An Evaluation of Different Design Options for Presenting Edit Messages in Web Forms[1]

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Introduction

Asking users to complete interactive forms on the Web has become a fairly common task, especially simple forms on commercial websites that ask for basic information such as name, address, phone number, etc. Similarly, follow-up checks, or automated requests to a user to check entries on a Web form, vary from very simple approaches such as the display of a graphic symbol (for example, a red asterisk or question mark) by an item to the use of more detailed messages presented in a variety of formats. Regardless of the approach used, such checks are viewed as an important tool for improving the quality of data obtained in interactive Web forms, including self-completed survey forms (Anderson et al., 2003; Fox et al., 2004).

Designers of Web forms make the explicit assumption that on-line edits will lead to higher quality data. However, usability testing of some Web survey applications at the Bureau of Labor Statistics has revealed two problems with edit messages. First, some users completely miss seeing the edit message, so that when the screen redisplays with the message after a navigation action is taken (for example, *Continue* or *Submit* is clicked), confusion results and the user clicks the navigation button a second time without either reading or responding to the edit message. Second, even when users do notice the message, they may not follow the instructions. On a commercial site, an application might require that entries must meet certain specifications before the user is allowed to continue (defined as a hard edit). But in many survey applications, hard edits are not routinely used because of concerns that they might frustrate or lead to increased burden and, thus, result in a user exiting a form without completing it.

A variety of issues are associated with the use of edits. In many surveys, the Web is offered as one of several reporting options (for example, mail, phone, and fax), so it competes with other data-collection modes, and perceived burden is an important consideration. Although edits are potentially useful for improving data quality, if overused, poorly designed, or confusing, they might increase respondent burden significantly and, therefore, have negative impacts on survey response or data quality. Moreover, it's not always clear when an edit should be used for maximum effectiveness. For example, should an edit appear immediately after an entry has been made, on a page-by-page basis (when a single page has multiple items), or at the very end of a form? Should edits appear automatically, or should they be placed under the control of the user (for example, the user initiates edits by clicking a button)?

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[1] The views and conclusions presented in this paper reflect the opinions of the author, and not the Bureau of Labor Statistics.

In addition to questions about timing and user control, edits can vary on a wide variety of design features. For example, any of the following features could be varied: font type, size, and color; location on the screen/page; formatting of the message; use of graphical features (e.g., a box, flashing); use of a pop-up or completely separate window versus displaying the edit in the current window; use of a hard or soft edit; the wording of the edit message; use of multimedia; the presentation order of edit results (for example in the event of multiple edit failures on the same page, presenting edits one at a time versus all at once), and the sensitivity of an edit - for example, for numeric entries, how much of a deviation from an expected value must occur before the edit appears?

Edits can be classified into two general types: hard and soft. With a hard edit, the entry must be changed before the application will allow the user to continue (for example, if the user tries to enter text into a numeric field or an out-of-range value). The user either makes the change, or he can go no further in the form. On the other hand, with a soft edit, the system will display a message asking the user to verify the entry and to make a change if necessary, but the user is not required to make this change before continuing.

Despite their importance, experimental studies of factors that impact the effectiveness of edits are rare. Some general design guidelines have been offered based on developer experience and observations conducted in usability studies (Murphy et al., 2001). Probably the most relevant of these suggestions for the current study is that edit messages should clearly identify the problem item (location), what the problem is, and what corrective action should be taken. Kanarek and Sedivi (1999) state that edit messages should be presented immediately after a questionable entry. Some other suggestions are that edit messages should be written clearly, use the active voice, and not confuse the use with multiple options (Anderson et al., 2003). Chatelaine (1998) argues that the text used in edit messages is important because in addition to providing guidance, it helps impart a personality to an application. She points out that users are more comfortable when they can figure out what a software's personality is, whether they like it or not.

The current study used an existing survey Web form[2] and varied the timing and location of edit messages to address the following research questions:

- Did the user notice the edit message on its first appearance?
- If noticed, was the proper corrective action taken on the first attempt?
- Which approach for presenting edits was preferred by a user?
- Is there a correlation between a user's subjective ratings of overall form usability and observed performance?

Based on previous research and personal experience, it was hypothesized that in terms of the timing of an edit message, the most effective edit would appear immediately after a questionable entry. Whereas, in terms of location, the most effective location would be immediately underneath the item, since this would simplify the user's task when referring

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[2] Survey of Occupational Injuries & Illnesses. See Attachment 4.

to the edit instructions and the entry that had been made. Therefore, it was hypothesized that the most effective design combination would be to present the edit message under an item as soon as the user left the entry field.

Method
An existing interactive survey Web form that used scrollable Web pages (Java server pages) was modified so that three separate edit messages were displayed in one of three ways.[3] In all cases, when edit messages were displayed they were always visible on the screen (that is, no scrolling was required to see them).

1. <u>Instrument 1</u>. Edit messages were displayed toward the top of a page (under a standard screen banner and progress indicator), but only after **all** items on a page had been completed, and **after** the *Continue* button was clicked by the user.

2. <u>Instrument 2</u>. Edit messages were displayed **under** the item that triggered the edit, but only after **all** items on a page had been completed, and **after** the *Continue* button was clicked by the user.

3. <u>Instrument 3</u>. Edit messages were displayed directly **under** the item that triggered the edit, as soon as the user left the field and moved to the next item (it was not necessary to click *Continue*).

The edit messages used in the three instruments were identical in appearance and size. They were presented in a text box and used red font that was slightly larger than the text on the form. The wording of the edit message itself varied slightly to accommodate differences in instrument design, since after correcting an item in Instrument 3, the user was asked to move to the next item on the page rather than to click the *Continue* button. The edit messages used varied as shown in the next table.

Table 1: Description of Edited Items Used in the Study

Edit	Location in Web Form	Soft or Hard	Occurrence	Type of Edit Instruction
1. "Total Hours Worked"	Item 2 (at beginning of form)	Soft	Only one on page & in scenario	Verify & re-enter entry
2. "Date of Injury"	Item 18 (toward end of form)	Hard	First on page (1st of 2 in scenario)	Match date format
3. "Age of Worker"	Item 23 (out of 31 items on form)	Hard	Second on page (2nd of 2 in scenario)	Enter new value

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[3] Examples of the screens and edit messages are shown in Attachments 1-3.

As noted previously, soft edits display a message to the respondent, but the user is able to move forward in the form without responding to or changing the entry. In Instruments 1 and 2, forward movement was allowed after a soft edit when the user clicked *Continue*. In Instrument 3, forward movement was allowed after a soft edit when the user left the entry field of the edited item either by pressing the tab key or clicking on the next item in sequence. On the other hand, a hard edit requires the entry to be corrected or some type of response made to it. If users attempt to continue without some type of corrective action or response, the edit message will be redisplayed until a specified action occurs with respect to the entry (for example, putting the date in the specified format).

Using a "talk aloud" procedure in each experimental session, 42 paid participants were asked to complete a survey Web form for three fictitious establishments. Participants were selected for this study if they answered yes to the following two questions: Are you experienced with the Internet? Are you comfortable using a keyboard and mouse? After covering the purpose of the survey and how the paper form would be completed, each participant was given a copy of the paper survey form with prefilled data and asked to transfer the data to the Web form. In a given form (scenario), either one soft edit (Edit 1) or two hard edits (Edits 2 & 3) were triggered by the mock data being entered (the two hard edits appeared on the same scrollable page). Since the same edit could appear twice in an experimental session (but on different forms), different values of the key items were used on the forms to reduce expected learning effects. The order of the three versions of the instrument and different versions of the edits were counterbalanced across the experimental sessions.

Results
The following variables were of most interest:

- Did the user notice the edit message on its first appearance?
- If noticed, was the proper corrective action taken?
- Which edit design was preferred by a user?
- Is there a correlation between a user's subjective ratings of design features and performance?

As shown in the table that follows, the soft edit message that occurred on the second item of the form (total hours worked) was missed an average of 40 percent of the time that it appeared. Depending on the instrument, the "miss rate" varied from 33 to 45 percent, but these differences were not statistically significant using a chi-square test (Pearson Chi-Square = 0.664, 2 df, P < 0.717).

Table 2: Proportion of Times Edit Was Missed

	Type of Edit		
	Total Hours	Date of Injury	Age of Worker
Instrument 1	0.43	0.27	0.05
Instrument 2	0.33	0.23	0.00
Instrument 3	0.45	0.10	0.18
Overall	0.40	0.21	0.07

The second edit, date of injury (hard edit), that appeared later in the form was missed an average of 21 percent of the time, with the miss rate ranging from 10 to 27 percent depending on the instrument. The third edit, age of worker (hard edit), that appeared on the same Web page as Edit 2, and which was triggered after the *date of injury* edit, was missed an average of only 7 percent of the time. In this case, the miss rate ranged between zero and 18 percent, depending on the instrument. As with the first edit, there were no statistically significant differences in miss rates among the three versions of the survey instrument for the "date of injury" or "age of worker" edits (Pearson Chi-Square = 1.051, 2 df, P < 0.591 for 'date of injury;' and Pearson Chi-Square = 4.428, 2 df, P < 0.109 for 'age of worker').

As shown in the next table, even when users saw an edit, a relatively large percentage of them failed to follow the instructions, or to make the desired change. The "success rate" was defined as making the specified change on the first attempt, since the edit would keep reappearing for Edits 2 and 3 if the entry was not corrected. Since Edit 1 was implemented as a soft edit, once users clicked the *Continue* key, the next screen would appear regardless of the correctness of their entry. Therefore, by definition, users had one attempt to correct Edit 1. Besides providing some rough comparability with Edit 1, another reason for limiting the definition of "success" to just the first attempt for Edits 2 and 3 is that in early runs of the procedure, it was quickly discovered that some users would start exploring other features of the software when edit messages continued to reappear (for example, users would click hyperlinks and access the help menu), and consequently introduce navigational complexities that severely lengthened each experimental session (also, some users got lost which required experimenter intervention).

As an aside, an anecdotal observation is that some users, upon noticing the edit message, would begin to hypothesize what might be wrong, rather than read the message that explained the problem and how to fix it. For example, a user might say, "Uh … I guess it wants the date in this format, so let me try that, " or "I guess it wants a comma in the number." Or, if a user had entered the number with a comma, the person might say, "I guess it doesn't want a comma in the number, so let me take it out."

For Edit 1 (total hours worked), 89 percent of the users correctly followed the direction to verify and re-enter the value (range was 83 to 93). But, for the second and third edits, the percentage of users correctly making the suggested change on the first attempt dropped to 72 percent for the date edit (range was 67 to 78) and to 76 percent for the age edit (range

was 71 to 79). In the second (date) and third (age) edits, the instructions were slightly more demanding (i.e., enter the date according to a specific format in Edit 2, and enter a specific value depending on the age entered in Edit 3). As in previous analyses, none of the edit-design factors were found to result in statistically significant differences using chi-square tests.

Table 3: Proportion of Correct Actions Taken When User Saw the Edit Message

	Type of Edit		
	Total Hours	Date of Injury	Age of Worker
Instrument 1	0.83	0.73	0.79
Instrument 2	0.93	0.67	0.78
Instrument 3	0.89	0.78	0.71
Overall	0.89	0.72	0.76

The overall effectiveness of an edit can be defined by how often the edit message is seen and handled correctly by the user as a function of the number of times the message is triggered (as opposed to how often it is handled successfully when the user sees it). As shown in the next table, depending on the edit, this rate varied between 52 and 71 percent, on average. In Edit 1, users were asked to verify and then re-enter the value. Probably reflecting the increased difficulty of the edit instructions, the "success" rate of 57 percent changed little for the 'date of injury' edit, even though it was noticed 19 percent more of the time than the 'total hours' edit (0.79 vs. 0.60). The overall success rate improved on the 'age of worker' edit, but even here, almost 30 percent of the users did not correctly follow the edit instruction on the first attempt.

Table 4: Proportion of Time Correct Action Was Taken Based on Total Number of Times an Edit Message Appeared

	Type of Edit		
	Total Hours	Date of Injury	Age of Worker
Instrument 1	0.48	0.53	0.75
Instrument 2	0.62	0.50	0.78
Instrument 3	0.44	0.70	0.59
Overall	0.52	0.57	0.71

Another question of interest was how did the different instrument versions compare in time spent dealing with the edit message? For example, how long did it take a user to respond to an edit and move to the next page of the instrument? Although timing data were collected for all edits, this analysis focuses only on Edit 1, because the times for Edits 2 and 3 were affected by their appearance on the same page, as well as the decision to focus on the first attempt to deal with these hard edits. For Edit 1 (total hours worked), the completion times for two separate groups were tabulated:

(1) The time it took users to notice and respond successfully to an edit message, and
(2) The time it took when a user missed the message.

The time for the first group is of most interest, since an edit message is useless if it's not noticed. Also, the time for the first group shows the effects of the design features under ideal conditions; that is, when the message is noticed, and a correct response results.

As an overview, none of the timing differences that appear in the next table are statistically significant.

Reflecting the diversity in skill level of the participants, the range of time required to notice the edit message and to take the correct action varied from a low of 36 seconds to a maximum of 232 seconds.

Although a user's computer proficiency was not measured in this study, if time to complete an edit is taken as an indirect measure of proficiency, there is some evidence that less proficient users missed more edit messages. The timer used for Edit 1 recorded the amount of time that expired between the time the user first moved the cursor into the "Total Hours Worked" entry field (item) and when the *Continue* button was clicked to move to the next page (section) of the form (since this was a soft edit, clicking the *Continue* button always moved the user to the next page). For Instruments 1 and 2, if an edit was triggered, the *Continue* button always had to be clicked at least twice (for a soft edit): the first click brought up the edit message, and the second click moved the user to the next page. This was true whether or not the user noticed the edit message. As an aside, in those instances where the user did not see the edit message after clicking *Continue* the first time, some users responded by saying, "Now why did this page appear again?" A typical user might then scroll down the page and click *Continue* again. For Instrument 3, however, if the edit message was missed, the user could advance by answering the next item in sequence on the page. And, once finished with the page, clicking *Continue* the first time would advance the user to the next page (in the case of a soft edit only).

Users who missed Edit 1 took an average of 87.1 seconds to move to the next screen, whereas users who saw Edit 1 and followed the correct action, took an average of only 84.2 seconds. Users who missed Edit 1 took an average of 15 seconds longer for Instrument 1, about 13 seconds for Instrument 2, but about 11 seconds less for Instrument 3.

Table 5: Time Required to Advance to Next Page for "Total Hours Worked" Edit

If user saw message & took correct action				If user missed message			
Instru	Mean (seconds)	sd	N	Instru	Mean (seconds)	sd	N
1	79.3	39.7	21	1	94.3	45.7	9
2	100.2	59.5	21	2	113.4	68.6	7
3	71.2	30.2	18	3	59.3	24.7	9
Overall	84.2				87.1		

Users were also asked to rank the different edit presentation methods in terms of their preference (where 1 was most preferred, 2 next preferred, 3 least preferred).

In general, users most preferred the design used in Instrument 2 (1.67), followed by the designs used in Instrument 3 (1.85) and Instrument 1 (2.46). Using a paired-samples t-test, the differences between Instruments 1 and 2, and between Instruments 1 and 3, were statistically significant (t =3.945, 37 df, p < 0.000; t =2.865, 37 df, P < 0.007, respectively); however, the difference between Instruments 2 & 3 was not significant (t = -0.550, 37 df, P < 0.586). Therefore, users expressed a clear preference for having the edit message appear under the item, but the timing of the message was not as important to them.

At the completion of the form-entry task, participants were asked to complete a few subjective questions about the difficulty of the task. In response to a question that asked, "How easy or difficult it was it for you to enter the survey data?" users reported that they found the task to be very easy. Their mean rating was 9 on a 10-point scale. Using the Pearson correlation coefficient, this subjective rating of usability correlated -0.313 with time to complete the first edit (P < 0.05, n = 41), but not with the number of times the first edit message was noticed (r = 0.095, n = 41).

Discussion
Contrary to expectations, none of the design factors varied in this study (location and timing of the message) had an impact on whether the edit message was noticed or, when noticed, if it was handled properly by the user. And, quite unexpectedly, this study demonstrated that when edits are used, they can be missed at a high rate, especially soft edits that appear early in a survey form. Less of a surprise, based on previous observations and usability studies, was that users often fail to follow instructions, even apparently simple instructions.

What accounts for this type of "attentional blindness?" A phenomenon known as "change blindness," or the failure to detect what should be an obvious visual change (McConkie and Currie, 1996; Rensink, O'Regan and Clark, 1997; Simon and Levin, 1997), appears to be the best explanation, since the presentation of edits in this study meets the criteria for a condition described in previous research as the "flicker effect."[4]

For example, a necessary condition for change blindness to occur is that a change to a visual field must occur simultaneously with a disruption to visual continuity, such as during an eye saccade or a "flicker," caused by the imposition of a blank screen, or, in the case of edit messages, a screen being redisplayed after a user action. The screen reappears, but users fail to notice what seems to be an obvious change to observers. In fact, this is how the phenomenon was first noticed. During usability studies with small numbers of users, what seemed to be very obvious edit messages were missed by users. When the edit message was pointed out by researchers, a typical reaction was, "I never saw it, but now I do." Change blindness has been found to occur in a variety of situations

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[4] For examples, see: http://www.cs.bris.ac.uk/~cater/PhD/ChangeBlindInfo/Examples.html

(Varakin et. al., 2004), and the use of edit messages on Web pages can now be added to the list of examples. Although this is only conjecture at this point, it is possible that the scrolling pages used in this study contributed to the "change blindness" effect, since a significant screen reorientation occurred after the edit message was displayed.

With interactive Web forms there are at least two obvious solutions for reducing change blindness: use of a hard edit or presentation of the edit message on a separate screen (use of a pop-up window is another option, but this approach must deal with "pop-up" blockers). If a hard edit is used, and navigation is prohibited, most users will eventually see the edit message, especially when visual cues (graphics, color, different font) make the edit message more noticeable. Of course, as this study demonstrated, depending on the edit, a relatively large number of users might still not make the correction, or the hard edit might lead them down undesirable paths in the instrument. As noted, another option would be to display the edit message on a completely separate screen, and then require the user to navigate back to the problem item to make the necessary correction. A criticism of this approach is that the user must retain relevant information in short-term memory to make the necessary correction. The use of a separate screen also increases programming difficulty and debugging, especially if a lot of edits are used.

The improved detection of the edit message that occurred in this study on the second and third edits can probably be explained by learning or increased expertise with the interface. In addition, by the time the third edit appears, users are probably primed for it, since in the experimental situation a hard edit occurred shortly before on the same page.

Another covariate that may be important, but which was not measured in this study, is the literacy skills of the user. According to Nielsen (2005), lower-literacy users[5] exhibit very different reading behaviors than higher-literacy users. For example, lower-literacy users tend to read word by word, take more time, and have a narrower field of view. Also, of potential importance to the results of this study, Nielsen claims that having to scroll breaks lower-literacy users' visual concentration because they cannot use scanning to find the place they left off. On the other hand, higher literacy users tend to scan a page. However, it should be noted that these generalizations resulted from studying user behaviors on websites. There is evidence that the behaviors required to complete an interactive survey form may differ from typical behaviors employed on a website, since the tasks and user expectations are different (Schober and Conrad, 2003).

Users approach form-completion tasks on the Web with varying levels of motivation. In commercial sites, hard edits are commonly used because it can be assumed that users are motivated to complete the task. So, once a hard edit appears, forward navigation is prohibited, and users must either fix the problem or abandon the form. In these situations, although "change blindness" might be important initially, it will eventually be overcome by most users as they peruse a form to see why their forward progress is being stymied. However, in other form-completion tasks, such as surveys that are completely voluntary, hard edits are generally not widely used because of concerns that perceived

[5] One definition of lower literacy places readers at the 7th grade level or below, http://www.worlded.org/us/health/docs/culture/intro_glossary.html

burden will increase and respondents will not complete the task. In these cases, it seems highly likely that soft edits will be completely overlooked, thereby leading to possible degradations in data quality.

The results of this study also advise caution when using subjective measures of usability. For one variable (time to complete a task), a subjective rating of usability was found to predict performance, but not for another (whether or not an error message was noticed). This result reinforces the importance of collecting observational data when assessing usability.

References

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Attachment 1 – Examples of edit messages displayed at top of screen

"Total Hours Worked" Edit
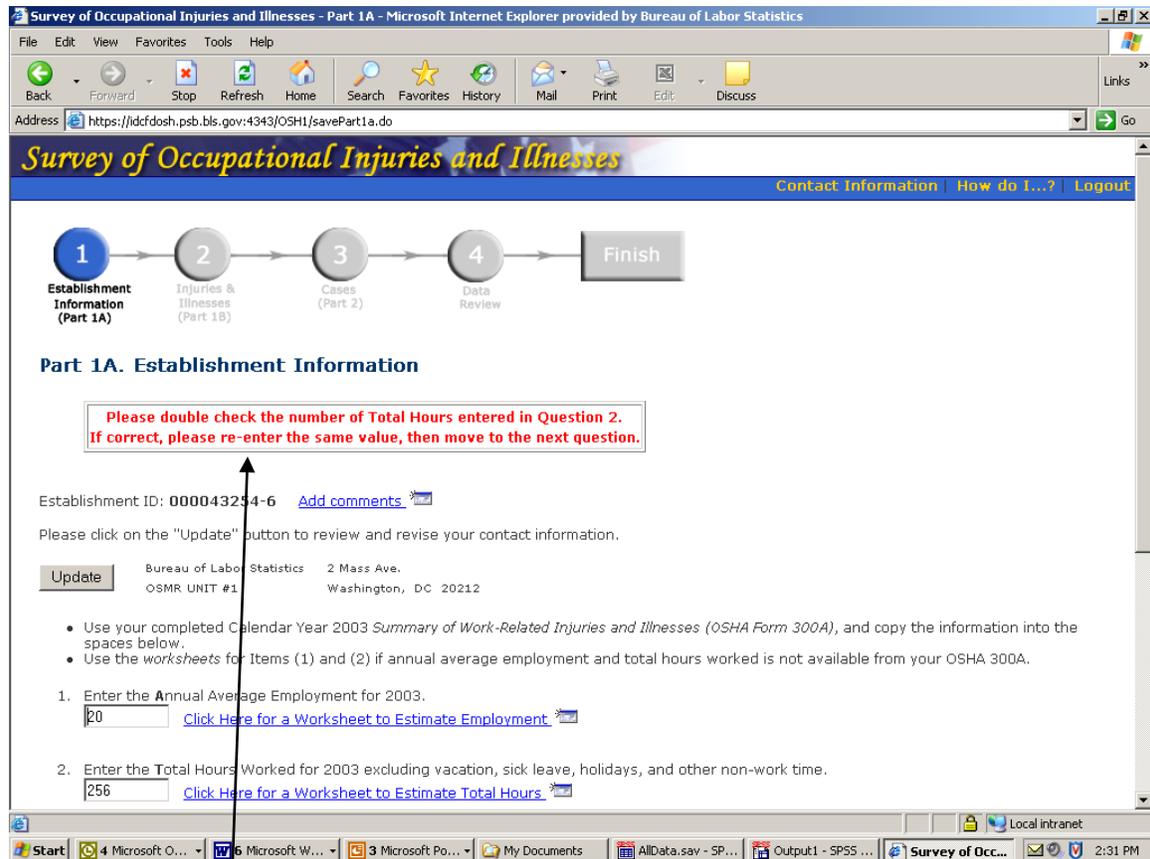
Location of Edit Message in Instrument 1
        ("Total Hours Worked" Edit)

Attachment 2 – Examples of edit messages displayed under item

"Date of Injury" Edit

Location of Edit Message in Instruments 2 & 3
("Date of Injury" Edit)

Attachment 3 – Examples of edit messages displayed under item

"Age of Worker" Edit

Location of Edit Message in Instruments 2 & 3
        ("Age of Worker" Edit)

Part 1A. Establishment Information

Using your completed Calendar Year 2003 *Summary of Work-Related Injuries and Illnesses (OSHA Form 300A)*, copy the establishment information into the boxes below. If more than one establishment is noted on the front cover under *Reporting Site*, add together the total lines from each specified establishment's OSHA Form 300A to complete the 2003 totals for all establishments. Then copy those totals into the corresponding spaces below. If these numbers are not available on your OSHA Form 300A, or if your establishment does not keep records needed to answer (1) and (2) below, you can estimate using the steps that follow.

1. For the reporting site identified on the cover: Enter the annual average employment for 2003.
(*You can copy this from your OSHA Form 300A.*)

Annual average number of employees for 2003

2. For the reporting site identified on the cover: Enter the total hours worked for 2003.
(*You can copy this from your OSHA Form 300A.*)

Total hours worked by all employees in 2003

Note: *Total Hours Worked* should exclude vacation, sick leave, holidays, and other non-work time.

If needed: Steps to estimate employment

STEP 1: Add the number of employees your establishment paid in every pay period during 2003. Include all employees: full-time, part-time, temporary, seasonal, salaried, and hourly.

Acme Construction pays its employees 26 times each year. During 2003,

In this pay period	Acme paid this many employees
1	10
2	0
3	15
⬇	⬇
25	15
26	10
	830 (sum)

STEP 2: Divide the sum by the number of pay periods your establishment had in 2003. Include any pay periods when you had **no** employees.

Because Acme has 26 pay periods, it would divide its sum by 26. 830 divided by 26 = 31.92

STEP 3: Round the answer to the next highest whole number. Write the rounded number in the box marked *Annual average number of employees*.

Acme would round 31.92 to 32 and write that number in the box marked *Annual average number of employees*.

If needed: Steps to estimate total hours worked

STEP 1: Find the number of full-time employees in your establishment for 2003.

ABC Company had 15 full-time employees during 2003.

STEP 2: Multiply this number by the number of hours worked for a full-time employee in a year. This is equal to the number of full-time hours worked.

ABC Company's 15 full-time employees worked an average of about 1,760 hours each per year after excluding vacation, sick leave, holidays, and other non-work time. *(The hours worked for a full-time employee in a year may be different at your reporting site)*

15 (full-time employees) times 1,760 (hours worked by a full-time employee in a year) equals 26,400 full-time hours.

STEP 3: Add the number of any overtime hours and the number of hours worked by other employees (part-time, temporary, seasonal) to the amount in Step 2:

ABC Company's full-time employees worked a total of 1,500 hours of overtime. In addition, 3 part-time employees worked a total of 2,715 hours during 2003. Adding these hours to those from Step 2:

Full-time hours from Step 2		26,400
Overtime hours	+	1,500
Part-time hours	+	2,715
Total hours worked by all employees in 2003	=	30,615

3. Check any conditions that might have affected your annual average number of employees or total hours worked during 2003:

❑ Strike or lockout
❑ Shutdown or layoff
❑ Seasonal work
❑ Natural disaster or adverse weather conditions

❑ Shorter work schedules or fewer pay periods than usual
❑ Longer work schedules or more pay periods than usual
❑ Other reason: _____
❑ Nothing unusual happened to affect our employment or hours figures.

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Attachment 5 – Web Form Version of Items 1-3 from Part 1A of SOII Instrument

On the paper form, this item appeared on the next page. It was not numbered on the paper form either.