leather work (31xx)	16.7%	13.9%	17%	17
Instrument work (33xx)	5.8%	5.4%	7%	12
Machine tool work (34xx)	8.4%	8.0%	5%	6
Machining (3414)	11.5%	7.7%	33%	70
General services and support work (35xx)	9.8%	5.1%	48%	31
Laboring (3502)	14.2%	8.5%	40%	61
Insulating (3610)	22.0%	16.3%	26%	104
Structural and finishing work (36xx)	17.6%	12.6%	28%	26
Metal processing (37xx)	17.7%	10.8%	39%	38
Welding (3703)	23.1%	17.1%	26%	169
Boilermaking (3808)	20.8%	11.8%	43%	23
Metal work (38xx)	20.1%	21.4%	-7%	2
Misc. metal work (3801)	11.7%	8.3%	29%	10
Sheet metal mechanic (3806)	17.1%	10.5%	38%	200
Shipfitting (3820)	24.8%	17.6%	29%	121
Painting and paperhanging (41xx)	20.4%	15.7%	23%	94
Pipefitting (4204)	17.1%	14.4%	16%	127
Plumbing and pipefitting (42xx)	14.8%	11.7%	21%	12
Pliable materials work (43xx)	19.8%	12.0%	39%	24
Wood work (46xx)	17.7%	12.2%	31%	81
General maintenance & operations work (47xx)	9.2%	9.0%	3%	9
General equipment maintenance (48xx)	8.0%	9.2%	-15%	-3
Plant and animal work (50xx)	12.3%	7.9%	36%	12
Miscellaneous occupations (52xx)	8.1%	11.8%	-45%	-3
Rigging (5210)	18.1%	15.8%	13%	68
Shipwright (5220)	23.0%	22.0%	4%	5
Air cond. equipment mech. (5306)	12.0%	10.1%	16%	19
Industrial equipment maintenance (53xx)	10.6%	10.8%	-2%	13
Marine machinery mechanic (5334)	15.2%	13.7%	10%	40
Boiler plant operating (5402)	8.2%	6.6%	19%	11
Industrial equipment operation (54xx)	10.7%	7.0%	34%	30
Sandblasting (5423)	30.2%	16.6%	45%	-4
Crane operating (5725)	12.3%	11.8%	4%	1
Motor vehicle operating (5703)	12.6%	9.7%	23%	36

Occupational group or series (codes) [a]	Mishap rate 89–90 [b]	Mishap rate 97–98 [b]	Mishap rate change [c]	Mishap reduction (safety) [d]
Transportation/mobile equipment operation (57xx)	13.1%	11.2%	14%	14
Automotive mechanic (5823)	15.0%	10.3%	31%	27
Heavy mobile equip. mechanics (5803)	20.0%	13.0%	35%	106
Transportation/mobile equipment maint. (58xx)	16.3%	12.1%	26%	11
Ammun., explosives, & toxic materials work (65xx)	11.8%	8.7%	26%	15
Armament work (66xx)	9.8%	7.9%	20%	24
Materials handling (6907)	10.7%	7.3%	31%	83
Tool & parts attending (6904)	8.4%	5.9%	30%	12
Warehousing and stock handling (69xx)	10.1%	10.1%	0%	5
Equipment cleaning (7009)	22.4%	16.0%	28%	-4
Packing and processing (70xx)	10.5%	6.9%	34%	9
Food preparation and serving (74xx)	8.9%	7.3%	18%	8
Fluid systems maintenance (82xx)	8.5%	5.6%	34%	22
Engine overhaul (mostly aircraft engine mechs.) (86xx)	8.5%	5.5%	35%	14
Aircraft mechanic (8852	13.0%	8.9%	32%	61
Aircraft overhaul (88xx)	8.5%	5.3%	37%	12
Shipboard (99xx)	8.7%	6.6%	25%	69
DoN total	6.5%	4.5%	32%	
DoN total, corrected for changing job mix	5.7%	4.5%	22%	2636

a. The table lists occupational groups and series used in our analysis. We considered occupational groups at the 2-digit level, except that we separated out some jobs at the 4-digit level if there were a large number of workerswith high mishap rates and the job seemed distinct from others in the group.

b. Mishap rates are averaged over 2-year periods (1989•1990 and 1997–1998) because of the relatively small number of mishaps within occupational groups.

c. "Change" shows the percentage improvement in the average mishap rate. Improvements are shown as a positive number. We have shaded rows corresponding to the 10 highest percentage improvements.

d. The "Gains" column shows our estimate of the reduction in mishaps we attribute to safety improvements.

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Appendix B: Activities and mishap rates

Table 9. Activities and mishap rates

Activity name	Workforce (1998)	Mishaps (1998)	Mishap rate (89–90)[a]	Mishap rate (97–98)[a]
Marine Corps Base, Camp Lejeune	1,628	261	13.2%	16.2%
Marine Corps Base, Camp Pendleton	1,509	126	16.2%	9.5%
Marine Corps Logistics Base, Albany	2,398	126	6.5%	7.3%
Marine Corps Logistics Base, Barstow	1,650	198	16.1%	12.1%
Fleet and Industrial Supply Center, Norfolk	1,608	62	6.0%	4.1%
Fleet and Industrial Supply Center, Pearl Harbor	528	20	8.1%	4.5%
Fleet and Industrial Supply Center, Puget Sound	576	66	9.1%	11.0%
Fleet and Industrial Supply Center, San Diego	975	26	6.1%	3.3%
Naval Air Warfare Center Aircraft Div., Patuxent River	4,148	90	3.3%	2.4%
Naval Air Warfare Center Weapons Div., China Lake	3,702	117	4.6%	3.5%
Naval Air Warfare Center Weapons Div., Pt Mugu	2,881	110	7.2%	3.7%
Naval Surface Warfare Center, Crane	3,209	68	3.0%	2.1%
Naval Surface Warfare Center, Indian Head	1,910	43	3.5%	2.6%
Naval Surface Warfare Center, Port Hueneme	2,205	34	2.2%	1.7%
Naval Aviation Depot, Cherry Pt	4,098	232	7.4%	6.0%
Naval Aviation Depot, Jacksonville	4,178	141	8.9%	3.6%
Naval Aviation Depot, North Island	3,514	330	12.1%	8.9%
Naval Shipyard Norfolk	6,994	354	8.4%	5.8%
Naval Shipyard, Pearl Harbor	2,793	229	11.4%	8.2%
Naval Shipyard, Portsmouth	3,496	314	14.1%	9.8%
Naval Shipyard, Puget Sound	8,895	1,154	19.5%	13.4%
Trident Refit Facility, Bangor	1,191	162	8.6%	12.2%
Trident Refit Facility, Kings Bay	1,530	189	10.4%	12.9%
Public Works Center, Norfolk	3,166	158	12.0%	5.6%
Public Works Center, Pearl Harbor	1,474	65	11.6%	4.6%
Public Works Center, Pensacola	688	75	6.8%	10.1%
Public Works Center, San Diego	2,477	182	7.5%	8.1%
Others	130,593	3,803	5.0%	3.0%
DoN totals	204,014	8,735	6.5%	4.4%

a. Mishap rates are averaged over 2-year periods (1989–1990 and 1997–1998).

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References

[1] Michael D. Bowes. *Workers' Compensation: The Case for Improved DoN Management*, May 2003 (CNA Research Memorandum D0008209.A2)

[2] United States Office of Personnel Management, *Handbook of Occupational Groups*, Aug 2001

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