Safety Signs & Labels

Does compliance with ANSI Z535 increase compliance with warnings?

By Stephen L. Young, J. Paul Frantz, Timothy P. Rhoades and Kristin R. Darnell

THE AMERICAN NATIONAL STANDARDS Institute (ANSI) accredits the National Electrical Manufacturers Assn. (NEMA), which, in April 1992, published ANSI Z535.4-1991, Product Safety Signs and Labels. This standard is one of a series of standards that includes:

- Z535.1, Safety Color Code
- Z535.2, Environmental and Facility Safety Signs
- Z535.3, Criteria for Safety Symbols
- Z535.5, Accident Prevention Tags (for Temporary Hazards)

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This standard was revised and approved in 1998, and the Z535 Committee is nearing completion of another revision. The standard's stated purpose is:

> 1) to establish a uniform and consistent visual layout for safety signs and labels applied to a wide variety of products; 2) to minimize the proliferation of designs for product safety signs and labels; and 3) to achieve application of a national uniform system for the recognition of potential personal injury hazards for those persons using products [ANSI(b) 1].

Following from this stated purpose, the standard focuses on the format and presentation of product safety signs and labels. For example, it includes specifications for the use of signal words (e.g., DANGER, WARNING, CAUTION), the format of signal word panels (e.g., colors, use of the safety-alert symbol), various other items related to a warning's format and, to some extent, content (Figure 1). Because the standard applies to a wide range of products, it contains a limited number of requirements (i.e., "shall" statements) and many recommendations (i.e., "should" statements and advisory material in appendices that are not part of the standard).

ANSI Z535.4 can offer practical benefits for those preparing product warnings or developing company-wide hazard communication programs. For example, the standard can help streamline the warning-development process by limiting the need to consider a wide variety of formatting issues that might otherwise consume considerable time and effort; this, in turn, allows resources to be expended on other potential HazCom challenges that may be more relevant to the goal of promoting product safety. In addition, from a product liability perspective, compliance with the standard may be viewed as evidence related to the "adequacy" of a warning in the event of "failure-to-warn" allegations.

Aside from these benefits, another potential rea-

son for using this (or any other) particular style of warning would be the expectation that it would reliably and significantly increase safe behaviors compared to another style. While this is generally desired by the ANSI committee, it should be noted that the tenets of the standard were not developed on theoretical or empirical bases which would support such an expectation (Martin and Deppa). For example, as Dorris noted in 1991:

> Warnings researchers have investigated a number of independent variables related to the design of warning labels. For instance, the signal word and the colors utilized in a warning have been investigated with some thoroughness. In the final analysis, there is no demonstration that either of these factors are reliable predictors of the behavior of those who are presented with a warning sign (1075).

While many companies have embraced the standard in whole or in part, use and acceptance of the standard has been gradual and is limited in many respects. While government safety agencies such as National Highway Traffic Safety Administration (NHTSA) and Consumer Product Safety Commission have considered the standard, they have not yet adopted it completely or incorporated it, by reference, into regulations. For example, during development of sun-visor labeling regulations for air bags, NHTSA conducted focus-group research related to people's reactions to various colors and signal words rather than simply adopting the ANSI Z535 scheme [NHTSA(b)]. Indeed, the agency explicitly rejected the idea that consumers draw any distinction between the words WARNING and CAUTION when used in safety information labeling. In addition, many consensus standards that specify warning messages, such as those promulgated by Underwriter's Laboratory, have not incorporated, by reference, the tenets of the ANSI standard.

Given that the standard has been available for several years, the authors endeavored to identify and summarize studies which address the relative merits of ANSI-specified warning formats compared to non-ANSI styles. Most of the relevant literature measures perceptions of or subjective reactions to warnings. For example, many studies have assessed people's perceptions of different signal words and colors. Example measures of reactions to these elements include ratings of perceived hazardousness and intent to comply with a warning. While these studies are not the focal point of this article, the reader may be interested to know that across much of this research, one finds that:

- The three-tiered hierarchy of signal words specified by ANSI Z535.4 (i.e., DANGER, WARNING, then CAUTION) has not been reliably interpreted by study participants in a manner consistent with the hierarchy defined in the standard. It is relatively common to find that people fail to perceive consistent and/or meaningful differences between these three signal words [e.g., Leonard, et al; Wogalter, et al(a), (b); Wogalter and Silver(a), (b); Young].
- The three-tiered hierarchy of safety colors specified by ANSI Z535.4 (i.e., red, orange, then yellow) are also inconsistently interpreted in the population, with the possible exception of the color red [e.g., Wogalter and Silver(b); Young].

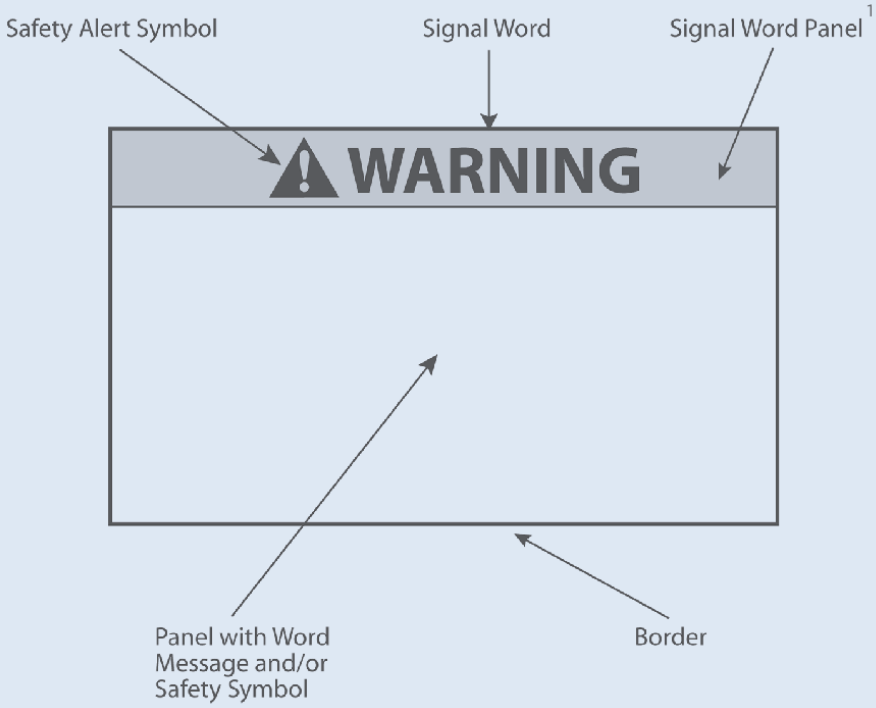
These rating studies focus on measures other than behavioral response to warnings. They also tend to evaluate individual elements of warnings rather than warning signs or labels as a whole. In addition, they rarely evaluate label elements in the context of application to a product. This article evaluates a much smaller body of research that addresses behavior in response to warnings. Specifically, it evaluates several studies that have examined people's response(s) to ANSI-style warnings compared to warnings which use non-ANSI formats. Given the limited number of such studies, this assessment includes some studies that employed ANSI-formatted signs rather than just those involving product labels. In these cases, one might have referred to ANSI Z535.2, Environmental and Facility Safety Signs, which has much in common with Z535.4 as it relates to the present study.

Behavioral Research Studies

Following is a summary of several studies that provide evidence regarding the behavioral effect(s) of an ANSI-style format compared to that of warnings which have few, if any, ANSI elements. However, it should be noted that none of these studies was

Figure 1

Warning Features Specified in Z535.4

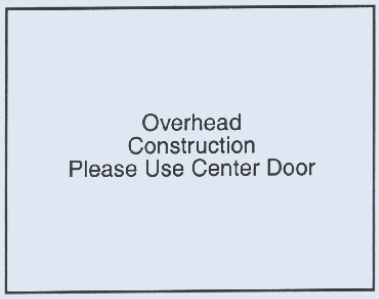


[1]The signal word panel and the exclamation point in the safety alert symbol would be printed in orange when the signal word WARNING is used.

Figure 2

Warning Signs from Shaver & Braun

Non-ANSI Style



ANSI Style

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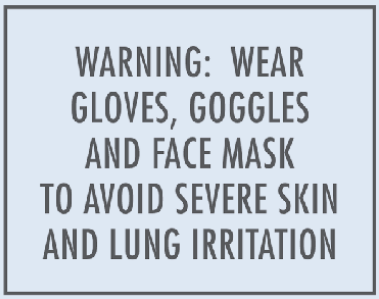
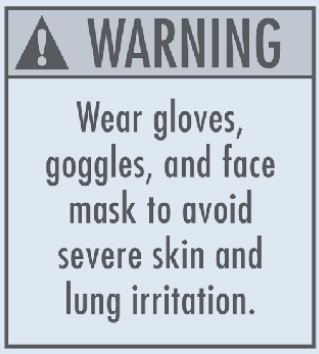
Figure 3

Warning Signs from Smith-Jackson and Durak

Non-ANSI Style



ANSI Style



The signal word panel and the exclamation point in the safety alert symbol for the ANSI-style sign were printed in orange.

ANSI Z535.4 can help streamline the warning-development process by limiting the need to consider a wide variety of formatting issues.

designed specifically to evaluate the ANSI standard. Therefore, it is sometimes true that the ANSI-style warnings in these studies do not comply with the standard in every detail. In addition, many of the studies compare warnings that differ not only in terms of format, but also in terms of content. However, in every case where content differences exist, the ANSI-style warning was arguably "stronger" than the non-ANSI version. Thus, to the extent that differences other than format play a role in people's behavior in these studies, one would expect that they would favor the ANSI-style warnings over the non-ANSI formats.

It should also be noted that most of these studies evaluated issues and variables which are extraneous to the present discussion. For the sake of simplicity, descriptions of the experimental protocols and research designs have been simplified to allow the direct examination of the effect of ANSI-formatted signs in relation to other formats. Despite these issues, effort has been made to present, as fairly as possible, those data that would allow a sufficient comparison.

Use of Protective Eyewear

In this study, Hathaway and Dingus unobtrusively observed the behavior of 420 racquetball players in response to signage indicating that protective eyewear should be worn when playing racquetball (577-584). A non-ANSI formatted sign was printed in plain black text on a white background and a second warning sign was developed in the ANSI style (a three-panel sign with signal word, text message and symbol). The researchers found that 10 percent of the players complied with the plain-text sign and 10 percent complied with the ANSI-style sign. The authors concluded that:

> . . . a warning constructed in strict adherence to ANSI standards resulted in no greater compliance in this study than no warning at all. Washington State University [where the study was conducted] has signs posted in areas near the racquetball courts, which read "EYE-GUARDS STRONGLY RECOMMENDED." Apparently, the addition of the ANSI warning did not significantly alter subject attitudes toward the necessity of using eyewear to avoid injury (583).

Avoidance of Construction Hazards

In this study, Shaver and Braun observed the behavior of 4,620 individuals in response to a scenario where a scaffold was erected in front of three contiguous doors to a single building (290-293). A warning sign that stated, "Overhead Construction Please Use Center Door," was installed at eye level on both sides of the left doorway, except for the control condition in which no sign was present. As shown in Figure 2, the sign was formatted in one of two ways: ANSI-style (a three-panel sign with a CAUTION signal word, color surround, symbol and text message) and plain-text (text message only in black print on a white background). The researchers found that when a sign was present—regardless of format—there was a significant increase in the proportion of people avoiding doors which presented a scaffold hazard. However, people's behavior was not influenced by the format of the sign, leading the authors to conclude that the "effectiveness of a warning was not related to the color, symbol, explicitness or warning format" (292). They further stated that "it appeared

Figure 4

Warning Signs from Frantz & Rhoades, and Frantz, et al

Non-ANSI Style

WARNING
TO AVOID TIPPING YOUR FILE:

(1) ALWAYS LOAD THE BOTTOM DRAWER FIRST, AND WHEN FULL, FILE IN THE NEXT DRAWER ABOVE.
(2) ALWAYS LOAD THE TOP DRAWER AFTER ALL OTHER DRAWERS ARE FULL.
(3) NEVER OPEN MORE THAN ONE DRAWER AT A TIME.

ANSI Style

⚠ WARNING

To avoid injury from cabinet tipping, load the bottom drawer first, and when full, file in the next drawer above.

To avoid fire hazards, do not use this cabinet to store combustible or flammable liquids.

To prevent a tripping hazard, do not leave a file drawer open when not in use.

The signal word panel and the exclamation point in the safety alert symbol for the ANSI-style sign were printed in orange.

that simply stating the hazard and providing mitigating directions was sufficient to significantly alter the proportion of people passing through the designated door. No significant benefit was realized with the addition of the three-panel warning and its components" (292-293).

Use of Personal Protective Equipment

In a study involving the use of personal protective equipment, Smith-Jackson and Durak had 37 participants perform a task that involved mixing "chemicals" (which actually were harmless powders and liquids made to seem potentially hazardous through context and instructions) (115-118). One of two signs was posted on a wall directly above the workspace indicating that participants should wear protective gloves and safety goggles, which were located on the table with the other materials. The content of the two signs was identical, but their format differed (Figure 3); one sign was designed with black letters on a white background (text-only), the other had a safety orange background and the signal word "WARNING" at the top (ANSI-style).

After completing the mixing task, participants were asked to provide a rating between 0 ("not at all likely") and 100 ("absolutely would wear gloves and goggles") to indicate the likelihood that they would wear the provided protective gear. They reported that they would be significantly more likely to wear gloves and goggles in response to a ANSI-style sign (mean rating = 87.6 out of 100) than to one in the text-only format (mean rating = 69.1 out of 100). However, during the actual task, no participant looked at or read the warning sign, regardless of format, prior to beginning the mixing task. Thus, although participants believed that such features would or should make a difference in how they behaved, no such effect on their actual behavior was observed.

Use of Office Equipment

Two different studies involving the use of file cabinets and their warning labels (Frantz and Rhoades; Frantz, et al) allow for an assessment of the effects of warning styles. In both studies, participants set up an office space under the guise that the study was examining how people might arrange office furniture and supplies. Among the materials to be arranged was a two-drawer file cabinet with a warning label attached to the front such that neither drawer could be opened until the label was physically removed.

The Frantz, et al study employed a warning label formatted according to ANSI Z535.4 (Figure 4). In this study, 82 of the 84 participants (98 percent) noticed and interacted with the label, at least to remove it and open the file drawers. However, only 14 (16.7 percent) complied with the target statement indicating that the file cabinet should be loaded from the bottom drawer first. Of these 14 particpants, 10 (74 percent) "complied" without having read any of the warning label (818-821).

In the Frantz and Rhoades study, a non-ANSI style warning was employed (Figure 4) (719-730). Looking at the two studies together, it is clear that both had comparable rates of noticing the cabinet label—93 percent in Frantz and Rhoades; 98 percent in Frantz, et al. Also, the number of participants who read at least some of the label was similar—67 percent in Frantz and Rhoades; 57 percent in Frantz, et al. However, 40 percent of participants who were exposed to the non-ANSI label in Frantz and Rhoades reported reading all of it, while no subjects reported reading all of the ANSI-style label in Frantz, et al. Frantz and Rhoades found, at most, 53 percent compliance while Frantz, et al found, at most, only 17 percent compliance.

Differences in compliance between these studies were most likely due to a combination of factors, including the warnings provided and the task being performed. However, despite the fact that the ANSI-style label in the 2000 study interrupted the task to some extent and was noticed by nearly everyone, information within the label was not actually processed at a more meaningful level than the non-ANSI warning used in the 1993 study.

Analysis of Lap-Belt Use for Ford Escorts: '91-'94

Like many other auto manufacturers during the late 1980s and early 1990s (e.g., Chrysler, General Motors, Honda, Hyundai, Mazda, Mitsubishi, Nissan, Subaru, Toyota), Ford Motor Co. sold cars with a motorized shoulder belt and a manual lap belt. The motorized shoulder belt was provided to meet government crash protection requirements and the manual lap belt was voluntarily provided for

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additional occupant protection. For the years 1991 through 1994, Ford Escorts contained a warning on the driver- and passenger-side sun visors that instructed occupants to wear both belts together (Figure 5, primary visor label). When the visors were in their stowed position, a visor alert label (Figure 5) instructed occupants to read the primary visor label on the opposite side. During this same time period, the style of the warnings became increasingly more consistent with the ANSI standard.

Data from the National Automotive Sampling Survey Crashworthiness Data System (NASS CDS) were used to compare lap-belt use rates for occupants of these model-year vehicles for the period 1990-1999. The NASS CDS contains detailed data on thousands of minor, serious and fatal crashes that involve passenger vehicles towed from the scene of an accident. Teams of trained crash investigators obtain data from crash sites, vehicle inspections, victim interviews and review of medical records.

NHTSA uses this data to evaluate, among other things, seatbelt use programs and the effectiveness of occupant protection systems [NHTSA(a), (b)]. While NASS investigators assess safety belt use based on various factors, they often rely primarily on self-reporting of belt use. As a result, the actual percentage of belt use is likely lower than the reported values. Nonetheless, since the objective of this study was to compare belt use between warning conditions (i.e., model years for the Ford Escort), the data are suitable for making such comparisons.

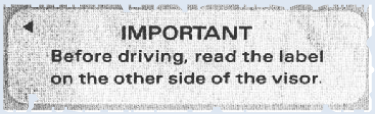
For the 1994 model year (m = 58 percent), belt-use rates for the driver and front seat passenger were as low or lower than for the 1991 (m = 58 percent), 1992 (m = 60 percent) or 1993 model years (m = 65 percent). No evidence suggests that any statistically reliable difference exists between lap-belt use rates for those model years, $\chi^2 = 1.7$, $p = 0.63$. Even a comparison of the two years with the highest and lowest belt-use rates (1993 and 1994) showed no significant difference in lap-belt use rates ($p = 0.36$). Given the lack of meaningful differences in belt-use rates between the four model years, it is clear that the addition of ANSI-style elements (e.g., signal word, color) to the labeling had no influence on the use of lap belts.

Figure 5

Visor Label Styles 1991-94 Ford Escorts

Visor Alert Label Styles

1991-92



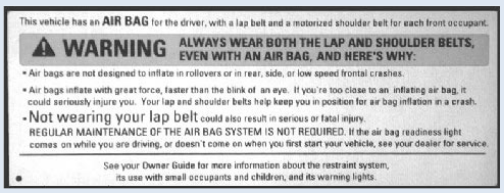
1993

1994

Primary Visor Label Styles

1991-93

1994



The signal word panel and the exclamation point in the safety alert symbol for the 1994 labels were printed in orange.

Discussion

Does compliance with ANSI Z535.4 increase compliance with warnings beyond that of other styles of warnings? Based on available research, the short answer is no. In general, this literature review would not support the proposition that using an ANSI-style warning increases compliance with a warning compared to a different style or variation of the ANSI-style. On the whole, these studies indicate that elements of the ANSI-style can be, and perhaps are, unimportant in terms of how people perceive and respond to safety information. Such conclusions are consistent with a larger body of literature related to various presentation features of warnings which fails to support the position that using a particular color or signal word reliably and positively affects attention to and compliance with product warnings.

Why do ANSI-style warnings not appear to yield improvements compared to other styles? One reason may be related to the way that the user population perceives various warning features as specified by ANSI Z535.4. For example, the standard attaches specific meanings to the signal words DANGER, WARNING and CAUTION, but there is little reason to believe that people perceive consistent and mean-

Figure 6

Meanings of Signal Words

⚠ DANGER	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme conditions. The word DANGER shall be in white letters on a safety red background.
⚠ WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury. The word WARNING shall be in black letters on a safety orange background.
⚠ CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices. The word CAUTION shall be in black letters on a safety yellow background.

ingful distinctions between these signal words in the way they are intended. Indeed, an annex to the standard acknowledges this fact and calls for help in educating the public about signal words as they are specified in the standard.

However, even if users perceived the specifications exactly as they were intended, it is possible that the domain over which Z535.4 has control is too inconsequential to have a significant influence on how people actually behave. Put another way, the signal words, colors and other label items that the standard specifies may, in themselves, have little influence in determining people's actions, and these low-level manipulations may be insignificant in relation to other nonformat and nonwarning sources of information about hazards. For example, Shaver and Braun concluded:

> The comparable performance of the [ANSI-style] warning and control [non-ANSI] signs might have resulted from the qualities of the situation rather than the signs themselves. In particular, the scaffolding might have provided all the salient information needed to interpret the hazard (293).

Yet another possibility is that the ANSI format has the unintended effect of allowing users to actually ignore or filter warning information (Frantz, et al). Specifically, if a user is presented with safety information that is perceived to be of low utility (for whatever reason), a format that clearly defines the warning and makes it stand apart from other information could allow users to bypass or ignore it altogether (also known as "pre-lexical" filtering). In such cases, it may be that the ANSI-style format actually helps users ignore safety information which they have generally found not to be relevant, credible, personally applicable, directly related to achievement of their goals, etc.

In conclusion, this literature review adds to the growing body of research indicating that factors other than the format of a warning itself are often greater determinants of a person's response to a warning. However, it is not the purpose of this article to suggest that the recommendations provided in Z535.4 are without merit or worth. For the reasons stated earlier, several benefits are associated with a consensus standard that addresses basic attributes of warnings which are likely to apply to a wide range of products and situations. However, the evidence presented here calls into question the proposition that either compliance with or deviation from ANSI Z535.4 would reliably or substantially influence people's response to a warning. While benefits can be gained by conforming to the standard, research to date suggests that it is not a necessity from a product safety perspective. ■

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