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# The Effects of Training, Goal Setting, and Knowledge of Results on Safe Behavior: a Component Analysis.

Robert Allen Reber
*Louisiana State University and Agricultural & Mechanical College*

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Reber, Robert Allen

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# THE EFFECTS OF TRAINING, GOAL SETTING, AND KNOWLEDGE OF RESULTS ON SAFE BEHAVIOR: A COMPONENT ANALYSIS

A Dissertation

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Robert A. Reber
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M.A., Louisiana State University, 1979
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## ABSTRACT

The present research investigated the effects of training, goal setting, and knowledge of results (KR) on safe behavior in a field setting. As a result, it addressed both a theoretical issue and a practical problem. Of theoretical importance is ascertaining the effects of KR when combined with goal setting. Of practical significance is assessing the utility of a behavioral approach to occupational safety.

Eleven departments (n = 105 employees) of a farm machinery manufacturing plant were divided into three groups. A multiple-baseline, across-groups design was utilized for the four phases: a) baseline, b) Training Only, c) Goal Setting and Training, and d) Feedback (KR), Goal Setting, and Training. The primary dependent variable was the percentage of employees observed to be working in complete accordance with the behavioral safety rules.

An ARIMA analysis suggested that a white noise model best described the time series data. A repeated measures ANOVA revealed that, as hypothesized, behavioral safety performance was significantly better than baseline ($\overline{X}$ = 62.20%) after the employees were trained via explanation and visual presentation of the safety rules ($\overline{X}$ = 70.85%). The ANOVA also indicated that, as predicted, assigning a specific, difficult but acceptable departmental goal further significantly enhanced performance ($\overline{X}$ = 77.54%). When KR was provided in relation to the goal, performance again significantly increased ($\overline{X}$ = 95.39%). In addition, the overall and lost-time injury rates for the plant decreased considerably.

It was concluded that feedback (KR) was a beneficial condition for the effects of goal setting to be maximally realized. Of practical significance is the finding that non-monetary incentives could be used to increase the frequency of safe behaviors. Future research was recommended to assess the function of KR in relation to goals and to determine the generalizability of these results to other types of organizations and behaviors.

# INTRODUCTION

The present study attempts to make both a theoretical and practical contribution to the existing literature in the field of safety research. First, from a theoretical perspective it will provide an analysis of the relative effects of goal setting and knowledge of results on safety performance. Second, of practical importance, the study will systematically measure the effectiveness of a behavioral safety program through the use of a multiple-baseline design. As a result, this study will endeavor to bridge the gap between theory and the application of psychological principles (Dubin, 1976; Hale & Hale, 1970) by attempting to resolve a current theoretical controversy in an actual organizational setting.

The following literature review summarizes the two research areas relevant to the present investigation. The review presents literature concerning 1) the applied behavior analysis approach to safety, and 2) the effects of goal setting and knowledge of results.

## SAFETY RESEARCH

### Introduction

Occupational safety has been an issue of concern since about 2000 years before the Christian period when Hammurabi ordered a body of laws concerned with indemnifying the injured. From the early days of Christianity until the end of the 15th century, information about industrial work situations is scanty. In the 17th and 18th centuries, however, there was a succession of statutes governing working conditions in the textile and mining industries in Germany and Great

Britain. The first safety regulations in the United States appeared in 1876, and the first workmen's compensation laws came in 1902 (Grimaldi & Simonds, 1975). Perhaps "the most pervasive safety law" ever passed in the United States was the Williams-Steiger Act (1970), more popularly known as the Occupational Safety and Health Act. This act authorizes the federal government to set and enforce safety and health standards for all places of employment affecting interstate commerce, and to enforce the standards with criminal and civil penalties for violations (U.S. Department of Labor, 1976; Grimaldi & Simonds, 1975). To establish and enforce the federal occupational safety and health standards, a new agency, the Occupational Safety and Health Administration (OSHA) was created under the auspices of the Department of Labor. In conjunction with OSHA, a new agency in the Department of Health, Education and Welfare (HEW) was authorized. The duties of the HEW agency, the National Institute for Occupational Safety and Health (NIOSH), include conducting research and demonstrations relating to occupational safety and health, developing OSHA criteria, conducting inspections, and publishing data on occupational illness.

In addition to these government agencies, several 20th century private organizations have been established for the purpose of promoting safety. These include the National Safety Council (established in 1915); the American Society of Safety Engineers (1947); and the Center for Safety at New York University (1938); to name but a few. Numerous insurance companies and industrial organizations have also contributed to the development of safety ideals and methodology (Grimaldi & Simonds, 1975).

Associated with such continuing safety efforts was a 71 percent reduction in accidental work deaths per 100,000 population between 1912 and 1979. In 1912, an estimated 18,000 to 21,000 workers lost their lives. In 1979, with a work force more than twice the size, there were 13,200 work deaths (National Safety Council, 1980). Nevertheless it has been estimated that in the United States every 8 minutes there is 1 work related fatality, 148 disabling injuries, and over 500 less serious on-the-job injuries (Shafai-Sahrai, 1973). These figures highlight a continuing need for the development of methods to improve occupational safety and reduce accidents and injuries.

The Human Side of Accident Prevention

Several reviews of safety literature have noted that the bulk of existing accident prevention research and legislation has concentrated on making the work environment less hazardous (e.g., Ellis, 1975; Fitch, Hermann, & Hopkins, 1976; Grimaldi & Simonds, 1975; Heinrich, 1959). However, safety researchers generally accept that the occurrence of an injury-producing accident requires both a behaving human being and a hazardous physical environment capable of producing injury to the human being (Fitch et al., 1976; Grimaldi & Simonds, 1975; Hale & Hale, 1970). Thus, while it is vitally important to continue the safety engineering approach for the latter causal factor, there is a need for a more effective approach to the behavioral half of the safety equation (Fitch et al., 1976).

Several early investigations concerned with the human-side of accident prevention focused on identifying personal characteristics of employees that may be correlated with accident rates. Such reports have generally been non-supportive of "accident-proneness" theory (Crawford, 1960; Davids & Mahoney, 1957; Harris, 1950; Kerr, 1957; Mintz & Blum, 1949). However, there does seem to be an inverse relationship between both age and experience on the job and the frequency of injuries (Cohen, Smith, & Cohen, 1975; Van Zelst, 1954).

Other correlation studies have attempted to evaluate the effectiveness of employee-directed safety programs by comparing the various safety efforts of high- and low-accident rate companies (e.g., Cohen et al., 1975; Ellis, 1975; Shafai-Sahrai, 1973).

Although these studies are important initial steps, the conclusions that can be drawn from them are limited. For example, Fitch et al. (1976) recognized that there were many difficulties with these correlational studies, not the least of which is that correlation is a measure of association rather than causation. Frequently, the statistically significant correlations obtained in safety research are so low that little of the total variation is accounted for by the variables in question (Fitch et al., 1976). Further, the variables found to be related to occupational accidents and injuries may not be directly controllable by management (e.g., Sherman, Kerr, & Kosinar, 1957). As Fitch et al. (1976) noted, knowledge of the influence of uncontrollable variables may be potentially valuable to the scientist, but is of limited value to the manager who needs to know about variables which he can manipulate inexpensively.

There have been efforts to assess the effectiveness of safety campaigns in actual organizations. Such research has generally focused on evaluating the benefits of informational campaigns (lectures, posters, booklets, etc.) and/or promotional campaigns involving departmental competitions accompanied by rewards of disciplinary actions (Haskins, 1969, 1970; Laner & Sell, 1960). It has been noted, however, that much of the existing safety research often reported in trade journals, is primarily descriptive and/or anecdotal (Ellis, 1975; Fitch et al., 1976; Haskins, 1969, 1970; Komaki, Barwick, & Scott, 1978). Thus, there appears to be a paucity of well-controlled studies demonstrating the effectiveness of safety programs in actual work settings (Grimaldi, 1970; Haskins, 1969, 1970; Komaki et al., 1978). As Ellis (1975) concluded after his review of the literature, "the quality and intensity of research necessary to draw firm conclusions . . . were found to be remarkably inadequate" (p. 180). He further warned that "unless much better evaluative research begins to be undertaken, all the innovative work safety programs in the future may well result in a waste of time and money" (p. 187).

The next section reviews several recent studies which have employed an applied behavior analysis approach to occupational safety for the purpose of filling this void in safety research.

## Applied Behavior Analysis in Safety Research

Applied behavior analysis, more commonly known as behavior modification, can be broadly defined as the collection of research methods and strategies used to evaluate scientifically the effects of any management program or procedure on any socially important behavior(s) (Fitch et al., 1976). Utilizing technology derived largely from the principles of operant conditioning, applied behavior management attempts systematically to modify precisely defined target behaviors.

Such an approach has already shown considerable promise for industrial-organizational applications (Jablonsky & DeVries, 1972; Luthans & Kreitner, 1975; Nord, 1969; Schneier, 1974). Numerous successful studies have been reported. For example, reward contingencies have been arranged to improve productivity (e.g., "At Emery Air Freight", 1973; Yukl, Wexley, & Seymore, 1972; Yukl & Latham, 1975), reduce absenteeism (Pendalino & Gamboa, 1974; Wallin & Johnson, Note 1), reduce tardiness (Herman, deMontes, Dominguez, Montes, & Hopkins, 1973), improve individual employee performance (Komaki, Waddell, & Pearce, 1977), and reduce residential energy consumption (Hayes & Cone, 1977).

Similarly, several researchers have advocated the use of behavior modification (b-mod) techniques for increasing safe behaviors (Fitch et al., 1976; Goldstein, 1975; McIntire & White, 1975; Smith, Anger, & Uslan, 1978; Tuttle, Dachler, & Scheider, 1975).

Rationale: The primary premise supporting the utilization of applied behavior analysis in safety research is that most safety experts agree that the majority of occupational accidents and injuries are the results of an unsafe act performed by an employee (Fitch et al, 1976; Grimaldi & Simonds, 1975; Heinrich, 1959; Schenkelback, 1975). Heinrich (1959) has estimated that 88% of all industrial accidents are caused by unsafe acts; 10% by equipment failure of the working environment; and 2% by Acts of God. Unsafe acts would include both direct and indirect behavioral actions. An indirect action would include failure to act, as in the case where an employee uses an unsafe tool without checking its condition first, or not performing preventive maintenance on equipment.

Heinrich (1959) also noted that one reason for the frequency of unsafe acts is that such actions rarely result in a disabling injury and may save time and energy expended. He estimated that for most jobs, of every 330 unsafe acts, 300 would result in no injury; 29 would result in only minor injuries; and 1 would result in a disabling injury. This ratio could be much higher (or lower) depending on the demands of a particular job. Thus, employees working unsafely may actually be reinforced for doing so, and rarely punished. Arranging reward contingencies so that workers are reinforced for safe behaviors should increase the frequency of safe acts and decrease competing unsafe behaviors. As the potential behavioral causes of injuries are eliminated, it only follows that the frequency of accidents will also diminish.

In sum, applied behavior analysis enables one to direct safety promotional efforts at the major cause of occupational accidents and injuries.

Measurement of Safety: A second advantage of using applied behavior analysis is that it can provide a reliable measure of safety. Safety research has often been plagued by a lack of consensus on how to measure safety performance (Grimaldi, 1970; Komaki, et al., 1978; Smith, 1976). Typical criterion measures include disabling injuries (lost-time accidents) and injuries requiring medical treatment (Grimaldi, 1970; Jacobs, 1970; Tarrants, 1970). It has been noted that lost-time accidents, which include deaths, permanent total disabilities, permanent partial disabilities, and temporary total disabilities, are considered "rare events" (Jacobs, 1970; Komaki et al, 1978). Since these events are infrequent and unpredictable, it is difficult to reflect the effect of a safety program using lost-time accidents as a primary index. Further, medical treatment injuries, those requiring first-aid treatment but not disabling, are an unreliable measure due to large-scale reporting and recording inaccuracies (Grimaldi, 1970; Komaki et al, 1978; Smith, 1976). Both of these measures are after-the-fact and offer little in the way of suggesting preventive procedures. In addition, accidents are expensive teaching devices (Kerr, 1957). In other words, taking steps to correct unsafe behaviors after an accident may prevent future problems; but post hoc action cannot repair the physical and financial damages already incurred by the organization and/or its employees.

A behaviorally specific observation and recording system, however, provides a sensitive and reliable measure of the safety level of the organization (Fitch et al., 1976; Komaki et al., 1978; Smith, 1976). Frequent repeated measurement of a behavioral criteria not only makes it possible to objectively assess safety performance, but also allows one to assess more readily whether a program is having its desired effect or whether new strategies need to be introduced (Komaki et al., 1978).

The measurement and modification of the behavioral causes of accidents not only has a logical rationale, but several recent studies provide empirical support as well. For example, Zohar (1980) reviewed two studies in which various tokens were made contingent upon the use of earplugs by employees in textile plants. As a result earplug usage was increased from an average baseline of 35% to a level of 85% - 90%.

Similar results were found in a metal fabrication plant where more employees began wearing earplugs after receiving feedback concerning the amount of their hearing loss (Zohar, Cohen, & Azar, 1980).

In the area of coal mine safety, a combined program of periodic inspections, contingent punitive control, praise, and graphic feedback was successful in reducing the number of ventilation violations to zero for ten months at a mine with four coal-producing sections (Rhoton, 1980).

Smith, Anger, and Uslan (1978) employed a social reinforcer (supervisory praise) to increase the use of eye protection equipment among shipyard employees. They had found that over 60% of the on-the-job injuries were eye injuries, and therefore trained firstline supervisors to observe, record, and appropriately praise worker behavior. In yet another field study, Larson and her colleagues used a tachograph recorder attached to patrol cars to monitor such vehicle functions as speed, distance traveled, non-movement, and the use of emergency equipment (Larson, Schnelle, Kirchner, Carr, Domash, & Risley, 1980). They found that appropriate use of the patrol cars improved after the police officers received monitored supervisory feedback in conjunction with the tachograph records. Further, there was a large reduction in repair costs and virtual elimination of personal injury for the 224 vehicles involved, which drove over 4 million miles per year.

In addition to the previous field studies, support for the use of applied behavior analysis has also been found with well-controlled laboratory investigations in which the frequency of unsafe acts was reduced with the use of accident simulation and other contingent negative consequences (McKelvey, Engen, & Peck, 1973; Rubinsky & Smith, 1973).

Methodological Contributions: A third advantage of the applied behavior analysis approach is that it offers methodological as well as substantive contributions to the area of safety research (Bouchard, 1976; Fitch et al., 1976; Hersen & Barlow, 1975; Kazdin, 1973; Komaki, 1977; Komaki et al., 1978). As Komaki (1977) has noted, the use of control groups or randomization of subjects is often difficult in field settings. It is still possible to draw conclusions about the efficacy of an intervention procedure with a within-subject, multiple-baseline design (Baer, Wolf, & Risely, 1968). This entails collecting concurrent baseline data repeatedly over a period of time on multiple behaviors, groups, persons, or settings. A second feature of the design involves staggering the introduction of the intervention across the various behaviors, groups, etc. (Hersen & Barlow, 1976; Komaki, 1977). This procedure allows one to rule out history, maturation, statistical regression, and instrumentation (Campbell & Stanley, 1963) as alternative explanations for the results (Komaki, 1977). To be more specific, if changes in behavior (e.g., safe behavior) occur only after the intervention has been introduced and only for those groups or behaviors receiving the treatment, then it is unlikely that an extraneous event (history) and/or process operating as a function of time (maturation) were responsible for the change (Komaki, 1977). Similarly, regression effects would be seen in any series of repeated measurements of the behaviors and not only after the introduction of a treatment. Instrumentation, i.e., observer bias or a faulty measuring device, can be eliminated as a plausible alternative hypothesis if the assessment of interrater realiability (common in behavioral studies) shows substantial agreement (Komaki, 1977).

Several recent studies exemplify the use of applied behavior analysis with a multiple-baseline design to evaluate the effectiveness of a safety campaign. For example, Zohar (1980) reports one study in which a token economy system designed to increase earplug usage was introduced at staggered intervals across three shifts of a textile plant's weaving department. The results showed that an increase in earplug usage occurred in each shift only after the treatment was employed in that shift.

Another across-subjects-multiple-baseline experimental design study is reported by Sulzer-Azaroff (1978). In the study, corrective feedback to ameliorate hazards was given to university laboratories assigned to either an early, middle, or late feedback condition. The results demonstrated that following the delivery of feedback there was generally a substantial reduction in safety hazards. A similar study employing a "feedback package" in several departments of a manufacturing firm yielded comparable results (Sulzer-Azaroff & Santamaria, 1980).

Two well-controlled studies by Komaki and her colleauges are particularly worth noting since the present investigation will attempt to replicate several features of these studies. The first study (Komaki, Barwick, & Scott, 1978) was done with the wrapping and make-up departments of a large wholesale bakery. The bakery had been experiencing an unusually high injury rate with previous safety efforts consisting of posting commercial safety posters and irregularly posting accident information.

A behavioral observation code was tailored for each department and field tested to eliminate ambiguities in interpretation. The non-participant observers would observe each area of each department and check the respective code items as safe, unsafe or not observed. The level of safety performance was the percentage of items performed safely by the group with respect to the total observed. The instrument used to measure safety was found to be very reliable as evidenced by the high level of interrater agreement (over 96.7%).

The investigation employed a multiple-baseline design with a reversal component. After the baseline observation period, the wrapping department employees were exposed to the intervention which had three salient features. First the employees went through a training session consisting of viewing pairs of 35 mm slides depicting safe and unsafe acts in accordance with the safety observational code. Next they were shown a graph depicting their baseline performance and asked to try to improve their safety to achieve a 90% goal. The graph was then posted in the departments and updated after each observation period. In addition to the feedback and training, supervisors were asked to comment and recognize workers performing safely. After 8 weeks of baseline, the second department was also exposed to the intervention procedure. Later the observers discontinued providing feedback via the graph data. Unlike previous studies (Sulzer-Azaroff, 1978; Sulzer-Azaroff & Santamaria, 1980), Komaki et al. (1978) did not provide the departments with any feedback concerning how they could improve their safety performance.

Visual inspection of the data showed considerable improvement in the performance of safe behaviors only after the intervention was introduced. The effectiveness of the training-goal setting-feedback treatment is further noted by the fact that safety performance returned to baseline levels during the reversal phase. The accident rate continued to decline for at least 10 months after the end of the study.

A second study (Komaki, Heinzman, & Lawson, 1980) was conducted in 4 departments of a city's vehicle maintenance division. The investigation essentially followed the same format as the first. Safety performance was measured by the behavioral checklist of safe and unsafe acts that were identified for each department based on their previous accident reports; and the training session consisted of a presentation of slides depicting the target behaviors. A multiple-baseline design across departments with a reversal component was again employed.

The latter study (Komaki et al., 1980) was designed to perform a component analysis of the relative effects of training and supervisory feedback. After baseline, the training was presented alone; then the feedback (and goal setting) was added; then feedback was removed; and finally it was reintroduced.

The results revealed that significant improvement in safety performance occurred only after feedback was given. The level of safety in each department decreased when supervisory feedback was withdrawn but the effects of training remained. Interestingly, performance did not increase when feedback was reintroduced. Komaki et al. (1980) noted, however, that the supervisors provided feedback quite irregularly and infrequently the second time around. In addition to behavioral changes, there was also a reduction of lost-time accidents during the 8 month period of the program.

It was concluded that training alone was not sufficient in improving safety performance, i.e., increasing the frequency of safe behaviors. Frequent feedback seems to be a necessary condition. In this experiment, as in the first, there were two types of feedback given--strictly knowledge of results (KR) and a more extrinsically evaluative type of feedback in the form of praise and recognition. Komaki et al. (1980) noted that the effects of the latter type were probably weak due to a lack of supervisory participation.

Summary and Comment

The review of the literature in this section has tried to illustrate the contributions that applied behavior analysis can make to safety research. To recapitulate, by pinpointing safe and unsafe behaviors and manipulating consequence contingencies to modify these acts, one is directly treating a major cause of accidents and thus preventing injuries. Furthermore, frequent observation and recording of operationally defined target behaviors allows one to measure safety performance without relying on infrequent and costly accidents and injuries. By using a behavioral measure of safety, the effectiveness of an intervention can be assessed more readily and action can be taken to prevent possible mishaps. Finally, methodological advantages associated with applied behavior analysis also makes it appealing for evaluating components of a safety program. That is, a within-subject, across-group, multiple-baseline design enables one to test the efficacy of an intervention without the need for a control group or randomization of subjects, both of which are difficult to obtain in actual field settings. As in the studies by Komaki and her colleagues (Komaki et al., 1978; Komaki et al., 1980), a reversal in addition to the multiple-baseline design can even more convincingly demonstrate the effectiveness of an intervention or interventions. If performance substantially decreases and perhaps returns to a prior level after removal of treatment, then one may say that improvements were a function of the intervention and not other extraneous variables (Hersen & Barlow, 1976; Komaki, 1977). However, one may question the removal of an effective intervention procedure in occupational safety research. To quote Hersen and Barlow (1976):

> Ethical considerations are of paramount importance when the treatment variable is effective in reducing self- or other-destructive behaviors in subjects. Here the withdrawal of treatment is obviously unwarranted, even for brief periods of time. (p. 225)

Therefore, when removal of a treatment is unfeasible for either ethical or practical reasons, a multiple-baseline design is sufficient (Baer et al., 1968; Hersen & Barlow, 1976; Kazdin, 1973; Komaki, 1977).

In addition to exemplifying the criteria and experimental design advantages of an applied behavior analysis approach to safety research, several of the studies reviewed also demonstrated the utility of non-monetary consequences such as performance feedback in enhancing safety performance. These studies typically employed knowledge of performance in conjunction with other extrinsic conditions such as praise and recognition, training, goal setting, corrective feedback, disciplinary action, accident simulation, and equipment stoppage (Komaki et al., 1978; Komaki et al., 1980; Larson et al., 1980; McKelvey et al., 1973; Rhoton, 1980; Rubinsky & Smith, 1973; Smith et al., 1978; Sulzer-Azaroff, 1980; Sulzer-Azaroff & Santamaria, 1980; Zohar, 1980; Zohar et al., 1980). It has been noted however, that future research is needed to determine the relative contributions of each of these components as procedures for enhancing safe performance (Komaki et al., 1980; Sulzer-Azaroff & Santamaria, 1980).

If the reader will recall, Komaki et al. (1980) demonstrated how a component analysis of the effects of training and feedback could be done with applied behavior analysis and a multiple-baseline design. A similar design would be useful for conducting future research separating the effects of the other procedures. For example, one current controversy concerns the relative importance of goal setting versus knowledge of results (KR) or knowledge of performance. Resolution of this controversy may not only benefit safety research, but may also have general theoretical significance as well. The next section will discuss this controversial issue in more detail.

## GOAL SETTING AND KNOWLEDGE OF RESULTS

### Introduction

The use of knowledge of performance to enhance learning and task performance has been reported to be one of the best established findings in psychology (Ammons, 1956; Annett, 1969; Bilodeau & Bilodeau, 1961). Support for the use of knowledge of results to enhance performance is found in both laboratory (e.g., Church & Camp, 1965; Leamon, 1974; Pritchard & Montagno, Note 2; Pritchard, Montagno, & Moore, Note 3) and field studies (e.g., Adam, 1972; Braunstein, Klein, & Pachla, 1973; Catano, 1976; Hundal, 1969; Panyan, Boozer, & Morris, 1970; Payne & Hauty, 1955; Quilitch, 1975; Seligman & Darley, 1977). It has been suggested that in discussing the effects of feedback, a distinction between informational KR and motivational KR needs to be made (Payne & Hauty, 1955). The former type of KR provides the individual with information about the correctness of a response and/or a way to achieve the desired response. Motivational KR refers to simply providing information concerning one's performance score. The latter type of KR indicates an incentive value when it is given in relation to a standard. The latter KR may also serve a reinforcement function especially when it signifies achievement of a desired level of performance (Bilodeau & Bilodeau, 1961; Campbell & Pritchard, 1976; Chapanis, 1964; Hundal, 1969; Pritchard & Montagno, Note 2; Pritchard, Montagno, & Moore, Note 3). The controversial issue to be discussed in this review concerns only the motivational or incentive/reinforcement function of KR. Henceforth, in this review of the literature, the terms knowledge of results (KR), or performance feedback shall refer to motivational type.

## Goals as Mediators of Incentives

The controversy surrounding KR stems from Locke's (1968) thesis that an incentive (or an external environmental condition) has no effect independent of its effect on the goals set by the individual. Locke (1968), in accord with others (Annett, 1969; Dulany, 1962, 1968;

Fryer, 1964; Mace, 1935; Ryan, 1958, 1970), contends that the most immediate determinant of an individual's behavior in a specific situation is his/her goal, intention, desire, want, wish, or task in that situation. Therefore, the effects of incentives on performance are dependent on their influence on goals and intentions. Specifically, an incentive such as instructions (e.g., assigning performance goals), will affect behavior only if they are consciously accepted by the individual and translated into specific goals or intentions (Locke, 1968). As Locke (1968) further notes:

> This applies equally well to the instruction by an experimenter to 'try for quality in your answers' to the instruction by a shop foreman to 'produce 400 portzeebies an hour'. It is not enough to know that an order or request has been made; one has to know whether or not the individual heard it and understood it, how he appraised it, and what he decided to do about it before its effects on his behavior can be predicted and explained. (p. 174)

It should be noted that the use of instructions, i.e., the assignment of specific and difficult goals to enhance performance, is one of the more durable findings of goal setting research (reviews by Latham & Yukl, 1975a; Locke, 1968, 1975; Miner & Dachler, 1973; Mitchell, 1979; Steers & Porter, 1974). Goal acceptance, however, is a key element (Locke, 1968). Several recent studies have shown that accepted assigned goals which are specific and reasonably difficult can be equally effective as participatively set goals and usually saves time (Dossett, Latham, & Mitchell, 1979; Ivancevich, 1976; Latham, Mitchell, & Dossett, 1978; Latham & Saari, 1979; Latham & Yukl, 1975b, 1976; Yukl & Latham, 1978).

Goals or intentions are also considered to mediate the effects of incentives such as time limits (Bryan & Locke, 1967; Dossett, Latham,

& Saari, 1980; Latham & Locke, 1975; Nevin & Ford, 1976), supervision (Ronan, Latham, & Kinne, 1973), and evaluation apprehension (White, Mitchell, & Bell, 1977).

Monetary incentives, according to Locke (1968), serve to commit subjects to tasks which they would not otherwise undertake. In other words, money (if it is valued by the workers), will encourage employees to accept tasks and set goals that they would not accept or set on their own (i.e., for the intrinsic enjoyment of the work itself). The empirical basis for this proposition stems from five laboratory studies by Locke, Bryan, and Kendall (1968) which found no relationship between incentive condition and behavior when goals were controlled or partialed out.

More recent studies using larger monetary incentives than Locke, Bryan, and Kendall (1968) have failed to confirm their findings. Instead, significant main effects for both incentive and goal conditions were often found (Latham, Mitchell, & Dossett, 1978; London & Oldham, 1976; Pritchard & Curts, 1973; Terborg, 1976; Terborg & Miller, 1978; Yukl & Latham, 1978). The recent findings suggest that maximum effects can be obtained by combining goal setting with monetary incentives/reinforcements (London & Oldham, 1976; Pritchard & Curts, 1973; Terborg, 1976; Terborg & Miller, 1978).

Goals as Mediators of KR

Rationale: As with these previous incentives, Locke (1968) stated that the effects of KR are mediated by goal setting. He further noted that it is not enough to simply provide knowledge of results. In order for it to be effective, KR has to be interpreted and evaluated. Understanding the information implies that cognitive processes are operating (Locke, 1968). Thus the important factor is what an individual does with the KR that he/she receives.

In concern with this proposition, Latham and Yukl (1975a) reviewed the literature and concluded that performance feedback or KR could lead to an increase in effort and performance in at least four ways: a) KR may induce a person who previously did not have specific goals to set them; b) KR may induce a person to raise his goal level after attaining a previous goal; c) KR may inform the individual that his current level of effort and performance is insufficient to attain his goal or standard, thus greater effort may result; and d) KR may inform the person of ways to improve his method of performing a task (i.e., informational KR). The first three "motivational" aspects of feedback are the primary concern in Locke's (1968) goal setting theory. These three statements indicate that KR is only effective through its effects on goals or intentions.

Empirical Evidence: The empirical evidence supporting Locke's (1968) contention that goals mediate the effects of KR comes largely from laboratory studies (reviews by Latham & Yukl, 1975a; Locke, Cartledge, & Koeppel, 1968). For example, Locke, Cartledge, and Koeppel (1968) reviewed a number of studies in which the relative effects of goal setting and KR were separated by a) post hoc questionnaire analysis (Locke & Bryan, 1966, 1968); b) experimental manipulation (Locke, 1967), or c) comparing the effects of KR alone relative to the effects of KR plus goal setting. The general conclusion reached from these studies was that the effects of KR were vitiated when the effects of goal setting were removed.

The importance of goal setting was illustrated in a series of experiments by Locke and Bryan (1969a). They found that having the subjects focus their goals on one task parameter resulted in performance improvement for only that parameter. This result occurred even when the subjects received KR for all of the task parameters. For example, one task involved having subjects either minimize the number of errors or maximize the number of correct answers to addition problems. They received KR on both dimensions but improvements were generally seen for the goal-dimension only. These results were also generalized to a vehicle driving task involving five separate dimensions. This experiment required the subjects to set goals for improving their performance on two parameters. Again, despite KR given for all, improvements were seen only for those parameters for which goals had been set.

In another study, Locke and Bryan (1969b) measured subjects' performance on several series of simple addition problems in an experiment employing a 2 (KR vs. No-KR) X 2 (hard vs. easy goal) factorial design. As in the previous studies, the hard goal group generally performed better than the easy goal group, regardless of the KR condition. Again, KR was found not to account for much of the performance variance when goal setting was partialed out (Locke & Bryan, 1969b).

Cummings, Schwab, and Rosen (1971) were able to show directly that past performance and KR were determinants of goal setting. They hypothesized and found that a higher level of previous performance would lead to higher goal setting for future performance on simple addition problems. Further, with previous performance accounted for, the greater the amount and accuracy of KR, then the higher the level of goal setting. They found that 26% of the self-reported goal setting variance was accounted for by past performance. When past performance and KR were combined, 44% of the variance was accounted for. Interestingly, the study did not report any task performance results.

While the previous laboratory studies (i.e., Cummings et al., 1971; Locke, 1966, 1967; Locke & Bryan, 1966, 1968, 1969a, 1969b) may provide evidence that KR has no effect on performance independent of its effect on goal setting, there has been a paucity of field research in which goal setting and performance feedback have been independently manipulated (Latham & Yukl, 1975a). Many studies which have tested the "practical significance" of Locke's (1968) theory have usually provided KR in conjunction with the goal setting procedures. It was often assumed that KR would not have any additional effects over and above the effects of goal setting, nevertheless, it was considered necessary (e.g., Campbell & Ilgen, 1976; Dachler & Mobley, 1973; Dossett et al., 1979; Latham & Baldes, 1975; Latham & Kinne, 1974; Latham & Saari, 1979; Latham & Yukl, 1975b; Latham et al., 1978; Umstot, Bell, & Mitchell, 1976; Umstot, Mitchell, & Bell, 1978; Wexley & Nemeroff, 1975; Yukl & Latham, 1975b).

One field study which has been noted (Locke, 1980) as demonstrating the necessity of goals in addition to KR was completed by Latham and Baldes (1975). They assigned specific hard goals to truck drivers concerning the size of the load of logs they hauled. The drivers had always been able to determine the weight of their load, i.e., receive KR, but it was not until specific goals were set did they begin increasing the amounts hauled. In this case, goal setting may have facilitated an increased awareness of the feedback measures that were already available. Latham and Baldes (1975) also reported that supervisors gave "specific praise to drivers when goals were met." Thus, a possible confound existed. Further, while the goal setting and KR seemed to increase the drivers' sense of achievement, recognition, and commitment to the company, the drivers also modified the trucks and suggested other ways to increase load size.

Locke (1980) found further support for his "goals as mediators of KR" hypothesis by reinterpreting the results of Komaki et al.'s (1978) safety study. Locke (1980) asserted that a cognitive explanation of the results was more plausible as he logically critiqued the claim that feedback acted as a reinforcer in the study and/or whether it played any causal role in the experiment at all. It is not exactly clear whether Locke (1980) is referring only to the praise or recognition "feedback" or the KR-performance feedback found (and confounded) in Komaki et al.'s (1978) experiment. Nevertheless, he proposed a number of arguments against the feedback-as-reinforcement thesis provided post hoc by Komaki et al. (1978).

First, based on previous reviews (Annett, 1969; Locke, Cartledge, & Koeppel, 1968), Locke (1980) noted that feedback itself does not automatically improve performance, but serves as a source of information regarding the adequacy of performance in relation to one's goal or standard. Thus, as noted earlier, the primary motivational element is actually the goal, value, or conscious purpose.

Second, Locke (1980) claimed that feedback in the Komaki et al. study was not given contingent on good performance, but simply on performance. According to reinforcement principles, this should have resulted in static performance and not the improvement that was found. According to Locke (1980), the subjects cognitively chose to improve their performance based on their interpretation of the feedback.

A third criticism with the findings of Komaki et al. (1978) is that there was no learning curve showing gradual improvement as expected in classical reinforcement theory. The dramatic improvement, shown before reinforcers (praise and recognition) were presented, and the sudden drop during the reversal phase suggest that a more parsimonious explanation of this and other behavior mod experiments is that:

> . . . more likely what occurred was a conscious redefinition of the job resulting from the new standards and the more accurate feedback regarding performance in relation to those standards. (Locke, 1977, p. 548)

Two other arguments raised by Locke (1980) further suggest that feedback, an external event, must first operate through cognitive processes before having effects. For example, feedback that is "closer" to a standard is considered more positive than feedback that is "farther" from the standard. This would suggest that higher performance would be reinforcing. This would also require a conscious awareness on the part of the employee of where they stood in relation to their goal. In addition, if feedback is to provide information to someone, that information must be understood. If feedback is given via praise, reproof, or recognition, it is still translated into knowledge of results of prior performance. This is an implicit assumption in all feedback research, including that done by behaviorists (Locke, 1980).

In sum, Locke (1980) makes a strong argument that a cognitive explanation is more plausible for the findings of Komaki et al. (1978).

Necessity of KR: The studies reviewed thus far which have tried to separate the effects of goal setting and KR have all provided similar results and conclusions. Whether the relative effects were separated by post hoc manipulation (e.g., Cummings et al., 1971; Locke & Bryan, 1966, 1968); by experimental manipulation (Locke, 1967; Locke & Bryan, 1969b); or by comparing the effects of KR alone relative to KR plus goal setting (Latham & Baldes, 1975; Locke, 1966b; Locke & Bryan, 1969a), the general conclusion was that goal setting was a necessary condition for KR to have any motivational effects on behavior. Another implication of these studies is that successful manipulation of an individual's or group's conscious goal(s) may be a sufficient condition for motivating performance. That is, if assigned, specific, and difficult performance goals are accepted by an individual or group, then task performance will be enhanced without the need for other extrinsic incentives such as KR or monetary contingencies. However, the empirical evidence concerning this implication is not unequivocal. It has already been noted that monetary incentives may have effects over and above the effects of goal setting alone (London & Oldham, 1976; Pritchard & Curts, 1973; Terborg, 1976; Terborg & Miller, 1978). The same result may also be true of nonmonetary incentives such as KR. Recent evidence has been found to support this conclusion.

In another test of Locke's (1968) theory, Erez (1977) hypothesized that goals were related to performance only when KR was present. Such a prediction is in accord with the theorem that behavior is a function of the interaction of the environment (KR) and the individual (cognitive intentions).

Erez (1977) used two forms of a number list comparison section of a clerical aptitude test as the task for the lab study. Performance was measured by the number of correct answers. At the end of the first trial, the experimental (KR) group received information concerning their performance relative to the others (i.e., among the highest 10%, 25%, 50%, 75%, or 90%). The control group did not receive any information concerning their performance. Before the second trial, the subjects checked their level of intention on a five point scale.

The results indicated that KR subjects had higher levels of intentions (self-set goals) than those in the No-KR condition. The relationships between self-set goals and performance ($r = .24$) and between KR and performance ($r = .25$) were significant across all subjects. When KR was controlled for, the self-set goal/performance relationship was $r = .60$ with KR but .01 for No-KR. Thus, the effects of goal setting were moderated by KR. However, it was also noted that the interaction of KR and goal setting accounted for 39% of the performance variance while 34% was accounted for by initial differences, feedback, and goal setting combined. It would appear, therefore, that feedback is a necessary condition for goal setting to be effective (Erez, 1977).

Other laboratory investigations also suggest that feedback may be a necessary complement to assigned goals in facilitating performance. Arnett (1974), for example, found that KR and competition had significant, albeit weak, correlations with performance on a repetitive construction task, even after the effects of goal indices were removed. The goal indices, measured by a post-experimental questionnaire, remained strongly correlated with performance even after KR and competition effects were separately and jointly removed by partial correlation analysis.

Similar to the study by Erez (1977), Strang, Lawrence, and Fowler (1978) also investigated the necessity of feedback for goal setting. They assigned quantity and quality goals for performance on complex arithmetic computation tasks, and provided KR with respect to each task dimension. The results confirmed Locke's (1968) conclusion that the effects of motivational KR depend upon goal conditions, (i.e., specific, hard goals). Strang et al. (1978) found that computational speed was enhanced only when accompanied by explicit KR coupled with the assignment of a challenging goal. Furthermore, this increase in computational speed was not paralleled by any loss in accuracy. There was, however, no evidence that goal setting alone facilitated performance. In fact, subjects assigned challenging goals but not given KR actually showed a significant increase in errors.

Strang et al. (1978) concluded that KR may function not only as a complement but, as Erez (1977) suggested, a necessary partner of goals in determining subsequent performance. Replication of the results in applied settings was also suggested.

Two recent field studies also provide evidence that KR can increase performance above and beyond goal setting alone. In one study, Becker (1978) used a 2 (high vs. low goal) X 2 (KR vs. No-KR) factorial design to determine the joint effect of feedback and goal setting on residential energy consumption. He reasoned that giving a person knowledge of his/her performance in relation to a standard would influence the amount of effort exerted and thereby enhance performance. If one has no information concerning their performance, then one has no way of knowing if a change in effort is required. Likewise, if one has no goal or standard level of performance to achieve, then feedback is irrelevant.

The results of Becker's (1978) study confirmed the proposition that both a difficult goal and KR in relation to that goal were necessary to produce a significant decrease in energy consumption. Residents with easy, low goals and No-KR actually wasted more energy.

In the second study, Kim and Hamner (1976) used a quasi-experimental design to determine if goal setting with a contingent extrinsic outcome enhanced performance more than goal setting alone.

The subjects were blue collar unionized workers of four plants of Midwestern Bell. They were not randomly chosen, and, for logistical reasons, each plant served as the group for one experimental condition. Though there were similarities in functions, between plant differences should have been accounted for in the final analysis. It is not clear if this was done or not. In such incidences, a within-subject multiple-baseline design may have been more appropriate (Baer et al., 1968; Hersen & Barlow, 1976; Jones et al., 1977; Kazdin, 1973; Komaki, 1977).

Overall, the results demonstrated that while there was an increase in performance after goal setting, there was an even greater increase when feedback or KR was given. There did not appear to be any significant differences between extrinsic or intrinsic feedback; the maximum effects were attained when they were combined. These findings were restricted to cost performance (forecasted costs/actual costs) and safety performance (points subtracted from 100 for various accidents) only.

Summary and Comment

To recapitulate the findings of these recent lab and field investigations, the evidence indicates that feedback may be a necessary addition for goal setting to be maximally effective (Arnett, 1974; Becker, 1978; Erez, 1977; Kim & Hamner, 1976; Strang et al., 1978). Several investigators have noted that KR adds meaning to the task goals (Annett, 1969; Erez, 1977; Latham & Kinne, 1974; Locke, 1980; Steers & Porter, 1974). Further, the addition of KR in relation to a goal or standard may enable one to obtain a sense of achievement which may affect future goals and performance (Hall & Foster, 1977; Hall & Hall, 1976). The presence of KR may also provide the individual or group with information concerning the amount of effort required to achieve a desired level of performance (Becker, 1978; Latham & Yukl, 1975a).

While the latest evidence presented here suggests that the effects of KR and goal setting may be additive, much of this evidence comes from laboratory studies (e.g., Arnett, 1974; Erez, 1977; Strang et al., 1978), with college students as subjects. One may question if the results of these studies will generalize to the real world (Campbell, Dunnette, Lawler, & Weick, 1970). The field studies completed have been few but generally supportive of the proposition that goal setting and KR should be combined (Becker, 1978; Kim & Hamner, 1976). These studies, however, suffered possible methodological problems. For example, one may question comparing performance across different plants at different locations (e.g., Kim & Hamner, 1976). Initial individual differences need to be accounted for as well as other extraneous occurrences taking place at each separate geographical location. Further, since an evaluative type of an incentive, i.e., praise, was present, the effects of "motivational" KR and goal setting may have been confounded in the Kim and Hamner (1976) study. Similarly, Becker's (1978) study on residential energy consumption may have had an inherent extraneous variable confounding the results. As the KR plus difficult goal residents reduced their energy usage, they also reduced their bills, thus a monetary incentive and/or reinforcer may have been operative.

It has been fairly adequately shown, both logically and empirically, that KR alone is not sufficient for enhancing performance. Implicit or explicit goals or intentions are necessary conditions for KR to be effective (e.g., Annett, 1969; Arnett, 1974; Cummings et al., 1971; Hall & Foster, 1977; Latham & Kinne, 1974; Latham & Yukl, 1975a; Locke, 1968; Locke, Cartledge, & Koeppel, 1968; Steers & Porter, 1974). More research is needed however, to determine if goal setting alone is sufficient for enhancing performance in actual industrial/ organizational settings (Mitchell, 1979).

## RESEARCH OBJECTIVES

The purpose of the present study is two-fold. First, for theoretical advancement, it will attempt to correct some of the methodological problems of the previous research in evaluating the possible additive effects of KR and goal setting in an organizational environment. To accomplish this, a within-subject, multiple-baseline across-groups design will be employed. Further, as in the Komaki et al. (1980) study, a component analysis of the two variables will be done in which goal setting will be established and KR later added. Performance (in this study, safe behavior), is expected to improve when specific, difficult, and accepted departmental goals are assigned. Employee performance will be further enhanced, however, when they receive feedback concerning their department's performance in relation to their goal. The study does not question Locke's (1968) proposition that cognitive processes must operate before KR can be effective. It is concerned with the necessity of an extrinsic incentive such as KR in relation to a conscious goal or standard.

The second objective is of practical importance in that the study will systematically evaluate the effects of a safety program. Specifically, it will attempt to show that the combined effects of goal setting and KR will increase the frequency of safe behaviors and thereby reduce the frequency and liklihood of an industrial accident and/or injury. Thus, the study will contribute to the growing body of literature utilizing applied behavior analysis in safety research.

The specific hypotheses of this study are:

1. Safety performance after training employees to engage in safe behaviors will be greater than performance during baseline.
2. Safety performance after the assignment of a specific, difficult, yet acceptable goal will be greater than performance after training only.

3. Safety performance after the addition of frequent knowledge of results (KR) will be greater than performance after goal-setting and training.

## METHOD

### Setting and Subjects

Setting: The study was conducted in a sugar cane machinery manufacturing plant located in southeast Louisiana. The company's top management expressed a concern over the relatively large number of accidents being reported. This concern was well founded as evidenced by the comparison of the company's accident rate with the national average reported by the National Safety Council (1980). The average occupational injury and illness incidence rates for similar organizations for 1977-1979 were 15.82 total recordable cases and 7.19 lost workday cases per 100 employees. Using the same criteria and computational formula suggested by the National Safety Council and OSHA, the rates for this company for 1979 were 40.0 total cases and 14.32 lost-time cases per 100 employees. The national average number of workdays lost was 90 compared to 383.21 for the organization in question. For 1980, the company's rates were 43.61 total cases; 9.81 lost-time cases; and 159.50 lost workdays per 100 employees.

The plant's safety program at this time consisted of posting commercial safety warning signs and assigning the electrical-maintenance supervisor to be in charge of safety. His duties included keeping abreast of current OSHA rules and regulations, and maintaining the equipment and machinery in safe condition. There was no formal company safety policy or training program for the plant employees. The investigator was therefore asked to assist the safety supervisor (a.k.a. electrical-maintenance supervisor) in developing a safety manual and corresponding safety training session. In addition, the management requested a program for motivating employees to follow the safety rules. They stipulated a preference for a program not utilizing extrinsic incentives such as monetary bonuses, safety prizes, and/or disciplinary action. It should also be added that improving safety performance was a goal unanimously set by the shop's first-line supervisors when they participated in a recent MBO seminar. Thus, safety was a concern expressed by all the levels of management.

The following proposal was submitted to the executive vice-president, vice-president in charge of production, safety supervisor, and first-line supervisors for their approval. The research interests of the investigator and the experimental nature and rationale of the design were fully explained to these managers, who in turn gave their complete support for the project. Later, permission to use the data for a doctoral dissertation was also given.

Subjects: An analysis of the company's accident reports for the past three years revealed that 95% of the recorded injuries and illnesses occurred in eleven departments located in the shop area of the plant. It was therefore decided that the 105 full time employees in these departments would serve as subjects for the study. The departments are Crating (N = 6); Final Assembly (N = 25); Heavy Equipment (N = 10); Hydraulics (N = 8); Machine Shop (N = 6); Mechanics (N = 6); Painting/Sandblasting (N = 5); Parts (N = 13); Raw Material Prep (N = 14); Sub-Assembly (N = 8); and Welding (N = 5). A brief description of each department appears in Appendix A. The relative location of each department is shown in Appendix B.

Criteria Measures

The main dependent variable in this study was the percentage of employees in each department performing their job in complete accordance with the observational checklist and company safety manual.

Instrument: Prior to the study, the investigator assisted the plant's safety supervisor in writing a company safety manual. The rules and regulations stated in the manual were obtained from several sources. First, the accident reports for the last three years were reviewed to identify unsafe acts which resulted in injuries. For each unsafe act found, a behavioral safety rule was written to specify the correct and safe way to perform the task in question. However, many of the accident reports were incomplete and unable to provide information concerning the antecedent conditions of the accidents. Therefore, additional behavioral items were obtained from supervisors' and employees' suggestions; established safety practices advocated by OSHA and the American Standards Institute (ANSI); other related companies' manuals; and the recommendations of the various tool and equipment manufacturers. A copy of the manual appears in Appendix C.

An observational checklist based on the manual was also developed (Appendix D). The manual's items were classified as General Safety, Personal Protective Equipment, Housekeeping, Material Handling, and Tool & Equipment Use. Sub-categories of items were also identified under the above classifications listed on the observation form. For example, under personal protective equipment, the observer could mark if an employee was wearing proper eye and face protection or hand and arm protection for the particular task he/she was performing at that time.

The observational checklist was developed in an abbreviated form in order to allow an observer to carry the form easily and make unobtrusive observations. One of the long term objectives of the company was to have the first-line supervisors trained to make observations; thus, a form which could be carried on their person at all times was requested. Further, many of the behavioral items could be grouped or coded for easy scoring, and habitual violations could still be identified. By taking note of the activity the employee was engaged in, one could determine which behaviors they were performing safely or unsafely.

A pretest of the observation form revealed several ambiguities in the scoring form and the safety manual items. For example, the different observers were unable to remember all of the safety rules or agree on which rules applied in which situations. Therefore, a second list of 37 behaviorally specific safety items (Appendix E) was developed for observational and training purposes. This list was not only more precise in the operational definitions of safe and unsafe acts than the safety manual, but it also focused on the behaviors judged by the first line supervisors to be the most problematic and potentially hazardous. The list of actual observational items, how they were scored, and their safety manual reference item appears in Appendix E. Further, the various departments for which the safety items were applicable are also designated in Appendix E.

Observation Procedure: The observation procedure involved observing each employee in the eleven departments for 15 to 20 seconds. After observing an employee, the observer then recorded the individual's department, the date, the time of day (am or pm), and his/her current activity or task on the safety check form (Appendix D). Next, the behavioral safety items (Appendix E) that were applicable for the employee's activity were marked as being performed safely ( ✓ ) or unsafely ( X ). The observations were made in full view of the employees, but attempts were made to record the scores unobtrusively. The observation session generally lasted about 2½ hours.

Observations were made 2 to 4 times ($\bar{X} \approx 3$) per week depending on the length of the work week. The observations were made at various times of the day and varying days of the week. They were never made twice on one day. A total of 162 observations were made during the 56 week study.

The observations were made by 2 observers: the investigator (primary observer) and the safety supervisor (secondary observer). A tertiary observer (a graduate student in management) made observations through sixteen weeks of the first two phases of the study. Overall, the primary observer made 77.16% of the observations, the secondary observer--11.73%; and the tertiary observer--11.11%.

Prior to actual data collection, the secondary observer (and later the tertiary observer) was trained to make the behavioral safety inspections. Training consisted of reviewing the abbreviated observational code and scoring form (Appendices E and D respectively); viewing 35 mm slides which depicted the safe and unsafe acts to be observed (Appendix G); and making practice observations while accompanied by the primary observer. By having the primary and secondary observers make concurrent yet independent observations, interrater reliability could be assessed as a check for observer bias or instrumentation effects. To check reliability, a percentage agreement method was used in which the number of agreements was divided by the total number of observations and multiplied by 100. An agreement was tallied when both raters scored an employee's behavior in an identical manner. Data collection began after the two observers reached 90% agreement on the practice observations. This training procedure and reliability criterion was also used for training the third observer who made observations from the 7th week through the 21st week of the study.

In addition to assessing interrater reliability prior to data collection, it was also computed throughout the study. Reliability checks were made at the average rate of approximately one every 5 weeks (or 15 observations), with a total of 11 checks for the study. The agreement checks always involved the primary observer and one of the other observers. Interrater agreement between the second and third observers was never assessed due to scheduling difficulties of the parties involved.

Computing the Safety Score: As noted earlier, the main dependent variable being measured was the percentage of employees in each department performing their job in a completely safe manner. In this respect, safe performance of a job was considered to be all or none. It was possible for several of the behavioral safety items to apply to an employee performing any given task at any time. While an employee may have been working in accordance with most of the applicable rules, if he/she was violating just one of the safety items, then there existed a possibility of an injury. Therefore, that employee was considered to be working unsafely.

After each observation session, the safety performance for each department was computed by dividing the number of employees working completely safe by the total number of departmental employees observed and multiplying by 100. Weekly departmental safety performance was determined by averaging the results of the observations made that week. As in other behavioral safety studies (e.g., Komaki et al., 1978; Komaki et al., 1980), this measure of safety accentuated positive behavior, i.e., safe behavior. It was assumed that safe and unsafe behaviors were in competition, therefore an increase in one should have been associated with a decrease in the other.

A second dependent variable of the study was the frequency of on-the-job injuries, as recorded by the personnel director of the plant in accordance with OSHA requirements (Public Law 91-596). A pre- and post-intervention analysis of the whole company's accident frequency was planned. There were problems associated with the reporting and recording of injuries occurring at the plant, however. For example, informal interviews with key personnel revealed a lack of consistency of how injuries were reported and/or who they were reported to. While lost-time injuries had a more objective criteria and thus were recorded more consistently than non-lost time accidents, they occurred too infrequently to permit correlational analysis and/or other statistical tests of significance (Komaki et al., 1978).

Since the accident data had deficiencies, a caveat must be issued concerning any conclusions drawn from it. Any change in the accident rate is of practical significance, but such changes must be considered tentatively since they may be a product of measurement variation and not an intervention procedure.

## Design and Procedure

A multiple-baseline design was employed with a total of 4 phases: baseline, Training Only, Training and Goal Setting, and Training, Goal Setting, and Knowledge of Results. Baseline data were collected in all eleven departments, and the intervention phases were introduced in a staggered sequence across groups of departments (see Appendix F). The departments were divided into three groups based on their proximity to one another (see Appendix B), and perceived amount of interdepartment interaction. The groups were: Group 1--Final Assembly, Hydraulics, Mechanics, and Painting/Sandblasting; Group 2--Heavy Equipment, Raw Material Prep, Sub-Assembly, and Welding; and Group 3--Crating, Machine Shop, and Parts. Combining the departments was also done in order to conduct safety meetings efficiently and to introduce each stage of the program without severely disrupting production. Data, however, was collected on a departmental basis.

Training Only: At the beginning of the 14th week of the study, workers in Group 1 attended a safety training session that lasted from 45 to 60 minutes during their regular workday. Due to production demands, half of the Group 1 employees attended the meeting in the morning while a second session was held in the afternoon for the remaining half. Prior to attending the meeting, the workers in the group were each given a safety manual (Appendix C) and asked to read it before coming to the training session.

The training session began with the company's executive vice-president and general manager addressing the workers. He explained to them that the majority of accidents were caused by someone performing an unsafe act. He further added that the responsibility for industrial safety was found at all levels of the organization. Therefore, he asked their (the workers') cooperation in following the regulations stated in the safety manual, in order to reduce the chance of injury by working in a safe manner. The meeting was then turned over to the safety supervisor.

The safety supervisor (with the author's assistance) then reviewed the safety manual with the employees. During this review, he instructed the employees to make certain additions and/or corrections to some of the safety items in their manual. These revised rules provided the employees with the specific behavioral items used for making observations (Appendix E). Next, the employees were shown a series of 35 mm slides depicting the unsafe and safe behaviors specified by the observational code. The slides were taken after work hours and involved employees of the electrical-maintenance department. The workers attending the training session were told that the actions exemplified in the slides were carefully posed for illustrational clarity. Further, while the majority of the slides pertained to behaviors for the entire shop in general, a few slides depicted behaviors and situations specific to a certain department or group of departments. A written description of each slide, the observational code items involved, and the departments and/or group which saw the slide (because of special relevance) is found in Appendix G. Each viewed a total of 38 slides: 17 pairs of safe and unsafe illustrations, 3 slides depicting actual housekeeping violations, and 1 slide exemplifying "horseplay".

The employees first viewed a slide depicting an individual(s) performing a task unsafely. As a group, the workers were asked to verbally state what they observed to be correct or incorrect ("What's safe or unsafe here?"). Invariably, the employees could recognize the unsafe behaviors exemplified in the slide. After the unsafe behaviors were identified, a slide illustrating an individual doing the same job safely was shown and the corresponding safety rules were restated. For the four unsafe behavior slides, the applicable rules were simply restated.

During this meeting, the employees were also shown the observational form and told how their department's safety performance was being observed and measured. The meeting ended with a question and answer period.

After five weeks, the group held another safety meeting again during regular working hours. During this meeting, employee safety knowledge was assessed by asking each worker in attendance to view 10 slides (5 safe - 5 unsafe) and write down what they observed the individual to be doing safely and/or unsafely. The employee's score on this safety quiz was the percentage of behavioral items recorded compared with the total number of items shown in the slides. A different set of ten slides was used for each group. The slides used in each quiz and their respective groups are designated in Appendix G.

The Training Only phase lasted 10 weeks and ended with the introduction of the Goal Setting and Training phase. The second group received the training sequence after 16 weeks of baseline and the third group after the 18th week of baseline. The Training Only phase continued through the 26th and 28th weeks of the study for these two groups respectively. Since the effects of training were considered to be irreversible, it remained a factor in each of the subsequent phases.

Goal Setting and Training: At the beginning of the 24th, 27th, and 29th weeks of the study, a safety performance goal was assigned to Groups 1 through 3 respectively. The safety goal was based on three considerations. First, in accordance with previous goal setting research (e.g., Latham & Yukl, 1975a; Locke, 1968; Mitchell, 1979; Steers & Porter, 1974), the goal had to be specific. Second, the goal had to be perceived as difficult but attainable. The third goal criterion for this particular study was that the safety goal had to be the same for each department. Differing department safety goals may have suggested a difference in previous performance, i.e., the employees may have received implicit KR from different goals being assigned. It was recognized that assigning a constant goal for the entire plant may have varied the difficulty of the goal for departments performing at different levels of safety. Prior to assigning the goal, however, the supervisors from each of the departments agreed that the goal was specific and difficult but attainable by their employees. Therefore, possible differences in perceived goal difficulty across departments was considered to be less disturbing than possibly allowing implict KR to confound the results of this phase of the study.

The goal setting phase was introduced (at staggered intervals across groups) by posting a 12" X 12" sign which read "SAFETY GOAL--90%" (Appendix H). The level at which the goal was set was estimated by computing two standard errors above the mean performance for all the departments after they received the training session. As previously mentioned, this goal level was approved by the supervisors of the shop area.

Two days after the signs were posted, the employees attended another safety meeting during working hours. During this thirty minute meeting, the safety supervisor and the investigator reviewed the safety items covered by the observational code with the workers. Next, it was again explained exactly how the observations were being made and how safety performance was being measured on a departmental basis. The employees were then told that the safety goal was related to their department's weekly safety performance. Weekly performance was determined by averaging the results of the observations made that week. It was also mentioned that 100% weekly safety performance was unrealistically high and therefore not expected. It was noted that if 90% of all the shop employees performed their jobs completely safe, then not only would the goal be attained, but the frequency of injuries would be decreased as well.

After employees' questions concerning the measure of safety or the safety goal were answered, the workers were asked to raise their hand if they thought their department could reach the goal. They were also requested to indicate in a similar manner if they would try to help their department achieve the safety goal by working safety in accordance with the observational code and safety manual. The overall response to these queries was always positive, i.e., an across-group average of 95.79% of the employees gave an affirmative response to each question. The workers were then thanked for their cooperation and dismissed.

After this initial goal setting meeting, the department supervisors were asked to remind their employees each week to try to achieve the safety performance goal. Five weeks after the goals were set, the safety supervisor issued a written reminder to encourage the departments to achieve the goal (Appendix I). This reminder was posted near the safety goal sign in each department.

Since goal commitment and acceptance was considered to be vital to the success of goal setting in enhancing performance (Latham & Yukl, 1975a; Locke, 1968; Steers & Porter, 1974), a manipulation check of these conditions was planned. Though a verbal commitment to the goal was indicated at the initial goal setting meeting, a follow-up questionnaire was administered immediately before the KR phase was introduced in each group of departments.

The questionnaire was an opinion survey used as a measure of job satisfaction (Scott, 1967; Scott & Rowland, 1970; Reitz, Note 4). It consisted of three parts: a bipolar adjectives section, a section with Likert-type scale statements, and an open-ended comment section. The questionnaire was being used as part of an MBO program evaluation. Of concern in this study were responses to the bipolar adjectives concerning the assigned goal that were incorporated in the first section of the questionnaire. In the second section, 10 statements concerning goal commitment, perceived goal difficulty, perceived departmental safety, and supervisory feedback were also added (see Appendix J).

The original plan was for the Goal Setting and Training phase to last 12 weeks. Unfortunately, production demands dictated the postponement of the safety meetings in which the next intervention phase was to be introduced. Therefore, the goal setting and training phase lasted 16 weeks for each group.

Feedback (KR), Goal Setting, and Training: Employees in Group 1 began receiving feedback, i.e., knowledge of results, concerning their department's safety performance during the 40th week of the study. Three weeks later (43rd week), Group 2 employees began receiving KR. The third group of departments received KR starting the 45th week of the study. The goal setting sign (Appendix H) and goal reminder (Appendix I) remained posted during this fourth phase of the study. The procedural sequence for the feedback phase was as follows:

A sixty-minute safety meeting was scheduled for the group during regular work hours. The first half of this meeting was devoted to the employees completing the job satisfaction questionnaire (Appendix J). As previously mentioned, included in this questionnaire were manipulation checks for goal acceptance/goal commitment, perceived goal difficulty, goal clarity, current supervisory feedback, and perceived current departmental safety performance. After completing the questionnaires, the observational code items were discussed along with any new items that the employees suggested. The method for measuring safety for each department was also briefly explained again at this time. Next, the employees were asked to write down that they thought their department's average safety performance was. In other words, they were asked to estimate their department's current weekly safety performance based on the average percentage of employees working in a completely safe manner according to the safety rules.

The next step involved showing the employees in each department their respective average performance as recorded by the observers. To do this, a 12" X 15" sign was made for each individual department. The sign depicted an incomplete line graph with the abscissa labeled "WEEK" and the ordinate labeled "AVERAGE SAFETY PERFORMANCE (%)" (see Appendix K). The 90% mark on the vertical axis was highlighted in reference to the goal level. In addition, the goal level was designated by a horizontal red line drawn at 90%. For each department, the average level of performance observed and recorded for the Goal Setting and Training phase was marked on the vertical axis of the graph and thus provided the employees with their first KR in relation to the goal or standard. These features of the graph were explained to the employees.

The workers were then told that the two observers would continue to make safety observations approximately 3 times a week at various times and on various days. The graphs were posted in their respective departments, and after each observation session, the observer recorded the results on the sign. The observer recorded the date the observation was made and the percentage of employees observed working completely safe in each department. This information was written in the spaces provided after the statement found below the graph (see Appendix K). At the end of each week, the investigator wrote the beginning and ending dates of the work week at the intervals marked on the abscissa. He then recorded the department's average performance for that week on the graph. Thus, the departments received KR 2 to 4 times per week depending on the length of the work week. After this procedure was explained to the employees, and their questions answered, they were dismissed to return to their work. At their next regularly scheduled safety meeting (6 weeks later) the safety goal was reemphasized, and any questions the employees had concerning the KR being provided were answered. This meeting did not focus on the goal or performance levels; but mainly involved discussing new safety procedures and/or suggestions the employees might have for improving safety.

During the feedback intervention phase, neither of the observers provided any explicit evaluative feedback concerning the departments' progress (or regress) in relation to the goal. Attempts were made to provide only information regarding the level of performance in relation to the standard. While such KR may have produced implicit evaluation of performance, this evaluation had to have been intrinsically derived, i.e., the employees themselves being the source. The supervisors of the departments were asked to continue mentioning the safety goal on a weekly basis. They were not asked to provide any priase or reproof based on their departments' performance during this phase. Though such action on the part of the supervisor could not be sufficiently controlled, any observances of supervisory personnel making evaluative comments were noted. Similarly, the observers tried to be aware of and record incidences of informal competition which may have developed between departments according to Komaki et al. (1978, 1980).

The Knowledge of Results, Goal Setting, and Training phase lasted at least 12 weeks for each group of departments.

# RESULTS

In order to present the findings of the study succinctly, this section reports the results of the data analysis for the three groups (of departments) which the interventions were staggered across. The results of data analysis performed on a departmental basis is presented in Appendix L. The latter essentially substantiates the results presented here.

## Observational Reliability and Validity

In an effort to estimate the reliability of the observational procedure, interrater reliability employing the percentage agreement method was assessed eleven times throughout the course of the study. The mean agreement between the primary observer and the secondary observer (assessed 7 times) was 87.68%. The average agreement between the primary and tertiary observers (assessed 4 times) was 89.71%. Overall, the average interrater reliability was 88.41%.

To estimate the validity of the behavioral measure of safety, rank-order correlations between the departments' injury rates and their mean behavioral performance during the study were to be computed. However, the accident rates (computed per 100 employees as described by the National Safety Council, 1980) for the departments were too low to permit meaningful correlations. Since the baseline performance is assumed to be an extrapolation of previous performance, then correlating baseline levels with previous accident rates may provide an estimate of the validity of the observational procedure.

The Spearman correlation coefficient for the departments' overall-injury rate and mean baseline performance was -.85 ($p < .001$). The correlation between departmental lost-time injury rate and mean baseline performance was rho = -.69 ($p < .01$). These figures indicate that the higher the behavioral performance, the lower the accident rates. While this provides at least an indirect indication of the validity of the measure, it must be reiterated that the results should be interpreted cautiously since accident records tend to be unreliable.

## Manipulation Checks

Training: The results of the quiz administered midway through the Training Only period indicated that overall, the employees (N = 87) could identify 81.77% of the safe and unsafe behaviors exhibited in the slides (see Appendix E).

Goals: As previously noted, several bipolar adjectives and contingency statements were incorporated in a job satisfaction questionnaire completed by the employees prior to the introduction of the KR phase (see Appendix J). Specifically, 11 items were included to assess goal acceptance; 3 items were for perceived goal difficulty, and 1 item for goal clarity. Three separate items were included to estimate the perceived probability that the supervisors would give their employees positive (praise), negative (reprimand), or corrective feedback to their employees for performing safe or unsafe behaviors. All the items (footnoted in Appendix J) were scored on a 7 point scale with seven being the desired response. Eighty-six of the 96 employees who had been through each phase of the study responded. The mean response for each factor measured appears in Table 1.

Insert Table 1 about here

Overall, the employees considered the goal to be acceptable ($\bar{X}$ = 5.78) and clear ($\bar{X}$ = 5.82). They also perceived the goal to be slightly difficult ($\bar{X}$ = 4.54). The probability that the supervisors would praise the employees for working safely was low ($\bar{X}$ = 3.28). On the other hand, employees expected to receive corrective feedback ($\bar{X}$ = 4.76) and/or be reprimanded ($\bar{X}$ = 4.49) for performing an unsafe act. The employees also indicated that they and their fellow workers generally worked in a safe manner ($\bar{X}$ = 5.12).

The employees involved in the study were also asked (prior to receiving KR) to estimate their department's behavioral safety performance. In general, they estimated their performance to be lower ($\bar{X}$ = 79.43%) than the goal of 90% which they had been assigned and apparently accepted.

At the end of the KR phase of the study, the employees were asked to write what they perceived their current department goal to be. The mean goal of the 77 employees responding was 95.75%. All three groups had mean goals of 94% or higher. Thus, there is some indication that they were trying to achieve a level which was higher than assigned or expected of them.

Observational Data Analysis

ARIMA Analysis: The first step in the analysis of the observational data was to estimate the model that appeared to best fit the time-series. This was accomplished with the use of the autoregressive integrated moving average (ARIMA) modeling technique developed by Box and Jenkins (1976) and recommended by McCain and McCleary (1979) for interrupted, time-series analysis.

Visual inspection of the weekly average performance (shown graphically in Figure 1) indicated that there appeared to be marked intervention effects. Therefore, it was decided to perform the ARIMA analysis on the observational data for each period within each group to estimate the model which appeared to fit the entire time-series.

Insert Figure 1 about here

The resulting autocorrelations and partial autocorrelations exhibited a stationary process for each period. Differencing of the data did not appear to be warranted since there was no indication of a statistically significant secular trend for any of the periods. Further, the analysis did not reveal any significant autoregressive or moving average component. In other words, the autocorrelation function and the partial autocorrelation function were interpreted as identifying an ARIMA (0, 0, 0) model. Further evidence supporting the assumption that the data reflected a stochastic component or "white noise" model was found with the autocorrelation check of residuals. Since the Q-statistic (essentially a chi-square goodness-of-fit test for the autocorrelations) was not significant for any of the periods or groups, then it could be concluded that the estimated autocorrelation of the non-adjusted time-series data depicted a white noise process (McCain & McCleary, 1979).

Repeated Measures ANOVA: Given that the raw data within each period for each group resembled random fluctuations (i.e., a stationary process), a repeated measures analysis of variance with blocking on groups was considered appropriate for testing the hypothesis. The result was a highly significant main effect for the period or phase of the study ($F = 103.68$, $df = 3$, $p < .0001$). A Duncan's multiple range test was then performed on the period means. As expected, the means for each period were significantly different. Inspection of the means for each period (Table 2) revealed that they were in the hypothesized direction. Briefly, the mean performance after KR was introduced ($\bar{X} = 95.39\%$) was substantially higher than after a goal was set without KR ($\bar{X} = 77.54\%$). Performance during the goal setting phase was higher than the Training Only phase ($\bar{X} = 70.85\%$); which in turn was better than baseline performance ($\bar{X} = 62.20\%$). Inspection of the means for each group (presented in Table 2) and the weekly summary data (Figure 1) also reflect the differences in behavioral safety period performance for each intervention period.

## Accident Data

The overall injury incidence rate and the lost-time injury incidence rate were computed for the shop area of the plant. The rates reflect the number of injuries per 100 employees (National Safety Council, 1980). The average total incidence rate for the three years prior to the study (1978 - 1980) was 84.77 injuries. The yearly rate for 1981 was 55.14 injuries. The lost-time rates decreased from an average of 21.40 injuries to 9.88 injuries for 1981.

# DISCUSSION

## Theoretical Implications

The major finding of this study is that knowledge of results (KR) appears to be a beneficial condition for the achievement of maximum performance when specific and difficult but acceptable goals are set. While behavioral safety performance did improve significantly after a goal was assigned and apparently accepted, in general, the goal was not achieved until KR was provided. In fact, ten of the eleven departments averaged above the goal during the KR phase whereas only two of eleven departments achieved the goal without KR (see Appendix L). Thus, the evidence presented in this study provides external validity of the laboratory findings of other recent investigations (e.g., Arnett, 1974; Erez, 1977; Strang et al., 1978). Further, the multiple-baseline design and time-series analysis of the present study corrected some of the potential methodological problems associated with other related field studies (e.g., Becker, 1978; Kim & Hamner, 1976) while substantiating the findings of these studies.

One question that can now be raised is what is the function or role of goal setting? A possible answer stemming from the results of the present study is that goals "motivate" the individuals to perform. Though safety performance did increase significantly after training, further improvement was almost immediately seen after a goal was assigned and accepted. In support of Locke's (1968, 1980) theory, the sharp increase at the beginning of the goal setting phase (see Figure 1; also Appendix L, Figure 2a-k) suggests that the employees cognitively chose to increase their efforts to work in accordance with the behavioral safety rules.

The results of the questionnaire completed prior to the introduction of explicit KR may indicate an alternative hypothesis concerning the behavioral performance during the goal setting phase. The self-report measure revealed that the employees had probably not received much positive feedback (i.e., praise) from their supervisors concerning their safety efforts. However, they did believe they were likely to be reprimanded and/or corrected if they performed their job unsafely. Whether the supervisors increased their efforts to correct and/or to reprimand an unsafe subordinate after the goal was assigned could not be directly assessed in this setting. It is suspected that this was not the case since the supervisors had known what the rules were prior to the baseline period and were expected to enforce them as part of their regular duties. Further, as Locke (1980) suggested, one would expect more of a gradual improvement if these extrinsic conditions (i.e., reprimand and/or corrective feedback) were the primary causal factors. Since the increase in performance was sharp after goals were assigned and accepted, then the more plausible hypothesis is that the employees were "motivated" or were attempting to achieve their goal because they cognitively chose to do so.

A second query posed by the results of the current investigation concerns the role of KR in relation to goal setting. One possible explanation that has been suggested is that KR may lead to an increase in effort (Becker, 1978; Latham & Yukl, 1975a). Evidence for this hypothesis is provided by the fact that most of the departments did not achieve the goal until KR was introduced. Even though the majority of employees reported perceiving their department's performance to be less than the goal prior to receiving KR, actual goal achievement was infrequent. The KR may have served to substantiate their perceptions and thus they realized more attention to safety was required if they were to achieve the goal.

A second possible function of KR is that it may be used by individuals to set new standards or goals (Latham & Yukl, 1975a; Locke, 1968, 1980). Evidence for this postulate was found when most of the employees perceived their department's goal to be closer to 95% after the KR phase, as opposed to the assigned 90% safety goal. It is possible that once the employees knew they could achieve the goal, then they set new goals. Since goals were limited to a maximum of 100%, attempts to achieve new, higher goals (i.e., within the 90 - 100% range) served to maintain the high level of performance exhibited by most of the departments during the KR period.

Still a third possible function of KR is that it permits intrinsic reinforcement when it indicates goal achievement (Hall & Foster, 1977; Hall & Hall, 1976). The continuance of goal level performance after KR was provided may suggest that the employees were being reinforced for their accomplishment. Since there was little evidence of extrinsic incentives (i.e., supervisory praise or safety awards), any operating reinforcers would probably have to be intrinsically derived. As Komaki et al. (1980) found, some informal competition seemed to be present among the various departments. Further, the employees appeared to be quite interested when the daily and/or weekly KR was marked. Thus, there is at least indirect evidence suggesting that KR signifying goal achievement was valued and probably rewarding.

In sum, the results of this investigation indicate that KR plus goal setting improves performance more than the effects of goal setting alone. As Locke (1968, 1980) reported, however, assigning an acceptable, difficult, and specific goal can lead to an increase in performance. This study revealed that adding KR improves performance even more. The function of KR in relation to goal setting can only be speculated from the evidence of this investigation. It can be hypothesized that KR: 1) leads to an increase in effort, 2) encourages new goals to be attempted, and/or 3) reinforces performance. It may also be that KR serves all three functions simultaneously. Whatever the reason, KR appears to be a beneficial supplement for the maximum effects of goal setting to be realized.

## Practical Implications

The results of this study also have practical implications in the area of occupational safety. Behavioral safety rules were obeyed more when employees received frequent feedback (KR) concerning their performance in relation to an accepted standard. Though the implementation of a training session to teach employees exactly what was expected of them did result in a significant increase in performance it was not sufficient for optimum improvement. Instead, assigning employees specific, difficult yet acceptable safety goals, and providing information concerning their performance in relation to the goals resulted in considerably more improvement.

These results essentially generalize the findings of Komaki et al. (1980) to a different organization. Both investigations provide alternatives to the utilization of disciplinary sanctions or extrinsic incentives (i.e., safety awards) to encourage compliance with the rules. The present investigation differed from Komaki et al.'s (1980) since it did not confound the effects of KR in relation to a goal with the effects of supervisory praise. The results suggest that the former may be sufficient to obtain substantial increases in behavioral performance. The durability of the effects of such a safety campaign remains to be seen. In this study, overall performance stayed above the expected goal level for a minimum of 12 weeks after KR was introduced.

Another finding of practical importance is that there is at least indirect evidence supporting a behavioral approach to safety. First, rank-order correlations revealed significant inverse relationships between departmental baseline performance and injury rates (both overall and lost-time injuries). Second, when a program was implemented to improve behavioral safety performance, the yearly accident rates per 100 employees decreased in comparison with the company's previous yearly average. In fact, the company estimated that the reduction in lost-time injuries alone resulted in monetary savings of at least six figures. Extended monitoring of behavioral performance and accident rates may provide further evidence of the benefits and limitations of this approach.

## Conclusions

The benefits stemming from the provision of knowledge of results in relation to acceptable assigned goals has both theoretical and practical significance. Goal Setting plus Training, and Training Only each had positive effects on behavioral safety performance; but the addition of KR resulted in even greater increases in performance. Future research is required to determine the role(s) fulfilled by KR with regard to goal setting. In addition, the generalizability of the findings to other organizations and/or other behaviors remains an issue of concern.

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Table 1

Mean Group Response for Each Questionnaire Factor

| Group | n | Factor[a] | | | | | | | Estimated Performance (%) |
|---|---|---|---|---|---|---|---|---|---|
| | | Goal Acceptance | Goal Clarity | Goal Difficulty | Positive Feedback | Negative Feedback | Corrective Feedback | Current Safety | |
| One | 35 | 5.72 | 5.94 | 4.77 | 3.00 | 5.46 | 4.57 | 4.97 | 77.23 |
| Two | 32 | 5.94 | 5.75 | 4.55 | 3.50 | 5.97 | 5.03 | 5.44 | 82.50 |
| Three | 19 | 5.76 | 5.84 | 4.08 | 3.15 | 4.73 | 4.47 | 4.94 | 77.47 |
| All | 86 | 5.78 | 5.82 | 4.54 | 3.28 | 5.49 | 4.76 | 5.12 | 79.43 |

[a]Mean responses are based on a 7-point scale with a score of seven being desired.

Table 2

Mean Group Safety Performance for Each Period

| Group | Period | | | | All |
|---|---|---|---|---|---|
| | Baseline | Training | Goal Setting | Feedback (KR) | |
| One | 55.86 | 65.49 | 73.33 | 93.35 | 73.79 |
| Two | 59.05 | 67.96 | 75.19 | 96.02 | 74.37 |
| Three | 69.49 | 79.38 | 84.01 | 97.58 | 81.25 |
| All | 62.20 | 70.85 | 77.54 | 95.39 | |

*Note*. Safety performance refers to the percentage of employees working in a completely safe manner.

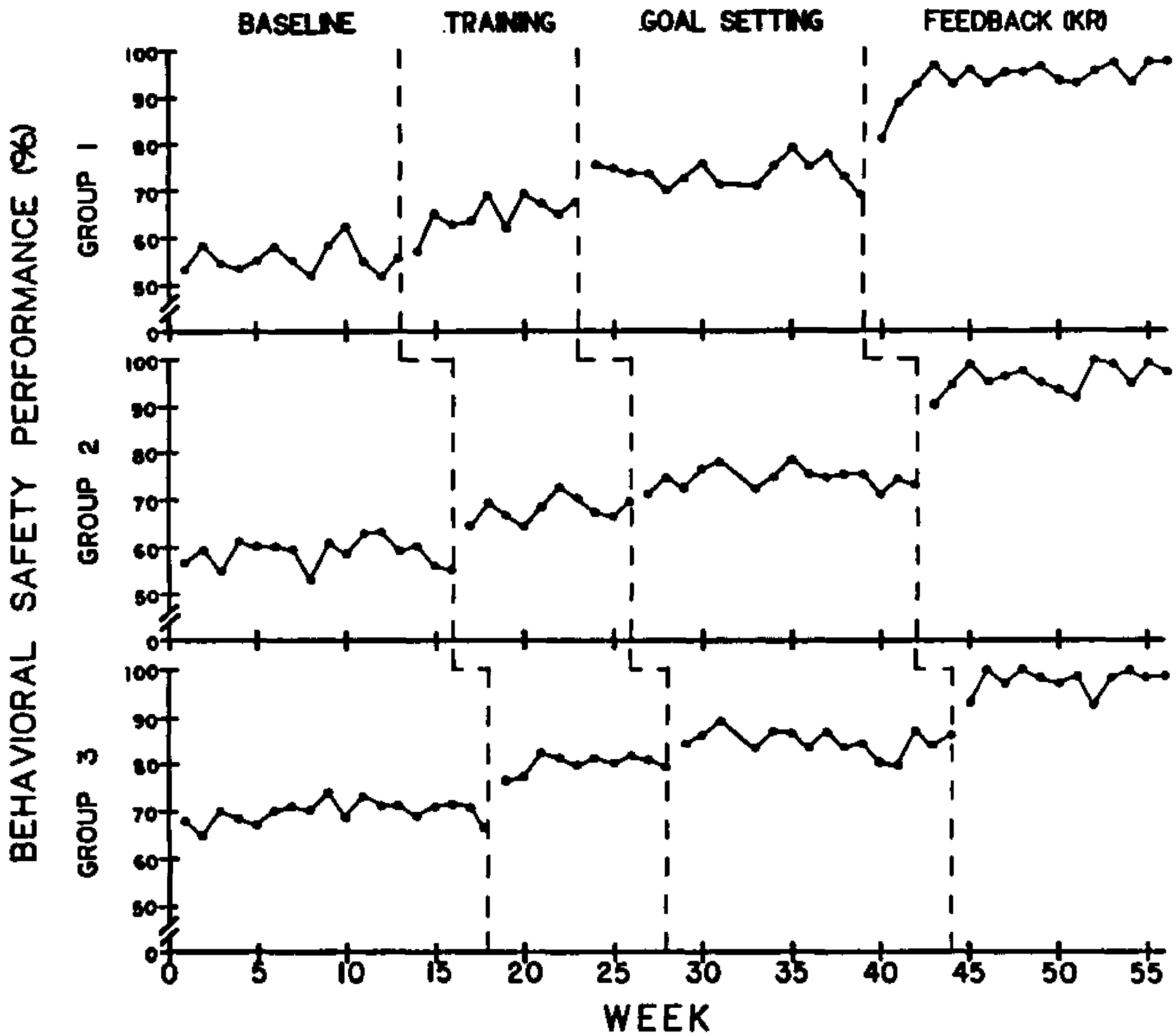



Figure 1. Average weekly behavioral safety performance for each group.

# APPENDICES

# APPENDIX A:

## Description of Departments

| GROUP NO. | DEPARTMENT | N | DESCRIPTION | EMPLOYEE DATA $\bar{X}$ AGE (years) | $\bar{X}$ EDUC. (years) | $\bar{X}$ HOURLY PAY | $\bar{X}$ TENURE (years) | FREQUENCY OF INJURIES 1979-1980 |
|---|---|---|---|---|---|---|---|---|
| 1 | Final Assembly | 25 | Assembles and tests the final product. Operations include buffing, grinding, oxygen/acetylene cutting, arc welding, hand tool use, fitting, crane/hoist use, lubrication, and driving the tractors, combines, etc. | 33.10 | 11.04 | $7.02 | 3.73 | 92 |
| 1 | Hydraulics | 7 | Installs hydraulic systems on the product in Final Assembly. Operations involve cutting hoses, attaching fittings, pipe threading, installing fluid, and preparing parts for installation. Also does some company vehicle maintenance. | 29.75 | 11.75 | $7.56 | 4.25 | 14 |
| 1 | Mechanics | 6 | Receives, prepares, and installs the engines in the tractors in Final Assembly. Also prepares and installs the tractors' instrument panel and lights. Maintenance and repair of company vehicles and tractor engines are also done. | 27.71 | 11.43 | $6.99 | 3.79 | 14 |

| GROUP NO. | DEPARTMENT | N | DESCRIPTION | EMPLOYEE DATA<br>$\bar{X}$ AGE (years) | $\bar{X}$ EDUC. (years) | $\bar{X}$ HOURLY PAY | $\bar{X}$ TENURE (years) | FREQUENCY OF INJURIES 1978-1980 |
|---|---|---|---|---|---|---|---|---|
| 1 | Painting/ Sandblasting | 5 | Cleans, sands, primes, and paints the final product for shipping. Equipment used includes pneumatic paint guns, steam cleaner, shot blasting equipment, sanders, and grinders. | 43.00 | 8.50 | $4.04 | 4.00 | 26 |
| 2 | Heavy Equipment | 10 | Mainly constructs prefabricated parts for assembly elsewhere. Major operations are arc welding, oxygen/acetylene cutting, fitting, grinding, shipping, scaling, crane use, and punching. | 30.73 | 9.50 | $7.73 | 4.04 | 42 |
| 2 | Raw Material Prep | 14 | Receives, cuts, bends, and shapes raw metal for fabrication in other departments. Equipment used includes power punch (piranha), shear press brake, automatic saw, electric eye torch, cutting torches, grinders, N-C punch and torch (panelmaster), and cranes. | 37.44 | 11.93 | $7.23 | 5.51 | 28 |

| GROUP NO. | DEPARTMENT | N | DESCRIPTION | EMPLOYEE DATA $\bar{X}$ AGE (years) | $\bar{X}$ EDUC. (years) | $\bar{X}$ HOURLY PAY | $\bar{X}$ TENURE (years) | FREQUENCY OF INJURIES 1978-1980 |
|---|---|---|---|---|---|---|---|---|
| 2 | Sub-Assembly | 8 | Fits, tacks, and otherwise partially assembles parts for Final Assembly. Primary functions include arc welding, oxygen/acetylene cutting, grinding, fitting, and crane/hoist operation. | 38.30 | 10.44 | $7.20 | 5.06 | 25 |
| 2 | Welding | 5 | Does the major portion of the arc welding on the fitted parts from Sub-Assembly. Other equipment use includes pneumatic chipping tools, scaling tools, and grinders. | 28.50 | 10.25 | $8.30 | 4.88 | 10 |
| 3 | Crating | 6 | Prepares the final product and accessories for shipment. Primary operations include use of power saws, pneumatic nail guns, hammers, banding equipment, fork lifts, and some rustproofing and painting. | 32.43 | 11.33 | $6.69 | 4.16 | 15 |

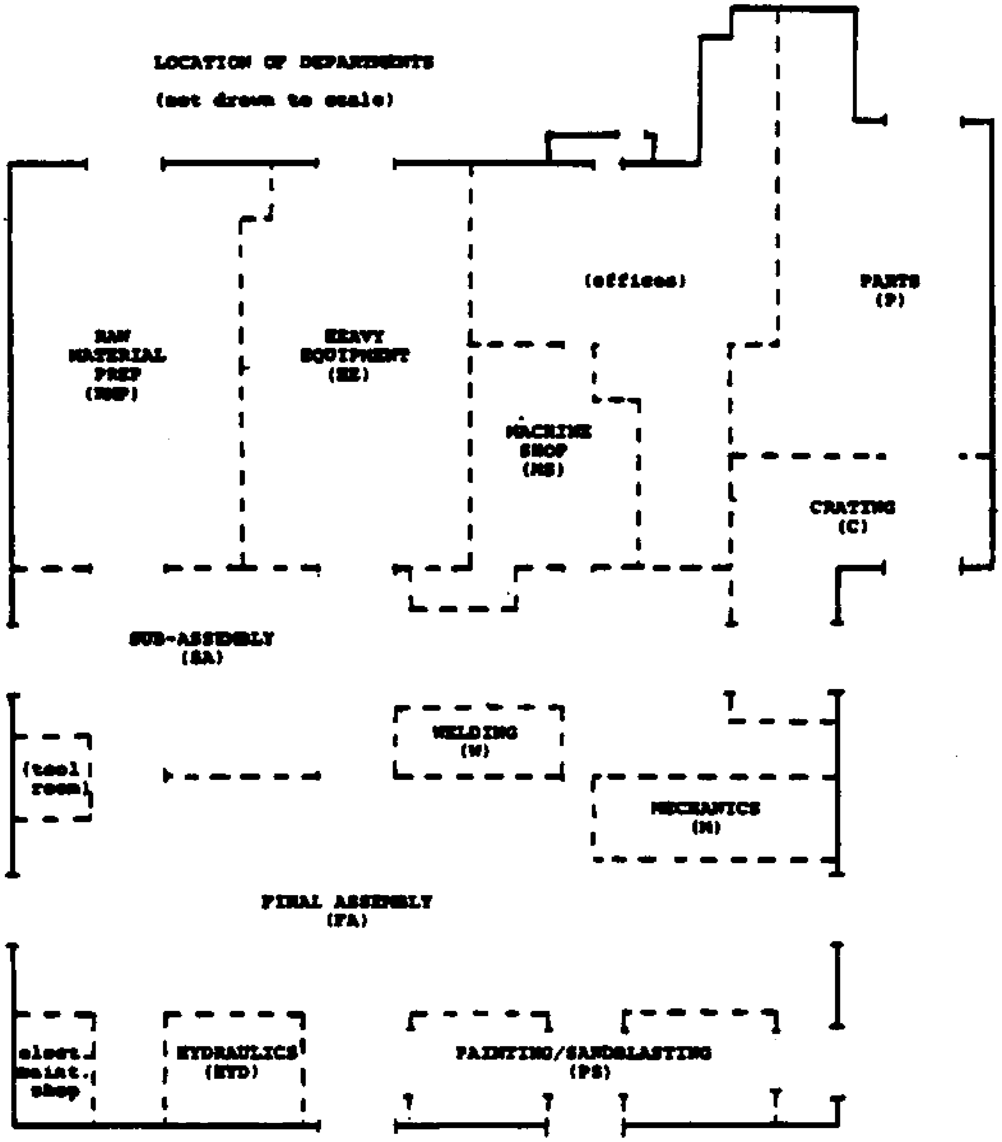
| | | | | EMPLOYEE DATA | | | | |
|---|---|---|---|---|---|---|---|---|
| GROUP NO. | DEPARTMENT | N | DESCRIPTION | $\bar{X}$ AGE (years) | $\bar{X}$ EDUC. (years) | $\bar{X}$ HOURLY PAY | $\bar{X}$ TENURE (years) | FREQUENCY OF INJURIES 1978-1980 |
| 3 | Machine Shop | 6 | Machine parts for use in final and sub-assembly of the products. Equipment used includes lathes, drill presses, milling machines, N-C lathes, grinders, crane/hoists, and life magnets. | 27.63 | 10.67 | $7.85 | 4.50 | 19 |
| 3 | Parts | 13 | Maintains parts inventory for product assembly and sales. Major operations include lifting and stacking parts, rust-proofing parts and tagging parts received. Equipment used includes fork truck, hydraulic pallet lift, and hand carts. | 29.69 | 12.08 | $6.60 | 4.00 | 23 |

# APPENDIX B

## Location of Departments

LOCATION OF DEPARTMENTS

(not drawn to scale)



# APPENDIX C

## Company Safety Manual

## TABLE OF CONTENTS



## SECTION 1 REPORTING OF ACCIDENTS

1.1 All accidents shall be reported to your supervisor/foreman immediately. In the event of his absence notify next line of supervision or any other available foreman/supervisor; then notify your immediate supervisor as to the nature of injury as soon as possible.

1.2 If medical attention is required, obtain necessary insurance forms from the Personnel Director before leaving.

1.3 In the event of needed medical attention, transportation will be provided.

1.4 Injuries, regardless of nature, shall be reported, and accident reports will be filled out upon notifying supervisor.

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**SECTION 2** **GENERAL SAFETY PROCEDURES**

2.1 If in doubt about a safe and proper way of performing a job, ask your foreman. Be alert for unsafe conditions and report them accordingly.

2.2 Horseplay is dangerous. Avoid distracting someone while they are performing their duties (except in an emergency).

2.3 Running on company premises is prohibited (except in an emergency).

2.4 Stay alert for tripping hazards (cords, hoses, etc.) and correct them where possible.

2.5 Reporting to work under the influence of or with the following on company premises is a cause for immediate termination:

A) Alcohol or alcoholic beverages
B) Illegal drugs or illegal drug related equipment
C) Fire arms or concealed weapons

2.6 Your skin should be thoroughly clean after using gas, oil, paint or other chemicals. Failure to do so could cause clogging of pores, dermatitis or other skin problems.

2.7 When using chemicals with acid or highly alkaline related chemicals, prior to using inquire about or use proper protection equipment.

2.8 The discharge end of compressed air equipment or tools shall not be pointed directly at anyone.

2.9 If in the presence of a ruptured air line, or any air line under pressure, shut off the pressure before trying to grab the ruptured end.

2.10 Operate only equipment you have been authorized to operate and only in the assigned work area. Lockman has authorization.

2.11 All safety equipment shall be in place before operating machinery or equipment. Guards may be removed for maintenance purposes only and replaced when finished.

2.12 Before operating equipment or machinery, check for the safety of other personnel by looking for others or sounding an audible warning.

2.13 Equipment must be locked out and/or disabled before attempting any repairs. Never attempt to operate equipment under repair or that is "Tagged Out ".

2.14 Observe and obey warning signs in all areas.

2.15 All tools and portable equipment must be maintained in safe and operable conditions. Defective tools or portable equipment should be turned in to maintenance dept. by your foreman/supervisor.

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2.16 Observe all traffic laws while operating company vehicles on company premises.

2.17 Only electrical personnel are permitted to perform any type of electrical work.

2.18 Portable appliances (e.g. fans, radios) brought from your residence should be taken to elect./maint. dept. to be inspected for equipment grounding before it is allowed to be used in production area.

2.19 All electrical equipment in this establishment will have the proper equipment ground. Report damage of electrical equipment to your foreman.

2.20 Portable power tools should be disconnected from their attachment plug as soon as it is not in use.

2.21 Exercise caution when disconnecting air tools from air supply.

2.22 Fingers should not be used to check alignment or condition of holes in materials.

2.23 Hoses (e.g. oxygen/acetylene) and electrical cables should be kept away from hot slag or other hot material.

2.24 Know the capabilities of your machine (size and thickness of materials) before putting machine into operation.

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2.25 In repairing equipment/machinery, worn or damaged parts should not be used.

2.26 When driving pins or bolts, check to see that no-one is on the blind side where they may be struck by a flying pin or bolt.

2.27 When finishing using any type of machinery, turn all switches to the off position unless told differently by foreman/supervisor.

2.28 When using equipment that utilizes chuck keys for tightening purposes, be sure the keys are removed before putting in operation. Equipment should also be unplugged before using chuck keys.

2.29 Files should have wooden or plastic handles.

2.30 Caution shall be exercised when using sanding material, i.e. emery cloth or other abrasive type material, on rotating material.

2.31 Defacing, marring or destroying company property is prohibited.

2.32 When using a wrench, pinch bar, hammer, ratchet lever hoist, position yourself so that if the tool slips, you will not fall or otherwise be injured.



2.33 When removing any part of machine that will cause damage or injury if machine is started, machine should be tagged out.

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<u>SECTION 3</u> <u>PERSONAL PROTECTION EQUIPMENT</u>

3.1 Clothing that is suitable for your work environment should be worn. Working with cutshirts or with half-cut (buttonless) shirts/T-shirts is not permitted.

3.2 Steel-toed safety shoes shall be worn at all times while working in production areas.

3.3 Long sleeve shirts shall be worn when performing welding and/or burning or when the presence of hot metal or sparks. Avoid pants with cuffs, oily or ragged clothes.

3.4 Rings, gloves and/or loose clothing shall not be worn when operating machinery or equipment with revolving parts.

3.5 Only approved leather type gloves shall be worn while performing any type arc welding or oxygen/acetylene burning.

3.6 Gloves should be worn when handling any type of material that has rough or sharp edges.

3.7 Only approved type safety glasses shall be worn in production areas.

3.8 Approved type safety glasses or goggles shall be worn while using drills, lathes, milling machines, nail guns, saws, hammers (metal to metal contact), scaling guns, chipping equipment.



3.9 Safety goggles or face shield shall be worn when performing any type of grinding, buffing or spray painting operations.

3.10 Approved eye protection shall be worn while performing any type of burning, heating (oxygen/acetylene), or cutting operations etc. - dark lens goggles.

3.11 Eye protection shall be worn when working beneath equipment where the danger of falling particles exists.

3.12 Eye protection shall be worn whenever the danger of flying particles may exist, e.g. in the vicinity (within 6 to 10 feet) of someone grinding, buffing, gouging, striking metal to metal, arc welding, oxygen/acetylene brazing or cutting.

3.13 As a general rule, "<u>When in doubt, wear eye protection</u>".

3.14 All types of safety equipment used for bodily protection will be of an approved type.

3.15 Long sleeved shirts shall be worn during welding and cutting operations. Wool clothing is preferred to cotton, since it is not so easily ignited.

3.16 Rings shall not be worn in shop areas/outside office buildings. Wearing heavy duty watchbands should be avoided.

3.17 Shirts/shirttails shall be tucked inside trousers while performing machine shop operations/rotary equipment. Wearing excessively baggy clothing shall also be avoided.

3.18 Workers shall have excessively long hair tucked inside of headgear.

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**SECTION 4** **HOUSEKEEPING**

4.1 Each employee is responsible for keeping his work area clean and in an orderly manner. Upon completion of a job, dispose of items that are unusable.

4.2 Place soft drink bottles, coffee cups, paper or litter in the proper containers that are provided.

4.3 If oil, grease or other slippery substances are spilled, wipe them up using rags or floor dry so you or other employees will not slip or fall.

4.4 Machinery shall be cleaned and free of tools, rags and of scrap material.

4.5 Floor around machinery shall be clean, dry and free from tripping hazards.

4.6 Hoses, cables, cords shall not be permitted to cross aisles passageways - in order to prevent someone from tripping.

4.7 Tools/equipment shall be returned to their locations upon finishing a job.

4.8 People who chew tobacco should have a container to spit in and not spit on the shop floor.

4.9 Avoid leaving blocks, chains, cables, hoses or tools lying about the floor after you are finished with them. Keep aisles clear and free from tripping hazards. Hoses, cables shall be rolled up at the end of the work week. Maintain good housekeeping standards at all times.

4.10 Piling or storing material or equipment on or near the following shall be avoided:

A) exits or passageways
B) crane ladders
C) fire fighting equipment
D) electrical substations, panel or equipment disconnecting devices.

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SECTION 5 FIRE PROTECTION

5.1 The classification of fires are as follows:

1) Class A - ordinary combustibles (wood, paper, cloth etc.)
2) Class B - flammable liquids, grease (gasoline, paints, oils etc.)
3) Class C - electrical equipment (motors, switches etc.)

* for type of extinguisher used see chart in section 16.

5.2 Be aware of the locations and types of fire extinguishers in your area before it is needed.

5.3 The type of fire extinguishers in this establishment can be used on the following classes of fires: Class A, Class B, Class C.

5.4 Water shall never be used on electrical or electrical operated machinery fires.

5.5 Extinguishers must be turned in to Elec/Maint. Dept. after each use.

5.6 Treat every fire, regardless of size, as a damaging agent.

5.7 If oxygen/acetylene type regulators should happen to catch fire; extinguish fire with a fire extinguisher.

5.8 Flammable liquids such as gasoline, solvents must be handled in an approved container with flame arrestors used away from open flames or sparks.

5.9 Smoking in, near, or while performing the following is prohibited:

A) using gasoline and/or related equipment
B) painting or paint storage areas
C) lead acid storage batteries
D) oxygen/acetylene storage areas
E) any other flammable, solid, liquid oxygen

5.10 Should your clothing become soaked with oil, grease, paint or other flammable substance, keep away from sparks or open flame.

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SECTION 6 — ELECTRICAL REPAIRS

6.1 All electrical construction, renovation or repair shall be in accordance with the 1981 or current National Electrical Code NFPA-70.

6.2 Only experienced and authorized electrical personnel shall perform any type of electrical troubleshooting, modification, installation or repair on any type equipment, tools or machinery.

6.3 All equipment that utilizes an electrical potential will have equipment grounding conductors in it, in accordance with NEC Article 250.

6.4 Equipment lock out tags or other approved lock method shall be used when performing electrical/maintenance work on machinery or equipment.

6.5 Only authorized electrical personnel shall enter sub stations except in an emergency.

6.6 All circuits shall be approached as if they are energized, unless proved to be deenergized.

6.7 Low voltages shall be treated with the same respect as high voltages.

6.8 High voltage protection equipment shall be used when necessary.

6.9 Voltage meters shall be used to determine the quantity of voltage present.

6.10 Equipment, tools or machinery that present an electrical hazard shall be removed, operations stopped, or deenergized immediately.

6.11 Distribution panel, safety switches, receptacles or other related devices shall not have the following:

a) exposed, unattended, energized wiring or interiors
b) with covers/doors removed, no danger tag
c) equipment/devices not UL approved.

6.12 When working in energized enclosures tools shall be of the approved type and one hand positioned out of or away from contact of the enclosure or cabinet.

6.13 Avoid contact with energized high voltage conductor insulation in panel boards - can be defective.

6.14 All hand tools used in this establishment shall have approved grounding or be of double insulated type.

6.15 Metal ladders shall not be used when working on energized equipment or in energized environments.



6.16 When closing a circuit (disconnect, breaker) make sure that machine controls are off and that no-one can be injured by the closing of the circuit.

6.17 Fuse links shall not be paralleled within the same cartridge as to increase overcurrent protection.

6.18 When finishing an inspection or repair, operate machinery or equipment before turning machine over to operator or department.

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**SECTION 7** — **MAINTENANCE AND REPAIR**

7.1 Oiling, removing guards or attempting to repair machinery while it is in motion should be avoided.

7.2 Detailed maintenance shall be performed by maintenance personnel. Operator type maintenance shall be performed by operators.

7.3 Any maintenance operation shall not be performed until proper authorisation has been given.

7.4 When working on overhead equipment, each department foreman/supervisor must be informed of overhead operation - before and after.

7.5 Detailed maintenance shall not be performed unless thoroughly familiar with that piece of equipment.

7.6 When working overhead and upon finishing overhead operations - tools/materials shall not be dropped to the lower level.

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SECTION 8 — MATERIAL HANDLING

8.1 When lifting, bend the knees and keep back nearly vertical. Then grasp the object firmly and raise by straightening the legs. Always get help when lifting loads that are too heavy for one person or use a crane or a chain hoist.

8.2 When piling material, build a solid, sturdy pile. Make sure there is a firm foundation and avoid piling the material so high that an unsteady pile results. In piling pipe, round bars, or other materials that may roll, use a sufficient chock at the base of the material.

8.3 When loading or unloading trucks, the driver must be out of the cab and in the clear of any loading operations.

8.4 Chains should be grasped above the load when holding slack before hoisting. If it is necessary to guide the load with your hand, be sure your fingers and hands are on the outside of the material or otherwise positioned so that they cannot be caught inside the material or between the load and adjacent material. Tag lines or hand hooks are recommended for such operations.

8.5 Avoid kinks or knots in chains. Protect chains with softeners where they pass over sharp corners or edges.

8.6 Check condition of chains, hooks, shackles, etc. before using. Avoid using if defective.



8.7 Avoid setting material too close to the edge of pallets or skids where it may fall.

8.8 Walk or step with caution when walking or stepping over material.

8.9 Maintain a good handhold and footing when handling material by hand. Use gloves when handling material with sharp edges and burrs or material that may be hot from burning, welding or grinding.

8.10 Be aware of pinch points when getting boards or other material from storage.

8.11 When handling long boards be careful not to strike co-workers with them.

8.12 Before sawing, check boards for knots and nails, and check the blade for any defects. When sawing, never force material against the blade.

8.13 Fingers should not be used to remove chips or objects from machinery; use a piece of wood or a brush.

8.14 When operating woodworking machinery, watch out for kickbacks.

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<u>SECTION 9</u> <u>WELDING, CUTTING, FITTING OPERATIONS</u>

9.1 Burning and welding equipment shall be checked for defects before operation. Report findings to your foreman/supervisor.

9.2 All loads must be secure before releasing crane hooks.

9.3 Valves on air hoses or tools should be opened gradually to prevent kickback.

9.4 Gloves, shoes, and clothing should be kept as dry as possible to prevent electrical shock.

9.5 Welders must be careful when changing electrodes in the electrode holder to prevent electrical shock.

9.6 When handling the electrode holder or cable, avoid electrical contact between body and objects connected to the work or "ground" of the welding circuit.

9.7 Avoid handling two different electrodes/holders at the same time.

9.8 Holders dipped in water to cool them is prohibited.

9.9 Welding or gouging cables shall not be looped around any part of the body.

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9.10 Welders should not wear rings, metal wristband or other jewelry.

[illegible] Never change polarity of machines while welding is in progress.

[illegible] Electrodes shall be removed from electrode holders when left unattended.

[illegible] The welding current must complete its circuit with its cables, joints or its connections. It cannot pass through equipment or structures which might be damaged or made unsafe by the welding current or its voltage.

For example:
- a) Acetylene, fuel gas, Oxygen or other compressed gas cylinders/lines
- b) Tanks, containers used for gasoline, oil or other flammable material
- c) Conduits carrying electrical conductors
- d) Chains or wire ropes
- e) Metal handrails or ladders
- f) Machines, shafts or bearings

9.14 Only qualified welders shall weld supports for staging or scaffolding or make welds attaching lifting hitches, pads or lugs.

9.15 No welding or burning should be done on any used drum, barrel or tank without checking with foreman/supervisor.



9.16 Before starting to weld or burn, check the vicinity in which welding is to be done. Combustible material shall be moved away or else it shall be guarded by someone else with adequate fire fighting equipment. When welding is to be done on, in or up above a floor, deck, wall, bulkhead or other partition, the welder must make sure there is no fire hazard or someone who might be injured in the vicinity.

9.17 Welding or burning on equipment with flammable liquids, gases or material in, on, or around should be avoided until after consulting with foreman/supervisor.

9.18 When welding or burning on some materials or in confined spaces, it may be necessary to use respirators. If not sure, check with foreman/supervisor.

9.19 Oxygen and fuel gas cylinders must be carried in a box or carrier, not with a sling or a magnet.

9.20 Compressed air shall not be used to blow out burning hoses or for cleaning any burning equipment.

9.21 Sparks or flames shall not be permitted to fly on other workers; use proper shielding equipment.

9.22 Avoid leaving torches inside compartments. When you leave, so does your torch - in case of leaks on torch.

9.23 Prevent hot slag and sparks from falling on hoses and cables. Damaged cables and hoses should be turned in to foreman/supervisor.

9.24 Avoid jerking on the regulator with the hose when moving to a new position.

9.25 Valves on empty cylinders should not be left open. Do not use leaky oxygen/acetylene cylinders. Report it to your foreman/supervisor.

9.26 Never interchange oxygen and acetylene regulators, hose or other burning apparatus. Connections and fitting should always be tight.

9.27 Never use oil,grease or any type of lubricant on any type of burning equipment. Handling burning equipment with greasy hands/gloves is prohibited.

9.28 Keep cylinders away from hot places or open flames. Do not permit cylinders to drop or be struck violently.

9.29 Cylinders should be standing in upright position secured with a rope or chain. Replace caps when cylinders are not in use.

9.30 Cylinders shall not be used as rollers or support.



9.31 Ignited torches shall not be used to warm up gauges or regulators.

9.32 Testing oxygen pressure with fingers should be avoided.

9.33 If welding or cutting on material is giving off irritating fumes or smoke, check with foreman/supervisor for probable respiration equipment.

9.34 Matches, lighters or electrodes shall not be used to light cutting torches. Strikers should be used.

9.35 Butane lighters should not be carried in pockets of personnel who perform welding and cutting operations.

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**SECTION 10** **CHIPPING/GRINDING OPERATIONS**

10.1 Equipment should be checked for proper operation before using, i.e. check for cracked stones, discs or equipment damage, correct air pressure.

10.2 Face shields shall be used while performing grinding or buffing operations.

10.3 When buffing or grinding be sure no-one is in the path of showering particles. Those in the immediate vicinity shall be warned about the possible hazard.

10.4 All grinders shall have approved guards in place while in operation.

10.5 Avoid dropping grinders to prevent grinding disc from cracking.

10.6 While grinding, make smooth contact with surface, avoid bumping or impact actions.

10.7 Avoid excessive pressure to stop motor or where work gets red hot.

10.8 When finishing a particular grinding, buffing or chipping operation, secure tool where it won't be damaged and disconnect the attachment plug.



10.9 When starting up stationary grinders, avoid standing directly in front.

10.10 The maximum distance between wheel and tool rest 1/8". Adjustments shall not be made while machine is on.

10.11 Grinding on side of wheel shall be avoided.

10.12 Loose clothing or gloves shall not be worn when using stationary grinders.

10.13 Before attempting to drill, grind or ream small objects, clamp or secure the item first. Avoid holding object with one hand and grind with the other.

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**SECTION 11** **USE OF CRANES/HOIST**

11.1 Walking or standing beneath suspended or swinging loads should be avoided.

11.2 When handling equipment or material with a hoist or crane, never pull toward you; push away from you. Stand clear in case the load slips or spills.

11.3 Lifts should not be made if someone is in the area or in a position to be injured.

11.4 Before using overhead cranes, check overhead for obstruction or personnel working overhead.

11.5 Stand clear from lowered loads that have a tendency of spreading.

11.6 Riding on loads or chains is prohibited.

11.7 Avoid swinging control pendant when letting it go.

11.8 Bumping into runway stops should be avoided.

11.9 Crane lift capacity is marked on bridge; when in doubt about a lift, consult your foreman.



11.10 Standard crane hand signals shall be used when handling materials. Always be sure the operator can see you.

11.11 Avoid overloading lifting devices or equipment. Place chains and hooks so that loads are equally distributed and balanced. The load hook and trolley must be directly over the load to be lifted.

11.12 Check to be sure load is properly hooked before lifting. Plate clamps, etc. must not be used to lift more than one plate or piece of steel at a time.

11.13 The side or edge of plate clamps shall not be used to pick up the edge of a plate or other material. Also, loads must not be carried on the point of a hook.

11.14 Pull chains free of load before hoisting. Be alert for lugs, brackets on the blind side that may engage hooks or chains and tip the material over.

11.15 Side pulls shall not be made unless supervised by supervisor.

11.16 When necessary, blocks must be in place before crane is in position to lower load. If necessary to place blocks under loads being lowered by crane or hoist, hold the blocks so that your fingers are on the sides of the block and not between block and load.

11.17 Small or loose material must be wired, banded or placed in trays before transferring.

11.18 Loads on cranes or hoists shall not be left unattended.

11.19 When transporting material, load shall be carried at lowest possible height.

11.20 Be alert when large or heavy loads are being transferred in your area.

11.21 When using magnetic drills on its side, a hoist shall be used for support in case of electrical failure.

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SECTION 12 USE OF LADDERS/SCAFFOLDING

12.1 Use ladder equipped with safety feet and in good working condition. Inspect before using.

12.2 Metal type ladder shall not be used while performing welding operations or working on or with energized electrical equipment.

12.3 When using ladders, they should be tied off and secured from falling (tied off at top). If unable to secure top, have co-workers hold while you are on the ladder.

12.4 The use of buckets, chairs or other makeshift devices for work platforms is prohibited. Always use a ladder or scaffold.

12.5 When ascending or descending, always face the ladder; using both hands. Sliding down is prohibited.

12.6 Ladders shall be used only for climbing purposes. Splicing of unlike ladders is prohibited.

12.7 Avoid accumulation of paint or other like materials on the rungs of ladders.

12.8 When using ladders to work on overhead equipment, the control station should be tagged or operator shall be notified.

12.9 Ladders shall not be leaned against loose material. Rails and footing on both sides of ladder shall be secure.

12.10 Scaffolds shall be inspected before using, i.e. loose pins, toe boards, damaged components.

12.11 Scaffolds shall not be overloaded with men and/or equipment.

12.12 Scaffold boards shall be kept free from materials that may cause tripping hazards i.e. clean from grease, mud, loose material.

12.13 Riding on scaffolds while being relocated is prohibited.

12.14 When ascending or descending a ladder or scaffold be sure no-one is directly above or below you to prevent objects and/or bodies from falling.

12.15 When using ladders, scaffolds or platforms avoid from leaning out too far to prevent from tipping over.

12.16 When ascending or descending a ladder or scaffold use every step. Avoid hurriedly skipping steps.



12.17 Lock or barricade doors that may open toward ladders.

12.18 Approximately three feet of straight ladder should extend above the topmost spot to be reached.

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SECTION 13 — PUNCHING/SHEARING OPERATIONS

13.1 Only authorized employees are permitted to operate such equipment.

13.2 Dies and punches shall be properly aligned and checked before operation of such equipment.

13.3 Hands and fingers shall be kept clear while punching or shearing.

13.4 When using hole punching equipment the punch shall be equal to or greater than the thickness of the plate.

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SECTION 14 — BLASTING/PAINTING/TOXIC CHEMICALS OPERATIONS

14.1 Paint contains toxic chemicals. Painters should avoid from biting fingernails, putting fingers or other contaminated areas in mouth, eating food until affected areas have been properly cleaned. Lunch should not be kept in the same enclosed area as your work clothes. Avoid chewing gum, eating while painting or while in enclosed painted area.

14.2 Cuts or sores should be properly bandaged before beginning painting operations.

14.3 Only clothing that will give you proper protection should be worn while blasting or painting.

14.4 Only approved air respirators shall be used while painting or blasting. Clean them daily.

14.5 Take advantage of air movement, avoid letting fumes blow back in your face.

14.6 Paints or coatings shall not be directed into an open flame or sparks.

14.7 Paint shall not be directed toward another person.

14.8 Painting and spraying equipment shall be inspected daily or on regular scheduled basis.

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## SECTION 15 — IN PLANT VEHICLES

15.1 Inspect vehicle at the beginning of the work day, i.e. brakes, horn, steering, battery back up signals.

15.2 Exercise caution when operating in the vicinity of other employees.

15.3 Loads shall be properly positioned as to balance, capacity, protrusions.

15.4 When leaving vehicle, master switch shall be turned off, forks lowered, and brakes applied.

15.5 Loads shall not be left unattended, transported or lifted. in an unstable position.

15.6 Sudden stops except in emergencies shall be avoided.

15.7 When exiting a passageway, doorway or operating in the plant, be aware of overhead protrusions.

15.8 Passengers are not allowed unless vehicle is altered or manufactured to do so.

15.9 Vehicles shall be kept free from materials unnecessary for the successful operation of the vehicle.

15.10 Speed limit for in plant vehicles is 5 mph in production areas , 15 mph outside shop area.

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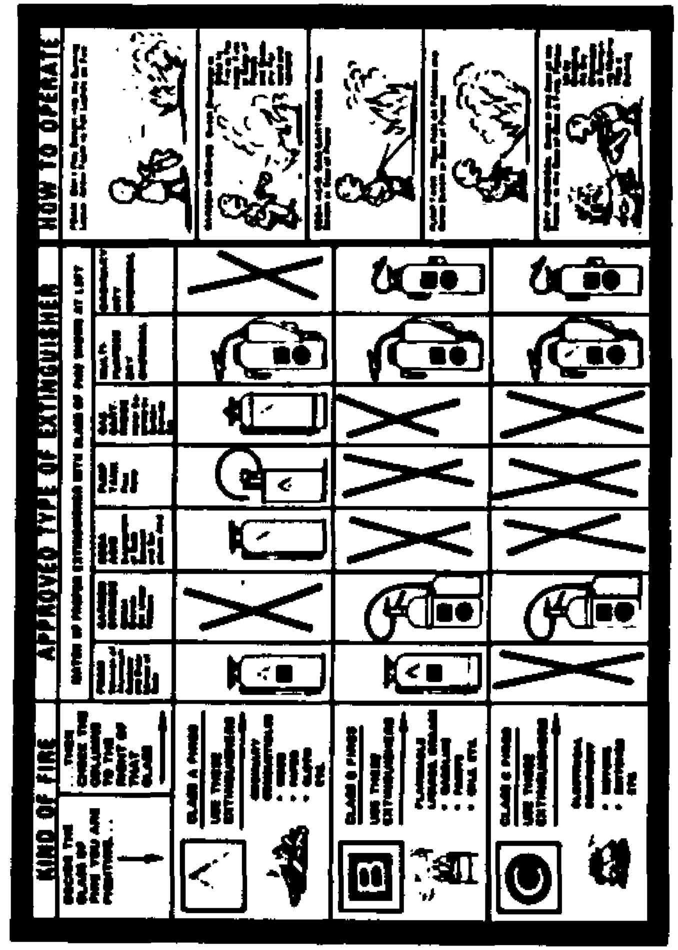


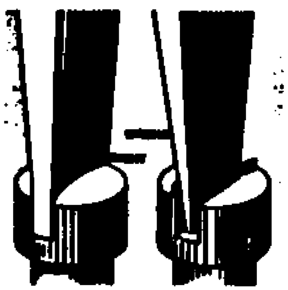
# SCREWDRIVERS

Next to the hammer, screwdrivers are probably the most abused item in your tool kit. They take the kind of abuse that frequently results in chewed up screw heads, damage to screwdrivers and gashed hands.

Too often we use screwdrivers to pry, chisel, scrape, punch and sometimes even stir paint. However, probably the most common abuse is when we use one that doesn't match or fit the screw.

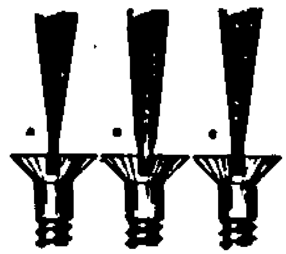
Screwdrivers have three main parts—the handle, the shank or steel portion extending from the handle, and the blade or end that fits into the slot of the screw.

Select a screwdriver so the blade's thickness fits the screw slot. This keeps the slot from becoming burred and the blade tip from being damaged. It also means less force is needed to keep the screwdriver in the slot.



*Select a screwdriver so that the thickness of its blade fits snugly in the screw slot. This reduces the force needed to keep the screwdriver in the slot and the possibility of damaging the blade tip or the slot.*

Most tips are tapered permitting a screwdriver to drive more than one size screw. The tip's thickness determines the size screw that can be driven without damaging the screw slot.



*Screwdrivers with blades ground parallel (C) or undercut slightly (A) will grip the slot more securely than a tapered blade (B).*

If the tip is ground correctly, the sides of the blade are practically parallel. Dress blades so the faces taper in very slightly leaving a short distance back of the tip. Then if severe twisting is exerted, blades ground this way will stay down in the screw slot. Blades that taper out from the tip have a tendency to rise out of the slot when much twisting is applied.

Usually screwdrivers are classified by tip width and blade length. Generally, the longer the blade length, the wider the tip, although some long screwdrivers such as cabinet style models have long, straight sided shanks and narrow tips. Short, stubby screwdrivers with wide tips are used in confined quarters.

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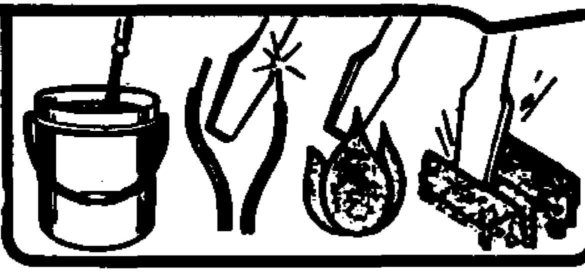
# A MOST USED AND ABUSED TOOL...



When extra turning power is absolutely necessary, a wrench—but never pliers—can be used on the shank. Heavy-duty screwdrivers with square shanks are available for the purpose. As a rule, the bigger the screwdriver, the longer the handle's diameter, the larger the handle's diameter, the greater the turning power.

To correctly and safely use a screwdriver, first make a pilot hole. This is especially important when using hardwood or when the screw is near the edge of a board. Make pilot holes in softwoods, and in some hardwoods, with an awl—if the screws are small. For larger screws, drill a pilot hole or use a threaded screw hole starter. For flathead screws, countersink the pilot hole so the screw's head is flush with the work when driven home. Applying wax to the screw's threads makes driving the screw easier. This is preferable to soap because soap tends to rust the threads.

Before beginning any job where you're using a screwdriver or other hand tools, put on your safety goggles or safety glasses with sideshields. While some tools have a greater injury potential than others, it pays to protect your eyes while you work.

Here are six basic safety rules to keep in mind when using screwdrivers:

1. Make sure the tip fits the screw's slot, not too loose and not too tight.
2. Do not use a screwdriver as a cold chisel or punch.
3. Do not use a screwdriver near electrical conductors.
4. Do not expose a screwdriver to excessive heat as it may reduce the hardness of the blade.
5. Repair a worn tip with a file in order to regain a good straight edge.
6. Discard a screwdriver with a worn or broken handle.

*Supervisors: During your five minute safety talk give your employees a chance to discuss the do's and don'ts when using screwdrivers. See page 11 for a checklist.*

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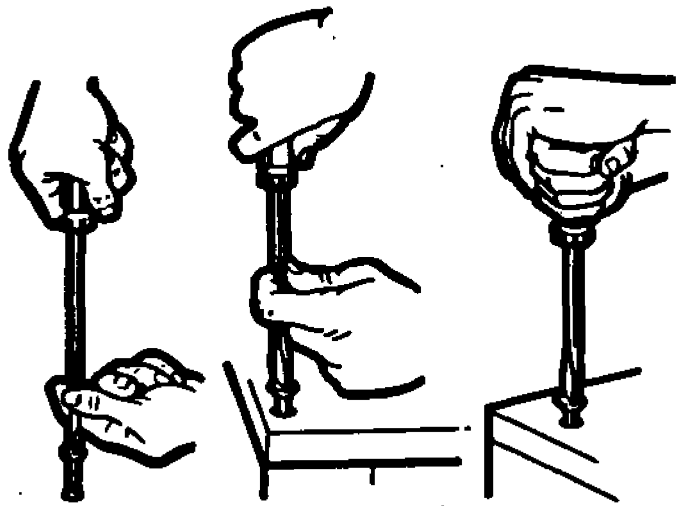
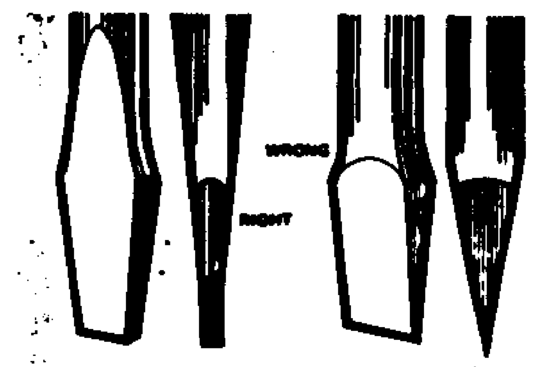
# THE RIGHT WAY TO DRIVE A SCREW



1. Insert the tip of the screw in the pilot hole. Insert the screwdriver tip in the slot of the screw. Hold the tip steady with one hand and make sure the shank of the screwdriver is perpendicular to the head of the screw and in line with the shank of the screw.
2. Use the left hand (if you are right-handed) to keep the blade steady as you turn the handle of the screwdriver.
3. After the screw is almost in, it is safe to use both hands as shown for extra turning power to seat the screw. Note the position of the left hand (if you are right-handed). This will allow additional downward pressure to be applied, thus making certain that the driver tip is firmly seated in the screw slot. If the screw is a flathead, make sure that the pilot hole has a countersunk recess at top and screwdriver tip is narrow enough to avoid touching wood.



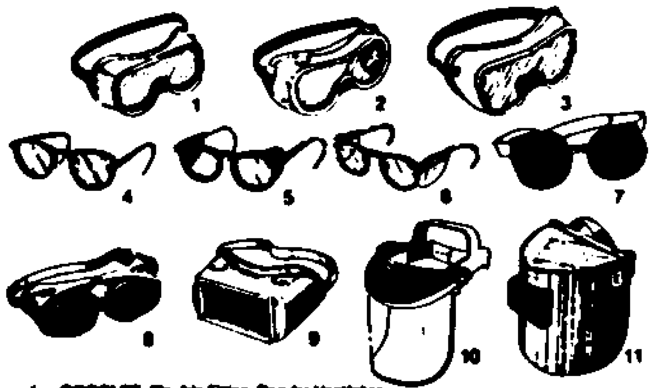



# DO's and DON'Ts When Using Screwdrivers

- Don't hold the work in one hand while using the screwdriver with the other. If the screwdriver slips out of the slot (remember to use the right size screwdriver!) you will be most likely to receive a gash on your hand.
- Don't use a screwdriver with rounded edges or tips; it will slip and cause damage to the work or yourself.
- A rounded tip should be redressed with a file; make sure the edges are straight.
- Don't use a screwdriver near a live wire or for electrical testing.
- Don't use a screwdriver to check a storage battery or to determine if an electrical circuit is live.
- Don't use a screwdriver for prying, punching, chiseling, scoring, or scraping.
- Use a screw-holding screwdriver to get screws started in awkward, hard-to-reach areas.
- Use an offset screwdriver in close quarters where a conventional screwdriver cannot be used.
- Use a ratchet-type screwdriver for speed and comfort when a great number of screws are to be driven.
- Don't use pliers on the handle of a screwdriver to get extra turning power. A wrench should only be used on the square shank or bolster of a screwdriver that is especially designed for that purpose.
- Don't expose a screwdriver blade to excessive heat as it may reduce the hardness of the blade.
- Don't use a screwdriver for stirring paint.
- Don't use a screwdriver with a split or broken handle.
- Screwdrivers used in the shop are best stored in a rack. This way, the proper selection of the right screwdriver can be quickly made.
- Keep the screwdriver handle clean; a greasy handle is apt to cause an accident.

# "WHICH EYE PROTECTION DO YOU NEED?"

This chart is adapted from ANSI Standard Z87.1 - 1979, Practice for Occupational and Educational Eye and Face Protection. It offers general recommendations only. Final selection of eye and face protective devices is the responsibility of management and safety specialists. (For laser protection, refer to ANSI Z136.1 - 1976.)




1. GOGGLES, Flexible Fitting, Regular Ventilation
2. GOGGLES, Flexible Fitting, Hooded Ventilation
3. GOGGLES, Cushioned Fitting, Rigid Body
*4. SPECTACLES, without Side Shields
*5. SPECTACLES, Eyecup Type Side Shields
6. SPECTACLES, Semi- or Flat-Fold Side Shields
**7. WELDING GOGGLES, Eyecup Type, Tinted Lenses (Illustrated)
7A. CHIPPING GOGGLES, Eyecup Type, Clear Safety Lenses (Not Illustrated)
**8. WELDING GOGGLES, Coverspec Type, Tinted Lenses (Illustrated)
8A. CHIPPING GOGGLES, Coverspec Type, Clear Safety Lenses (Not Illustrated)
**9. WELDING GOGGLES, Coverspec Type, Tinted Plate Lens
10. FACE SHIELD, Plastic or Mesh Window (see caution note)
**11. WELDING HELMET

*Non-sideshield spectacles are available for limited hazard use requiring only frontal protection.
**See Table A1, "Selection of Shade Numbers for Welding Filters," in appendix published with ANSI Z87.1-1979.

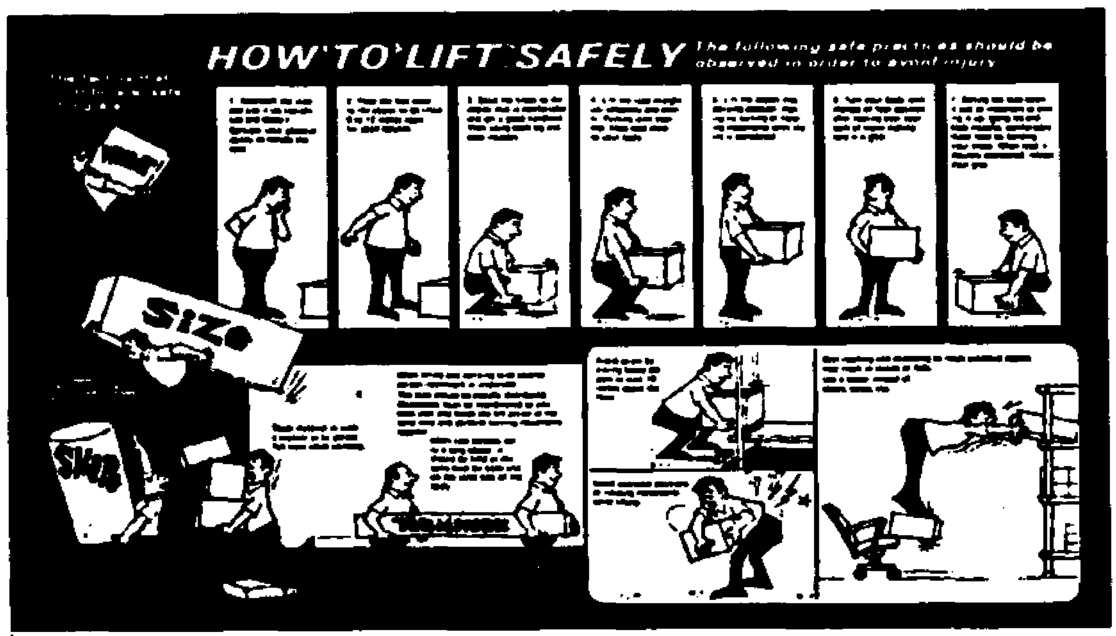


## APPLICATIONS

| OPERATION | HAZARDS | PROTECTORS |
|---|---|---|
| Acetylene - Burning<br>Acetylene - Cutting<br>Acetylene - Welding | Sparks, Harmful Rays, Molten Metal, Flying Particles | 7, 8, 9 |
| Chemical Handling | Splash, Acid Burns, Fumes | 2 (For severe exposure add 10) |
| Chipping | Flying Particles | 1, 2, 4, 5, 6, 7A, 8A |
| Electric (Arc) Welding | Sparks, Intense Rays, Molten Metal | 11 (In combination with 4, 5, 6, in tinted lenses, advisable) |
| Furnace Operations | Glare, Heat, Molten Metal | 7, 8, 9 (For severe exposure add 10) |
| Grinding - Light | Flying Particles | 1, 3, 5, 6 (For severe exposure add 10) |
| Grinding - Heavy | Flying Particles | 1, 3, 7A, 8A (For severe exposure add 10) |
| Laboratory | Chemical Splash, Glass Breakage | 2 (10 when in combination with 5, 6) |
| Machining | Flying Particles | 1, 3, 5, 6 (For severe exposure add 10) |
| Molten Metals | Heat, Glare, Sparks, Splash | 7, 8 (10 in combination with 5, 6, in tinted lenses) |
| Spot Welding | Flying Particles, Sparks | 1, 3, 4, 5, 6 (Tinted lenses advisable; for severe exposure add 10) |

**CAUTION:**
- Face shields alone do not provide adequate protection.
- Plastic lenses are advised for protection against molten metal splash.
- Contact lenses, of themselves, do not provide eye protection in the industrial sense and shall not be worn in a hazardous environment without appropriate covering safety eyewear.

Copies of ANSI Standards may be purchased from the American National Standards Institute, 1430 Broadway, New York, NY 10018.


HOW TO LIFT SAFELY
The following safe practices should be observed in order to avoid injury
SIZE

# APPENDIX D

## Observation Form

**SAFETY CHECK**

NAME ______________________
DEPT _FA_ OBSERVER _BAR_
DATE _10-1-81_ TIME _AM_
ACTIVITY _welding_

GENERAL SAFETY
___ Horseplay
_✓_ Position of self
_✓_ Position of others
___ Other (specify below)

PERSONAL PROTECTIVE EQUIPMENT
_✓_ Eyes/Face
_✓_ Hands/Arms
_✓_ Clothing
_✓_ Other (specify below)
welder's cap

HOUSEKEEPING
_✓_ Spills
_✓_ Equipment & Tools
_✓_ Tripping hazards
___ Other (specify below)

MATERIAL HANDLING
___ Lifting (manually)
___ Stacking/Crating
_✓_ Secure material
___ Other (specify below)

TOOL & EQUIPMENT USE
_✓_ Welding/Cutting/Fitting
___ Chipping/Grinding
___ Cranes/Hoists
___ Ladders/Scaffolds
___ Paint/Chemicals
___ Hand tools
___ Other (specify below)

COMMENTS ______________________

1. Example of completed form for employee working safely.

**SAFETY CHECK**

NAME ______________________
DEPT _SA_ OBSERVER _WJH_
DATE _9-27-81_ TIME _PM_
ACTIVITY _grinding_

GENERAL SAFETY
___ Horseplay
_✓_ Position of self
_✓_ Position of others
___ Other (specify below)

PERSONAL PROTECTIVE EQUIPMENT
_X_ Eyes/Face
_✓_ Hands/Arms
_✓_ Clothing
___ Other (specify below)

HOUSEKEEPING
_✓_ Spills
_✓_ Equipment & Tools
_✓_ Tripping hazards
___ Other (specify below)

MATERIAL HANDLING
___ Lifting (manually)
___ Stacking/Crating
_✓_ Secure material
___ Other (specify below)

TOOL & EQUIPMENT USE
___ Welding/Cutting/Fitting
_✓_ Chipping/Grinding
___ Cranes/Hoists
___ Ladders/Scaffolds
___ Paint/Chemicals
___ Hand tools
___ Other (specify below)

COMMENTS ______________________

2. Example of completed form for employee working unsafely.

# APPENDIX E

## Observational Code

## OBSERVATIONAL CODE

| OBSERVATION FORM CODE (Applicable Groups) | BEHAVIORAL DESCRIPTION | SAFETY MANUAL REFERENCES |
|---|---|---|
| GENERAL SAFETY (GS) | | |
| GS-1 (All) | Position of self: When using a wrench, pinch bar, hammer, or ratchet lever hoist, position yourself so that if the tool slips, you will not fall or otherwise be injured. Never rely on the tool to support your weight or force. | 2.32 |
| GS-2 (All) | Position of self: When handling equipment of material with a hoist or crane, never pull it toward yourself, push away from your person. Stand clear in case the load slips or spills. (Also score "crane/hoists" under Tool and Equipment Use) | 11.1, 11.2 |
| GS-3 (All) | Position of others: When buffing, grinding, welding, or cutting, be sure no one is in the path of showering particules or sparks. Use proper shielding equipment or warn those in the vicinity (within 5 ft. radius) about the possible hazard. (Also score "chipping/grinding", or "welding/cutting/fitting" under Tool and Equipment Use) | 9.16, 9.21, 10.3 |
| GS-4 (All) | Position of others: When driving pins or bolts, check to see that no one is on the opposite side where they may be struck by a flying pin or bolt. | 2.26 |
| GS-5 (All) | Position of others: When ascending or descending a ladder or scaffold, be sure no one is directly above or below you. (Also score "ladders/scaffolding" under Tool and Equipment Use) | 12.14 |
| GS-6 (All) | Position of others: Crane/hoist lifts should not be made if someone is in a position to be injured. Transport material at the lowest possible height, and never pass a load over someone. (Also score "crane/hoists" use) | 11.3, 11.19 |

OBSERVATIONAL CODE, cont'd.

| CODE | BEHAVIORAL DESCRIPTION | REFERENCE |
|---|---|---|
| GS-7 (All) | Other: Running and/or jumping on company premises is prohibited. Always walk (except in an emergency), especially at breaks, lunch time, and quitting time. | 2.3 |
| GS-8 (All) | Other: Equipment must be locked out and/ or disabled before attempting any repairs. Never attempt to operate equipment under repair or that is "Tagged Out". | 2.13, 2.33 |
| PERSONAL PROTECTIVE EQUIPMENT (PPE) | | |
| PPE-1 (All) | Eyes/Face: Approved safety glasses or goggles shall be worn while using nail guns, hammers (metal to metal contact), chipping guns, or punching equipment. | 3.8 |
| PPE-2 (1 only) | Eyes/Face: Approved safety glasses or goggles shall be worn when working beneath equipment where the danger of falling particules exists. | 3.11 |
| PPE-3 (All) | Eyes/Face: Approved safety glasses with side shields or goggles shall be worn when grinding, buffing, spray painting, drilling, machining, scaling, or sawing. For heavy buffing and grinding, e.g., sparks flying toward yourself, a face shield is also recommended. | 3.8, 3.9, 10.2 |
| PPE-4 (All) | Eyes/Face: Dark lens cutting goggles shall be worn when performing any type of oxygen/acetylene burning, cutting, or heating operations. | 3.10 |
| PPE-5 (All) | Eyes/Face: A welding helmet is required for performing any arc welding operations. (Item added to the manual.) | 3.20 |
| PPE-6 (All) | Eyes/Face: Eye protection should be worn whenever the danger of flying particles may exist. For example, when you are in the vicinity (within 6 ft.) of someone grinding, buffing, gouging, hammering, sawing, using a nail gun, spray painting, welding, or oxygen/acetylene brazing or cutting. | 3.12 |

OBSERVATIONAL CODE, cont'd.

| CODE | BEHAVIORAL DESCRIPTION | REFERENCE |
|---|---|---|
| PPE-7 (All) | Hands/Arms: Long sleeve shirts shall be worn when performing welding operations. | 3.3, 3.15 |
| PPE-8 (All) | Hands/Arms: Gloves shall be worn while performing any arc welding or oxygen/acetylene cutting or burning. | 3.5 |
| PPE-9 (All) | Hands/Arms: Gloves should be worn when handling any type of raw material or machined material that has rough or sharp edges. | 8.6, 8.9 |
| PPE-10 (All) | Clothing: Shirts/shirtails shall be tucked inside trousers while performing machine shop operations or using rotary equipment such as grinders, drills, power saws, reamers, and impact wrenches. Wearing excessively baggy clothing shall also be avoided. | 3.4, 3.17 |
| PPE-11 (1, 3) | Other: Approved air respirators shall be used while painting or blasting. Clean these daily. (Specific item for painting/sandblasting and crating departments.) | 14.4 |
| PPE-12 (All) | Other: A welding cap or other approved head protection should be worn when arc welding or oxygen/acetylene cutting or burning. (Item added to the manual). | 3.19 |

HOUSEKEEPING (HK)**

**For observational purposes, employees should be scored for the housekeeping of the area within a 5 ft. radius of their observed position. Therefore, the observable result of an act is scored rather than the actual behavior per se.

| CODE | BEHAVIORAL DESCRIPTION | REFERENCE |
|---|---|---|
| HK-1 (All) | Spills: If oil, grease, or other liquid substances are spilled, wipe them up using rags or floor-dri so you or other employees will not slip or fall. | 4.3 |
| HK-2 (All) | Equipment & Tools: Portable power tools should be disconnected from their attachment plug as soon as they are not in use. Secure the tool where it won't be damaged or return it to its proper location upon finishing a job. | 2.40, 4.7, 10.8 |

OBSERVATIONAL CODE, cont'd.

| CODE | BEHAVIORAL DESCRIPTION | REFERENCE |
|---|---|---|
| HK-3 (All) | Tripping hazards: Avoid leaving blocks, chains, hooks, cables, hoses, or tools lying on the floor after you are finished with them. Keep aisles (designated by yellow lines) clear and free from these tripping hazards at all times. Stay alert for tripping hazards and correct them where possible. | 2.4, 4.5, 4.9 |
| HK-4 (All) | Other: Piling or storing material or equipment near the following should be avoided: A) exits or passageways, B) crane ladders, C) fire fighting equipment, D) electrical substations, panels or equipment disconnecting devices (emergency shut-offs). | 4.10 |
| MATERIAL HANDLING (MH) | | |
| MH-1 (All) | Lifting: When lifting an object, bend your knees and keep your back nearly vertical. Then grasp the object firmly and raise by straightening your legs. (See chart in the back of the manual). Always get help when lifting loads that are too heavy for one person and/or use a crane or hoist. | 8.1 |
| MH-2 (All) | Secure material: Before attempting to drill, grind, or ream small objects, clamp or secure the item first. Avoid holding the object with one hand while performing the operation with the other. | 10.13 |
| MH-3 (3 only) | Secure material: Have a good foundation for cutting boards. Never cut between two saw horses. Set the blade for the job and cut across the two saw horses. Also, never balance a board on just one saw horse while sawing. Always use two saw horses. (Item added to the manual. Applies to Crating only). | 8.15 |

OBSERVATIONAL CODE, cont'd.

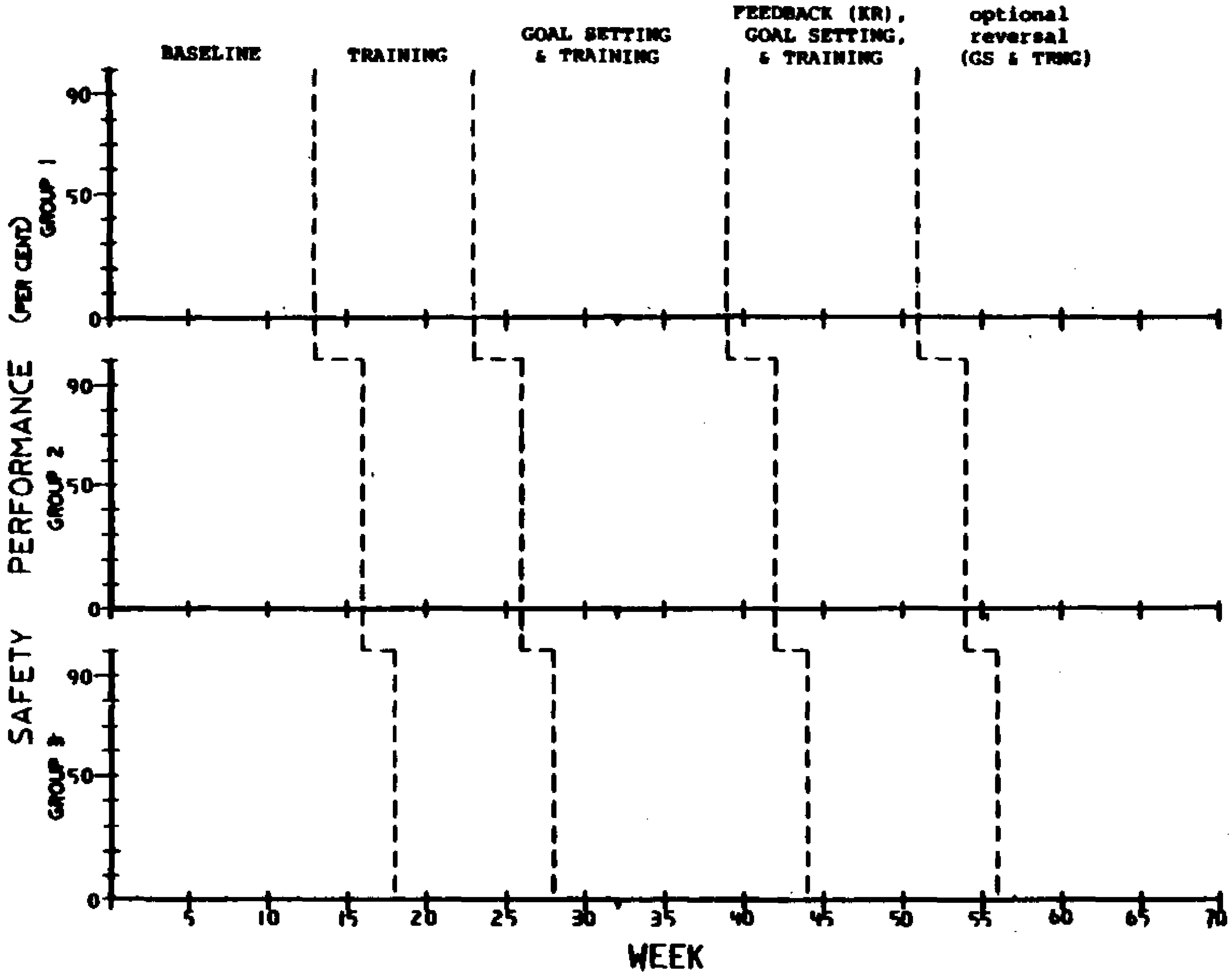
| CODE | BEHAVIORAL DESCRIPTION | REFERENCE |
|---|---|---|
| TOOL & EQUIPMENT USE (TE) | | |
| TE-1 (All) | Welding/Cutting/Fitting: Matches, lighters, or electrodes shall not be used to light oxygen/acetylene cutting torches. Strikers should be used. Butane lighters should not even be carried in the pockets of personnel who perform welding and cutting operations. | 9.34, 9.35 |
| TE-2 (All) | Chipping/Grinding: Always use both hands to operate a pneumatic grinder or chipper. | 10.13 |
| TE-3 (All) | Cranes/Hoists: Riding on a load or chain is prohibited. Balance the load and walk beside it while transporting it at the lowest possible height. | 11.2, 11.6, 11.19 |
| TE-4 (All) | Cranes/Hoists: Plate clamps should be used to lift only one plate or piece of steel at a time. Attach the clamp near the center of the plate and thus avoid making an unbalanced load or side pulls. | 11.12, 11.13, 11.15 |
| TE-5 | Ladders/Scaffolds: The use of buckets, chairs, fork lifts, or other makeshift devices for work platforms is prohibited. Always stand on a ladder or scaffold when working more than 1 ft. off the ground. | 12.4 |
| TE-6 (All) | Ladders/Scaffolds: When ascending or descending a ladder or scaffold, use every step. Avoid hurriedly skipping steps or jumping off. | 12.16 |
| TE-7 (1 only) | Paint/Chemicals: Paint booth doors should be kept closed when any spray painting is taking place inside. (Item added to the manual. Applies to Painting/ Sandblasting department only) | 14.9 |
| TE-8 (All) | Hand tools: Hand tools should only be used within their maximum capability. Never use add-on devices to try to extend the tools limits. For example, avoid attaching a cheater pipe to a wrench, use a larger wrench instead. (Item added to the manual) | 2.34 |

OBSERVATIONAL CODE, cont'd.

| CODE | BEHAVIORAL DESCRIPTION | REFERENCE |
|---|---|---|
| TE-9 (All) | Hand tools: Always use a tool for its designed purpose only. For example, never use a wrench or crane hook as a hammer. (Item added to the manual) | 2.35 |
| TE-10 (2 only) | Other: Never use your fingers to check alignment or the condition of a hole when using a punch press. Always use the proper tool to place the material in position for the punch. | 2.22 |

# APPENDIX F

## Multiple-Baseline Design of the Study


BASELINE
TRAINING
GOAL SETTING & TRAINING
FEEDBACK (KR), GOAL SETTING, & TRAINING
optional reversal (GS & TRNG)
SAFETY PERFORMANCE (PER CENT)
GROUP 1
GROUP 2
GROUP 3
0
50
90
5
10
15
20
25
30
35
40
45
50
55
60
65
70
WEEK

# APPENDIX G

## Description of Training Slides*

*Note: The following notation by the slide number indicates that the slide was used for a safety quiz:

a - Group 1 quiz
b - Group 2 quiz
c - Group 3 quiz

| SLIDE NO. | GROUP(S) VIEWING | DESCRIPTION | OBSERVATIONAL CODE REFERENCE |
|---|---|---|---|
| 1 | All | Unsafe: Horseplay example. Individual seen riding on a crane load. | TE-3 |
| 2 | All | Unsafe: Individual seen running/ jumping over a stack of metal. | GS-7 |
| 3 | | Safe: Individual seen walking around the stack of metal. | |
| 4[a] | All | Unsafe: Employee using a cheater pipe on a wrench and in a position to be hurt if the tool slips. | GS-1, TE-7 |
| 5 | | Safe: Shows employee using proper wrench and not applying his weight against the tool. | |
| 6[c] | All | Unsafe: Depicts employee using an improper hand tool to work on a power tool that is connected to its energy source. | GS-8, TE-8 |
| 7[b] | | Safe: Power tool clearly disconnected and proper hand tool is being used. | |
| 8[c] | All | Unsafe: Employee is hammering (metal to metal contact) while not wearing safety glasses. | PPE-1 |
| 9[b] | | Safe: Shows same employee now wearing safety glasses. | |
| 10[a] | 1 only | Unsafe: Worker is underneath a combine but is not wearing safety glasses. | PPE-2 |
| 11 | | Safe: Same worker, now wearing glasses. | |
| 12[b] | All | Unsafe: Shows a welder not wearing gloves, long sleeve shirt, or a welding cap. (Does have face shield on.) | PPE-5, PPE-7, PPE-8, PPE-12 |
| 13[a] | | Safe: Welder now wearing proper protective equipment: gloves, long sleeve shirt, and cap. | |

| SLIDE NO. | GROUP(S) VIEWING | DESCRIPTION | OBSERVATIONAL CODE REFERENCE |
|---|---|---|---|
| 14[c] | 3 only | Unsafe: Lathe operator has no eye protection, and has shirtail out. | PPE-3, PPE-10 |
| 15 | | Safe: Operator now shown with safety glasses with side shields and shirt tucked inside his trousers. | |
| 16[b] | All | Unsafe: Employee walking in aisle which has tripping hazards: blocks, pry bar, welding cable and welding wans. | HK-3 |
| 17[ac] | | Safe: Aisle now clear, tools put away. | |
| 18 | All | Unsafe: Material piled by: electrical substation. | HK-4 |
| 19[c] | | fire fighting equipment | |
| 20 | | crane ladders | |
| 21[b] | All | Unsafe: Individual is bending over to lift a piced of pipe with his bare hands grasping the edge. | MH-1, PPE-9 |
| 22[ac] | | Safe: Individual demonstrates proper lifting technique and is wearing gloves to grasp the sharp edges of the piece. | |
| 23 | 3 only | Unsafe: Worker is sawing a board without wearing eye protection. He is also cutting between two saw horses with a power circular saw. | MH-3, PPE-3 |
| 24 | | Safe: Worker is wearing glasses with side shields and is cutting the board across the saw horses. | |
| 25 | 3 only | Unsafe: Employee is not wearing safety glasses while cutting a board with a circular saw. He is also balancing the board on one saw horse. | MH-3, PPE-3 |
| 26[c] | | Safe: Employee now shown wearing glasses with side shields and has the board being cut laid across two saw horses. | |

| SLIDE NO. | GROUP(S) VIEWING | DESCRIPTION | OBSERVATIONAL CODE REFERENCE |
|---|---|---|---|
| 27[a] | 1, 2, only | Unsafe: Welder is preparing to weld too close to another employee. Welder is not wearing a long sleeve shirt, gloves, or cap (other employee is hammering without eye protection). | GS-3, PPE-5, PPE-7, PPE-8, (PPE-1, PPE-6) |
| 28[b] | | Safe: Welder is preparing to weld with no other workers within a 5 ft. radius. Welder is also wearing all required personal protective equipment. | |
| 29 | 1, 2 only | Unsafe: Shows employee lighting an acetylene torch with a butane lighter. | TE-1 |
| 30 | | Safe: Striker is shown being used to light torch. | |
| 31[b] | All | Unsafe: Grinder and Welder working within 5 ft. of each other: Grinder: Improper eye protection, allowing sparks to hit welder, has scaling gun still attached, lying at his feet. | GS-3, PPE-3, HK-2 |
| | | Welder: Proper personal protective equipment but welding too close to other without a shield between them. | GS-3, HK-2 |
| 32[a] | | Safe: Grinder only: wearing face sheild, sparks directed down, scaling gun disconnected and removed. | GS-3, PPE-3, HK-2 |
| 33[a] | All | Unsafe: Worker is using grinder with one hand, holding the piece of metal with the other hand. Wearing glasses only, and has his shirttail out. | PPE-3, PPE-10, MH-2, TE-2 |
| 34[c] | | Safe: Grinder now has piece clamped to work bench, is wearing a face shield, and has his shirt tucked in. | |

| SLIDE NO. | GROUP(S) VIEWING | DESCRIPTION | OBSERVATIONAL CODE REFERENCE |
|---|---|---|---|
| 35[b] | All | Unsafe: Employee passing a piece of material held by a lift-magnet on a crane, over another employee. He is also pulling the material towards himself. An oil spill is on the floor within 3 ft. of the crane operator. | GS-2, GS-6, HK-1 |
| 36[c] | | Safe: Load is shown being moved at a lower height, not over anyone; and the operator is pushing the part away from his body. The liquid spill has floor-dri on it. | |
| 37 | All | Unsafe: Shows a worker operating a crane to transport a large load. Employee is standing on the load to help balance it. | TE-3 |
| 38[b] | | Safe: Load is properly balanced. The crane operator is now standing beside the load. | |
| 39 | All | Unsafe: Shows a plate clamp holding two pieces of sheet metal. The crane is pulling on the plates at a $45^{o}$ angle. | TE-4 |
| 40 | | Safe: Shows plate clamp holding only one sheet of metal in the middle, and pulling (lifting) straight up. | |
| 41[a] | All | Unsafe: Depicts a worker standing on the raised forks of a fork lift to attach a hook on a part. | TE-5 |
| 42[b] | | Safe: Employee shown standing on a step ladder to attach the hook. | |
| 43[c] | All | Unsafe: Employee is standing on a bucket and stretching out to reach a part. | TE-5 |
| 44[a] | | Safe: Same employee is now shown standing on a proper work platform allowing him to easily reach the area he needs to work in. | |

| SLIDE NO. | GROUP(S) VIEWING | DESCRIPTION | OBSERVATIONAL CODE REFERENCE |
|---|---|---|---|
| 45 | 2 only | Unsafe: Worker not wearing glasses, is shown placing his fingers in a punch press (piranha) to adjust the position of the material. | TE-9, PPE-1 |
| 46 | | Safe: Worker, now wearing safety glasses, is shown using a tool to align the material to be punched. | |

# APPENDIX H

Safety Goal Sign*

*Reduced to 65% of actual size.

SAFETY
GOAL
90%

# APPENDIX I

## Safety Goal Reminder*

*Reduced to 74% of actual size.

CAMECO

**To:** (department)

**From:** Safety Supervisor

**Subject:** Safety Goal Reminder

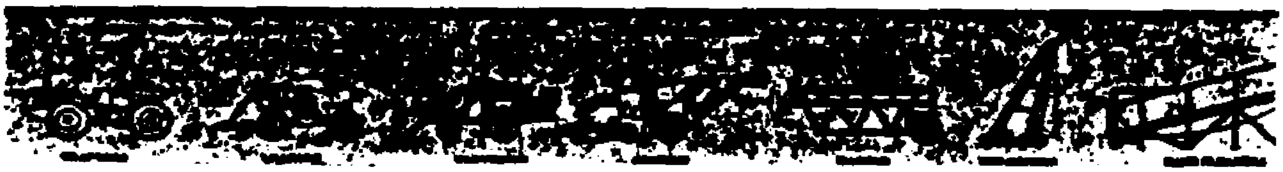
**SAFETY GOAL = 90%**

In an effort to improve the safety performance here at Cameco, the employees in your department are urged to try to achieve a goal of 90% safety. This means that at any given time of the workday, at least 90% of all the employees in your department should be doing their job <u>completely safe</u> according to the rules in the Safety Manual.

Safety checks will be made periodically and your department's safety performance will be recorded on a weekly basis.

The department's previous performance indicates that the 90% safety goal will be difficult to reach, but if everyone does his or her part, it can be attained. Remember to <u>THINK SAFETY</u>.

Billy Hadaway
Safety Supervisor



# APPENDIX J

## Questionnaire for Manipulation Checks*

*Note: The following notation by the questionnaire item indicates which factor it was used to measure:

a - Goal Acceptance/Commitment
b - Goal Clarity
c - Goal Difficulty
d - Positive Supervisory Feedback
e - Negative Supervisory Feedback
f - Corrective Supervisory Feedback
g - Current Level of Safety

## YOU AT WORK

Everyone experiences a variety of complicated feelings while at work. Each has his own opinions. However, these feelings and opinions are not always expressed. You may be very dissatisfied with something having to do with your work and not say anything about it. Or, you might be very satisfied with something but somehow it never gets said. There are many reasons for this. You may be too busy. Sometimes you may feel too embarrassed. And there are also times when you may not feel that you can be perfectly frank about your opinions.

Your feelings and opinions are very important whether they are expressed or not. Furthermore, your Management wants to do whatever they can to make this Company a better place to work. This is a difficult task especially when management is not certain about what is satisfying and what is dissatisfying.

This survey provides some time for you to sit down and seriously think about your opinions. It also provides an opportunity to express your feelings, good or bad, without fear of embarrassment.

Your opinions will be held in strict confidence. Please do not sign your name.

After you have completed the booklet, please drop it in the sealed box as you leave the room. When the survey has been completed, Bob Reber will take all of the booklets back to the University for analysis. Then the booklets will be destroyed. Later, a report of the results will be given to you and management, but your booklet will never be shown to anyone connected with the Company.

## INSTRUCTIONS

There are three major sections in this booklet. You may never have seen anything quite like it before, so we will give complete instructions for each section. Please do not hesitate to ask questions at any time.

To begin with, we would like for you to fill out the blank spaces below. This information helps to make the survey more meaningful. However, if you feel that it would be like signing your name to fill out one or more of the spaces, please leave them blank.

1. Supervisor's Name____________________
2. Department or Work Area______________
3. Job Title____________________________
4. Length of Service____________________
5. ____________________________________
6. ____________________________________
7. ____________________________________

DEPARTMENT SAFETY GOAL

| | Extremely | Quite | Slightly | Neither One Nor The Other | Slightly | Quite | Extremely | |
|---|---|---|---|---|---|---|---|---|
| a Reasonable | ____: | ____: | ____: | ____: | ____: | ____: | ____ | Unreasonable |
| c Difficult | ____: | ____: | ____: | ____: | ____: | ____: | ____ | Easy |
| a Acceptable | ____: | ____: | ____: | ____: | ____: | ____: | ____ | Unacceptable |
| a Important | ____: | ____: | ____: | ____: | ____: | ____: | ____ | Unimportant |
| b Unclear | ____: | ____: | ____: | ____: | ____: | ____: | ____ | Clear |
| a Meaningful | ____: | ____: | ____: | ____: | ____: | ____: | ____ | Meaningless |
| a Adoptable | ____: | ____: | ____: | ____: | ____: | ____: | ____ | Refusable |
| a Unsatisfactory | ____: | ____: | ____: | ____: | ____: | ____: | ____ | Satisfactory |
| a Disagreeable | ____: | ____: | ____: | ____: | ____: | ____: | ____ | Agreeable |
| a Useful | ____: | ____: | ____: | ____: | ____: | ____: | ____ | Useless |

SECTION TWO

Please refer to the following scale for marking your answers in this section:

| 100% Certain | Very Probable | Fairly Probable | Uncertain | Fairly Improbable | Very Improbable | 100% Improbable |
|---|---|---|---|---|---|---|

In your opinion, what is the probability that . . .

c21. Your department will achieve its safety goal.

100% Certain ___ ___ ___ ___ ___ ___ ___ 100% Improbable

a22. Everyone in your department is trying to achieve the safety goal.

100% Certain ___ ___ ___ ___ ___ ___ ___ 100% Improbable

a23. You are committed to achieving the safety goal.

100% Certain ___ ___ ___ ___ ___ ___ ___ 100% Improbable

d24. Your supervisor would personally compliment you if you did your job safely.

100% Certain ___ ___ ___ ___ ___ ___ ___ 100% Improbable

e25. Your supervisor would reprimand you if you consistently worked in an unsafe manner.

100% Certain ___ ___ ___ ___ ___ ___ ___ 100% Improbable

g26. You will get injured on the job if you continue to work as safe as you do now.

100% Certain ___ ___ ___ ___ ___ ___ ___ 100% Improbable

f27. Your supervisor will correct you if you are doing your job unsafely.

100% Certain ___ ___ ___ ___ ___ ___ ___ 100% Improbable

a28. Most of the people in your department don't care about the safety goal.

100% Certain ___ ___ ___ ___ ___ ___ ___ 100% Improbable

In your opinion, what is the probability that . . .

C 29. Your department has reached its safety goal.

100% Certain ___ ___ ___ ___ ___ ___ ___ 100% Improbable

S 30. You and your co-workers work as safe as possible at all times.

100% Certain ___ ___ ___ ___ ___ ___ ___ 100% Improbable

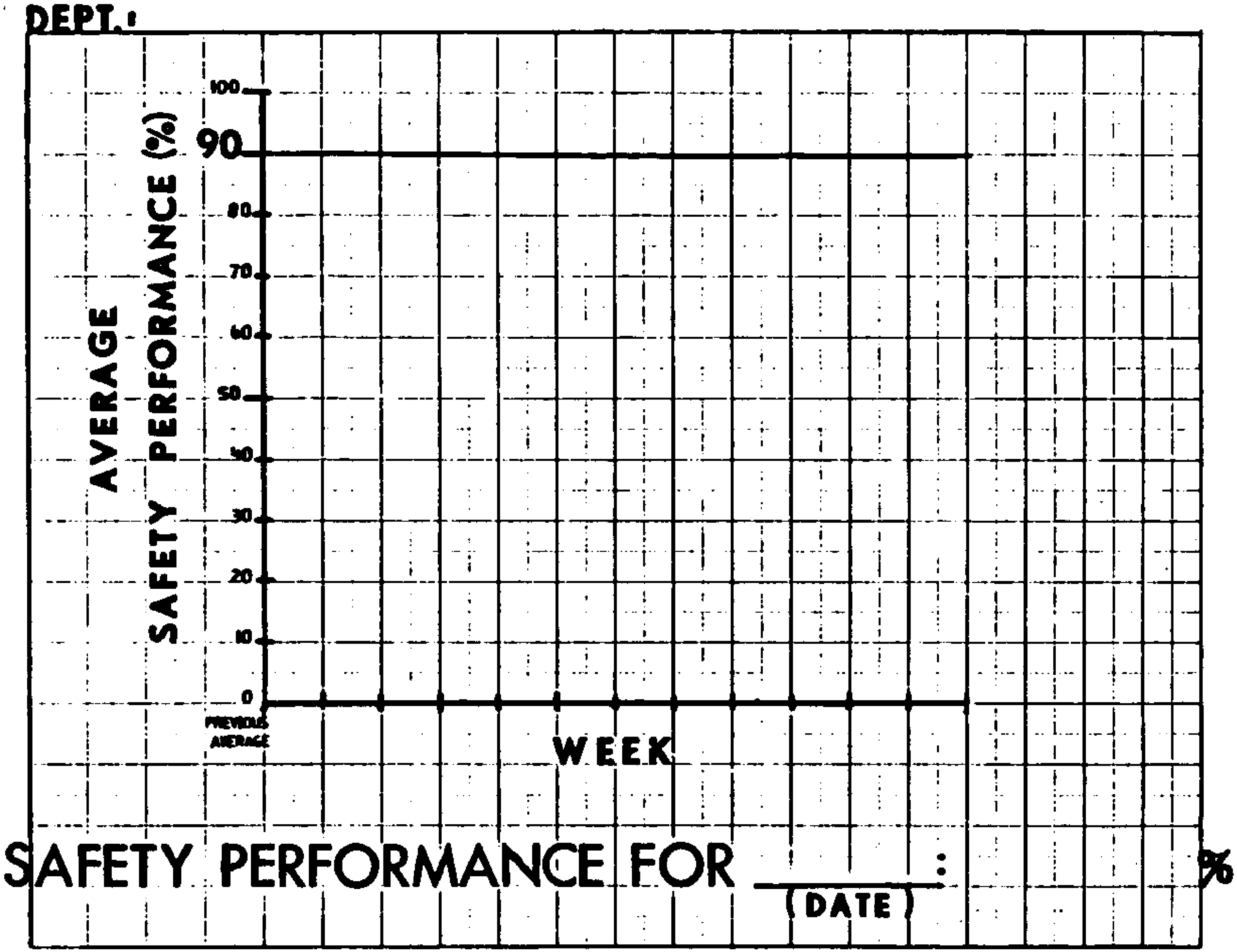
SECTION THREE

You have expressed your feelings about a number of things - your job, pay, supervisor, top mangement, opportunities for advancement, working conditions, company benefits, and fellow workers. However, we may have left out something very important to you. This section is included for that purpose. If you would like to comment about something you would like to see changed, please do so.

# APPENDIX K

## Feedback Sign*

*Reduced to 74% of actual size.


DEPT.:
AVERAGE
SAFETY PERFORMANCE (%)
100
90
80
70
60
50
40
30
20
10
0
PREVIOUS AVERAGE
WEEK
SAFETY PERFORMANCE FOR ______ (DATE) : %

# APPENDIX L

## Results of Departmental Data Analysis

## RESULTS OF DEPARTMENTAL DATA ANALYSIS

Manipulation Checks:

The mean responses for the variables measured by the questionnaire completed prior to introducing KR are shown in Table 3.

Insert Table 3 about here

In general, each department perceived the goal to be clear and slightly difficult. Goal acceptance appeared to be high for each department. Further, positive supervisory feedback (i.e., praise) was given infrequently. On the other hand, employees indicated that it was quite possible that they would receive negative feedback (reprimand) and/or corrective feedback from their supervisor if they were working unsafely. The results also indicated that the employees of each department perceived themselves as generally working safety. Interestingly, the behavioral safety performance was estimated to be less than the 90% goal by all but one of the departments (Welding).

Table 4 depicts the mean response for each department concerning the goals attempted after receiving KR. All but one of the departments indicated a safety goal higher than the assigned goal.

Insert Table 4 about here

Observational Data Analysis:

ARIMA Analysis--An ARIMA analysis was performed on the time-series data for each period of the study on a departmental basis. As with the group data, visual inspection of the behavioral performance for each department (displayed graphically in Figure 2a-k) indicated marked intervention effects. Therefore, the results of the ARIMA analysis for each period were used to determine the best model for the time-series for each department.

---

Insert Fiture 2a-k about here

---

Inspection of the autocorrelations revealed that none of the departmental observational data required differencing, i.e., corrections for trend or drift. Again, the autocorrelation function and the partial autocorrelation function for each period did not indicate the presence of an autoregressive or moving average component. Therefore, an ARIMA (0, 0, 0) model was diagnosed. The Q-statistic performed on the residuals of the autocorrelations supported the white noise model for every department and for every period with three isolated exceptions. The time-series analysis for the baseline period for Raw Material Prep, and the Goal Setting period for both the Hydraulics and Machine Shop departments resulted in a significant Q-statistic. However, closer evaluation of the respective autocorrelations and partial autocorrelations failed to identify an ARIMA model other than a stochastic one. The significant residuals checks were assumed to be due to several random (i.e., nonseasonal) lag spikes which appeared in the plot of the autocorrelations for the periods and departments in question.

Repeated Measures ANOVA--Given the aforementioned implications and the fact that a white noise model was identified for the majority of the departmental time-series, it was decided to analyze the data as a repeated measures design with blocking on departments. Table 5 summarizes the data used for this analysis.

Insert Table 5 about here

In concert with the group data analysis, the repeated measures ANOVA for the departmental data resulted in a strong main effect for the study phase or period ($F = 151.50$, $df = 3$, $p < .0001$). The Duncan's multiple range test was then performed on the period means. As hypothesized, the mean performance during the KR phase ($X = 95.40$) was significantly greater than the mean performance during the Goal Setting phase ($\bar{X} = 77.27$). Further, performance after Goal Setting was significantly better than performance after Training ($\bar{X} = 71.09$); which in turn was better than baseline performance ($\bar{X} = 61.57$). These differences appear for each department as seen in Table 5 and Figures 2a-k.

It may be worth noting that ten of the eleven departments' average performance during the KR phase was above the assigned goal; whereas only two of the departments achieved goal level performance during the Goal Setting period.

Table 3

Mean Departmental Response for Each Questionnaire Factor

| Department | n | Factor[a] Goal Acceptance | Goal Clarity | Goal Difficulty | Positive Feedback | Negative Feedback | Corrective Feedback | Current Safety | Estimated Performance (%) |
|---|---|---|---|---|---|---|---|---|---|
| Final Assembly | 21 | 5.41 | 5.57 | 4.51 | 2.81 | 5.05 | 4.38 | 4.67 | 75.48 |
| Hydraulics | 5 | 6.16 | 6.40 | 5.00 | 3.20 | 5.20 | 4.20 | 5.60 | 77.00 |
| Mechanics | 5 | 6.32 | 6.80 | 5.47 | 3.40 | 6.80 | 5.40 | 4.90 | 87.60 |
| Paint/Sandblast | 4 | 6.05 | 6.25 | 5.00 | 3.25 | 6.25 | 5.00 | 5.63 | 73.75 |
| Heavy Equipment | 9 | 5.92 | 5.67 | 4.59 | 4.00 | 6.00 | 5.33 | 4.72 | 77.22 |
| Raw Material Prep | 14 | 5.88 | 5.93 | 4.40 | 3.14 | 5.71 | 5.00 | 5.54 | 81.71 |
| Sub-Assembly | 6 | 5.97 | 5.50 | 4.44 | 4.00 | 6.00 | 5.33 | 5.83 | 86.67 |
| Welding | 3 | 6.33 | 5.67 | 5.33 | 3.67 | 7.00 | 3.67 | 6.33 | 93.67 |
| Crating | 5 | 5.76 | 5.40 | 4.53 | 3.60 | 4.60 | 4.80 | 4.90 | 75.00 |
| Machine Shop | 5 | 5.47 | 5.80 | 4.00 | 3.60 | 4.80 | 4.40 | 4.60 | 76.00 |
| Parts | 9 | 5.69 | 6.11 | 3.89 | 2.67 | 4.78 | 4.33 | 5.17 | 79.67 |
| Overall | 86 | 5.78 | 5.82 | 4.54 | 3.28 | 5.49 | 4.76 | 5.12 | 79.43 |

[a]Mean responses are based on a 7-point scale with a score of seven being desired.

Table 4

Mean Goal for Each Department After

Receiving Feedback (KR)

| Department | n | Goal (%) |
|---|---|---|
| Group 1 | | |
| Final Assembly | 16 | 92.63 |
| Hydraulics | 5 | 99.00 |
| Mechanics | 4 | 92.50 |
| Painting/Sandblasting | 4 | 95.00 |
| Group 2 | | |
| Heavy Equipment | 8 | 98.75 |
| Raw Material Prep | 12 | 96.83 |
| Sub-Assembly | 6 | 89.17 |
| Welding | 3 | 100.00 |
| Group 3 | | |
| Crating | 6 | 96.67 |
| Machine Shop | 5 | 95.00 |
| Parts | 8 | 98.75 |
| Overall | 77 | 95.68 |

Table 5

Mean Departmental Safety Performance for Each Period

| Department | Period | | | | Overall |
|---|---|---|---|---|---|
| | Baseline | Training | Goal Setting | Feedback (KR) | |
| Final Assembly | 53.56 | 62.62 | 71.40 | 93.05 | 72.08 |
| Hydraulics | 60.02 | 71.62 | 77.29 | 97.26 | 78.19 |
| Mechanics | 62.54 | 75.38 | 80.91 | 96.53 | 80.27 |
| Painting/Sandblasting | 52.76 | 59.46 | 67.99 | 88.09 | 68.88 |
| Heavy Equipment | 59.14 | 66.28 | 75.08 | 96.01 | 74.04 |
| Raw Material Prep | 58.49 | 66.66 | 73.65 | 97.31 | 73.85 |
| Sub-Assembly | 47.11 | 59.52 | 64.69 | 91.05 | 65.22 |
| Welding | 80.21 | 91.13 | 93.70 | 100.00 | 90.94 |
| Crating | 59.43 | 68.11 | 73.48 | 95.29 | 72.47 |
| Machine Shop | 57.55 | 71.39 | 76.99 | 98.09 | 74.02 |
| Parts | 81.36 | 90.37 | 94.48 | 99.12 | 90.40 |
| Overall | 61.57 | 71.09 | 77.27 | 95.40 | |

Note. Safety performance refers to the percentage of employees working in a completely safe manner.

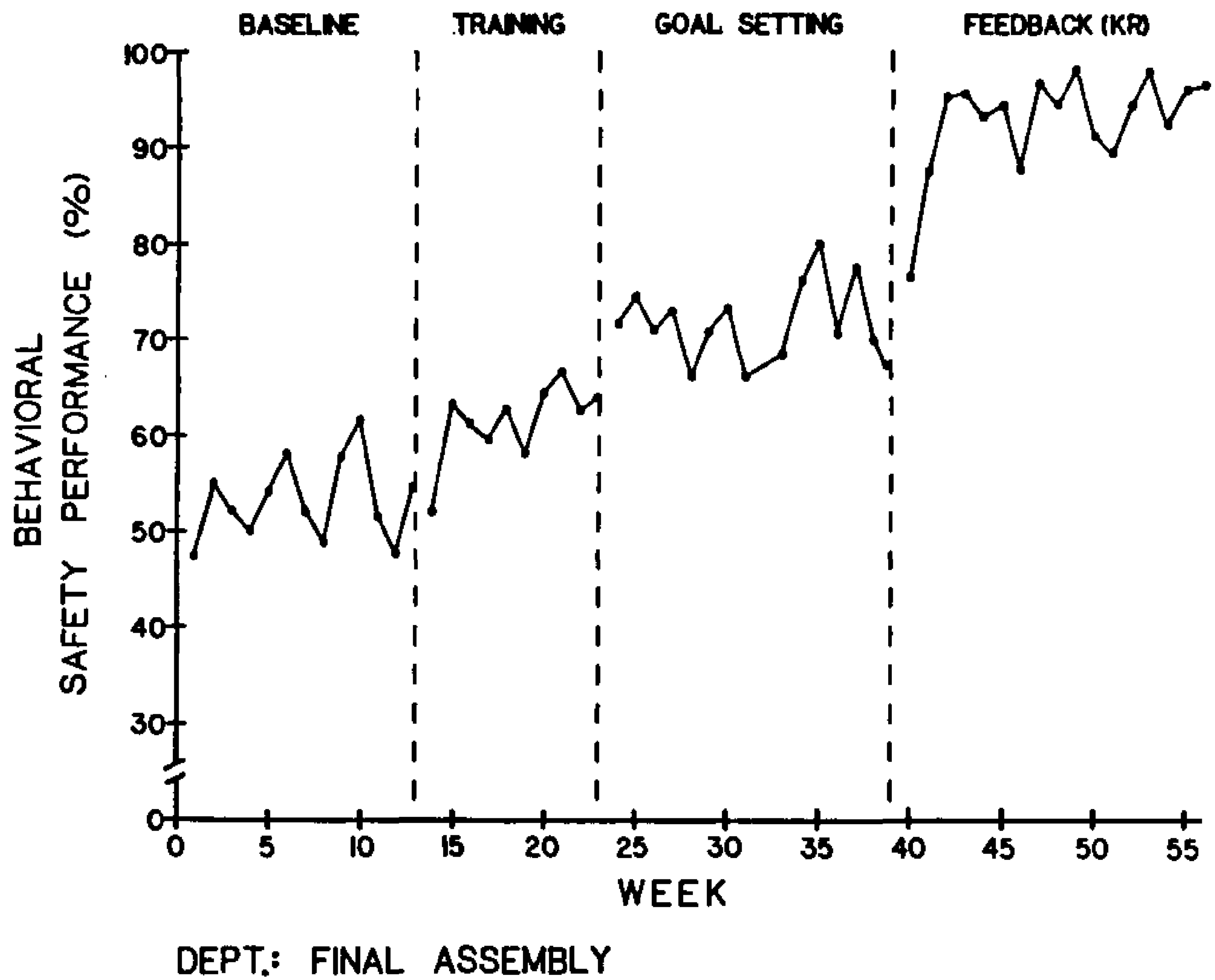



Figure 2a. Average weekly safety performance for final assembly.

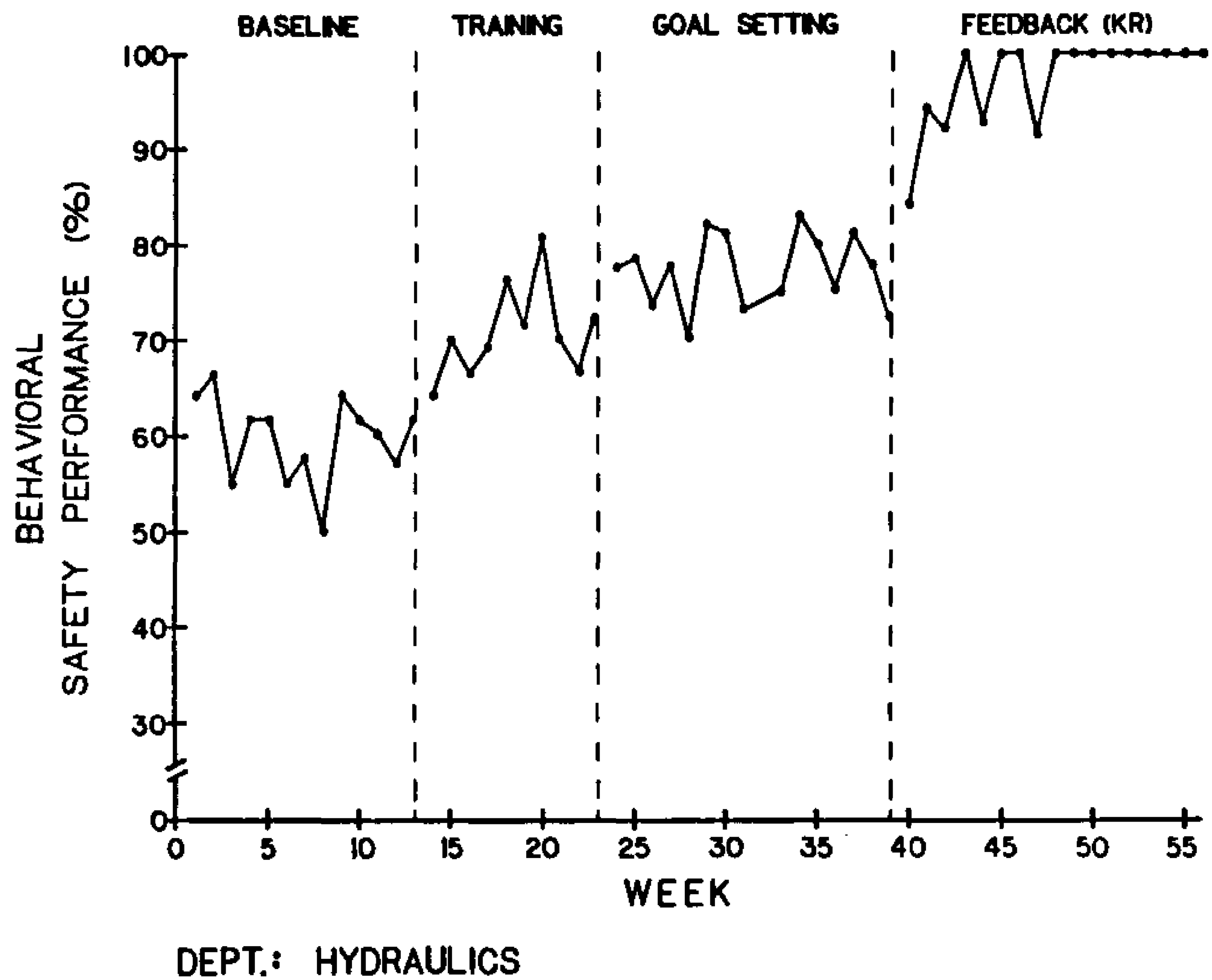



Figure 2b. Average weekly safety performance for hydraulics.

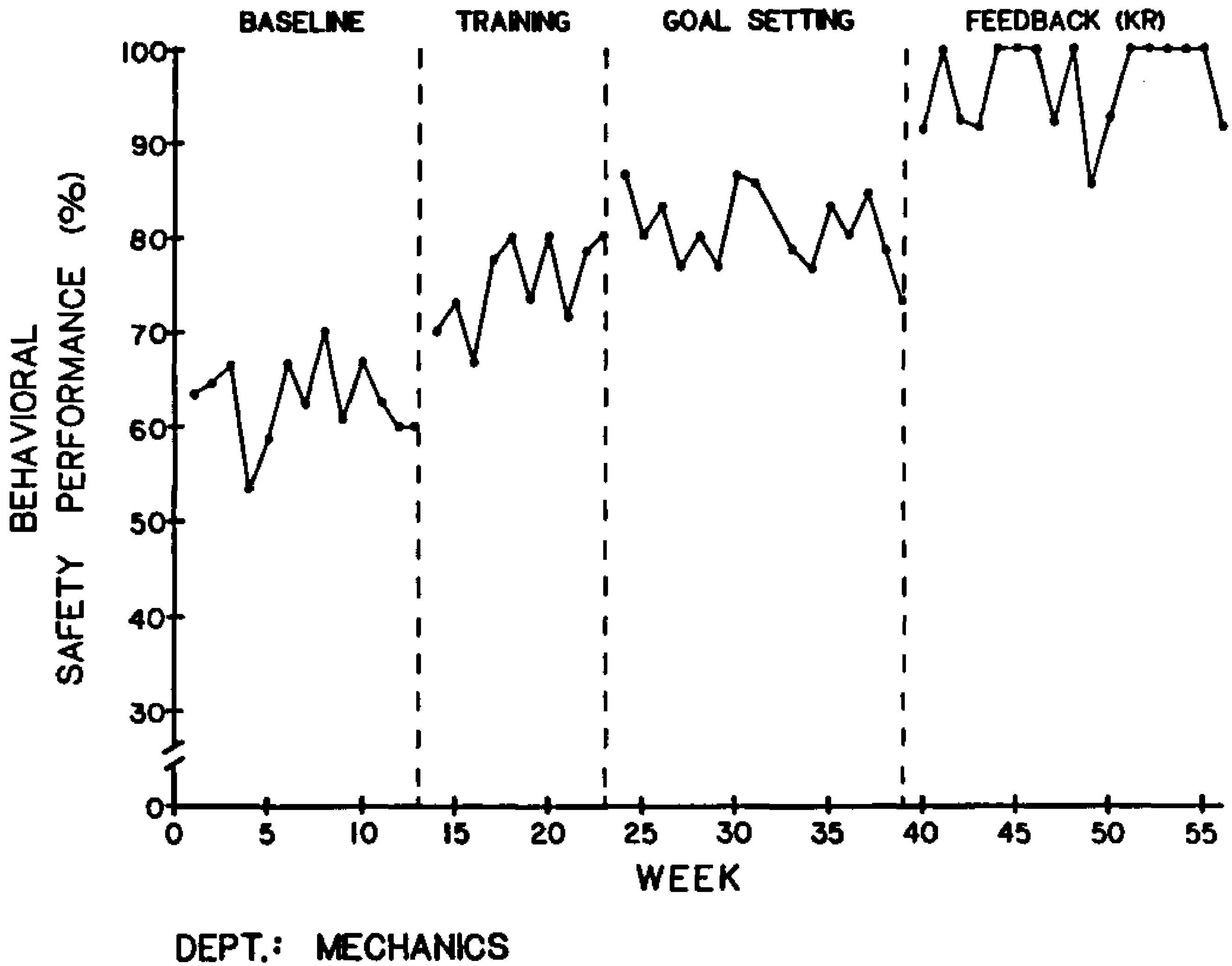



Figure 2c. Average weekly safety performance for mechanics.

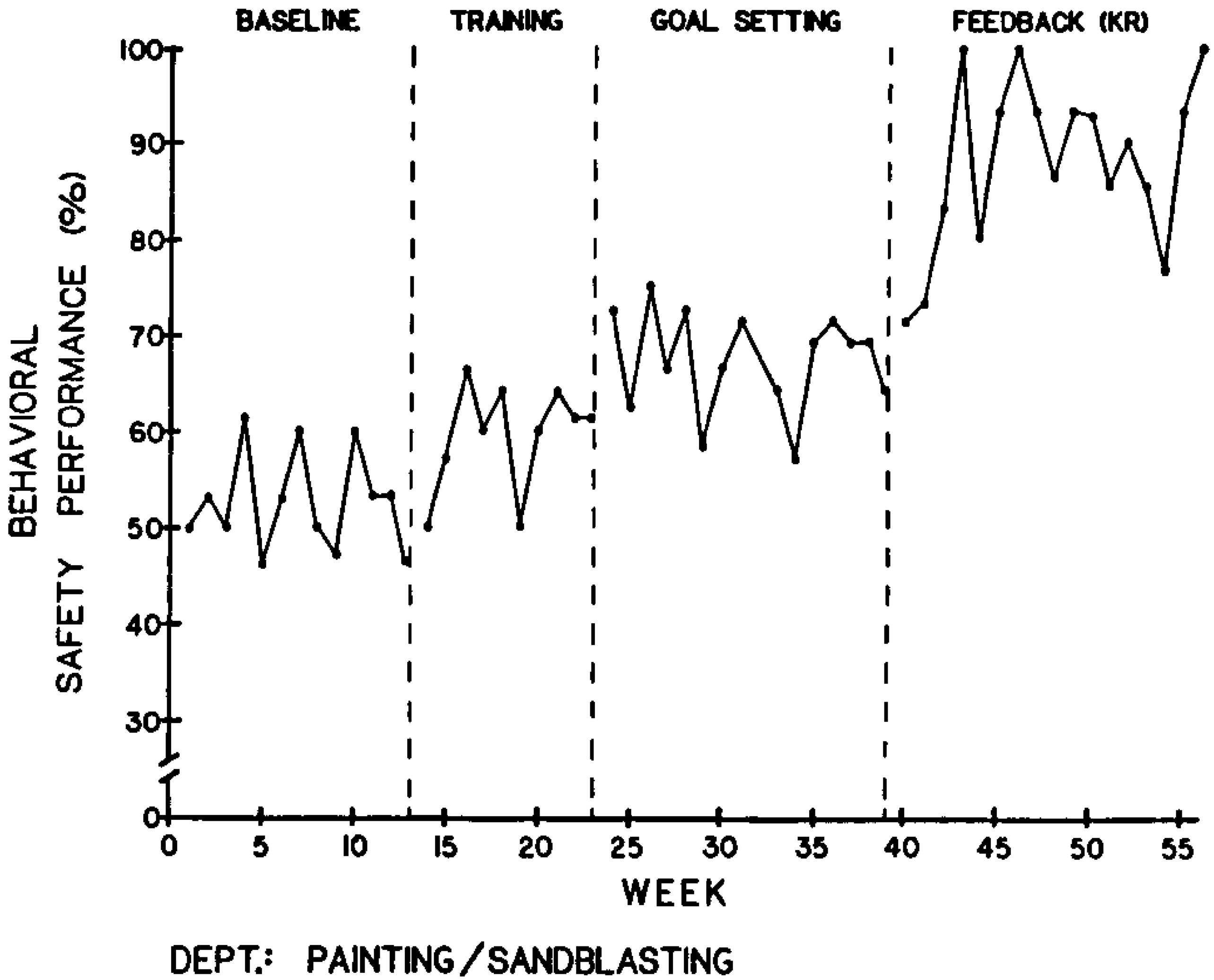
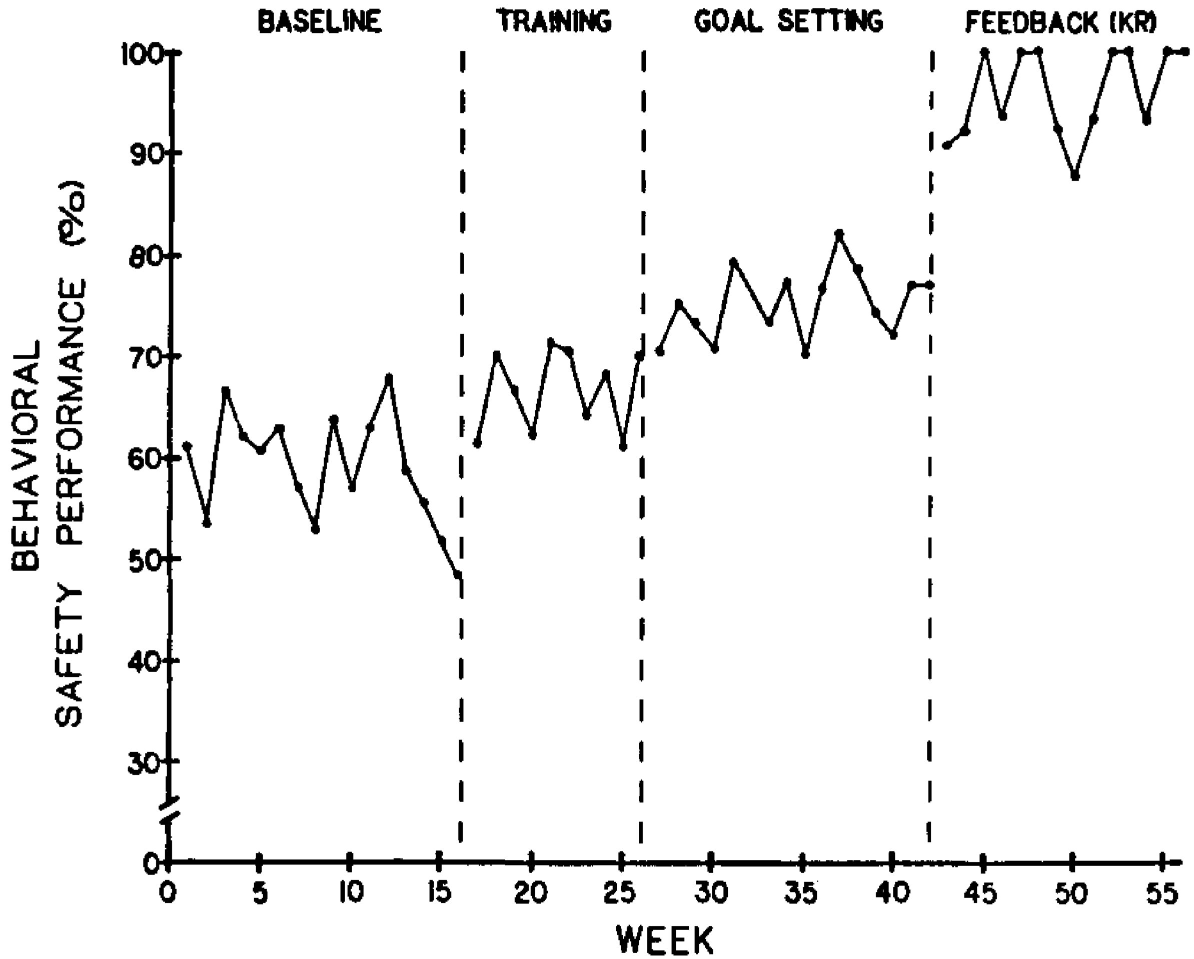



Figure 2d. Average weekly safety performance for painting/sandblasting.




DEPT.: HEAVY EQUIPMENT

Figure 2e. Average weekly safety performance for heavy equipment.

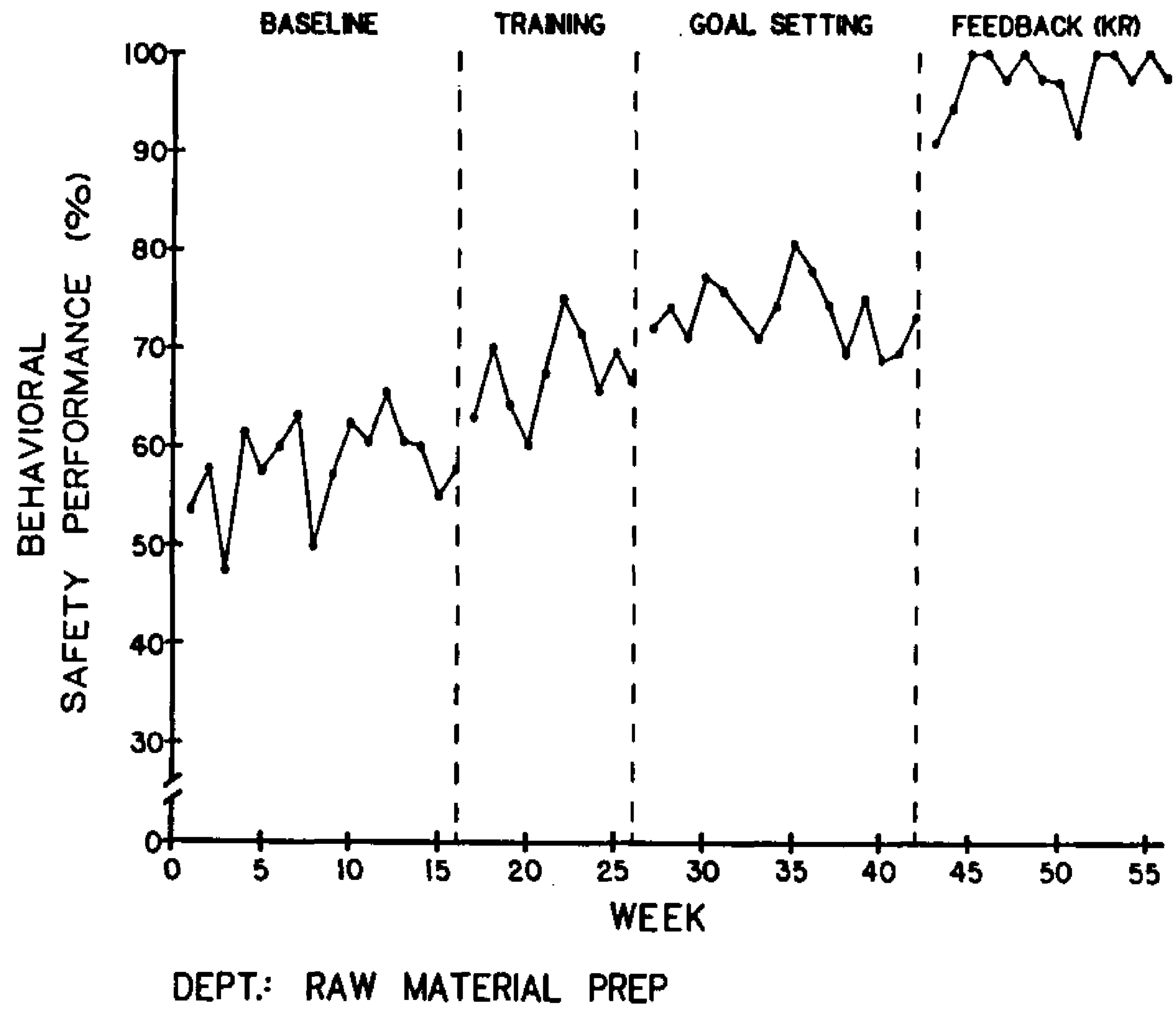



Figure 2f. Average weekly safety performance for raw material prep.

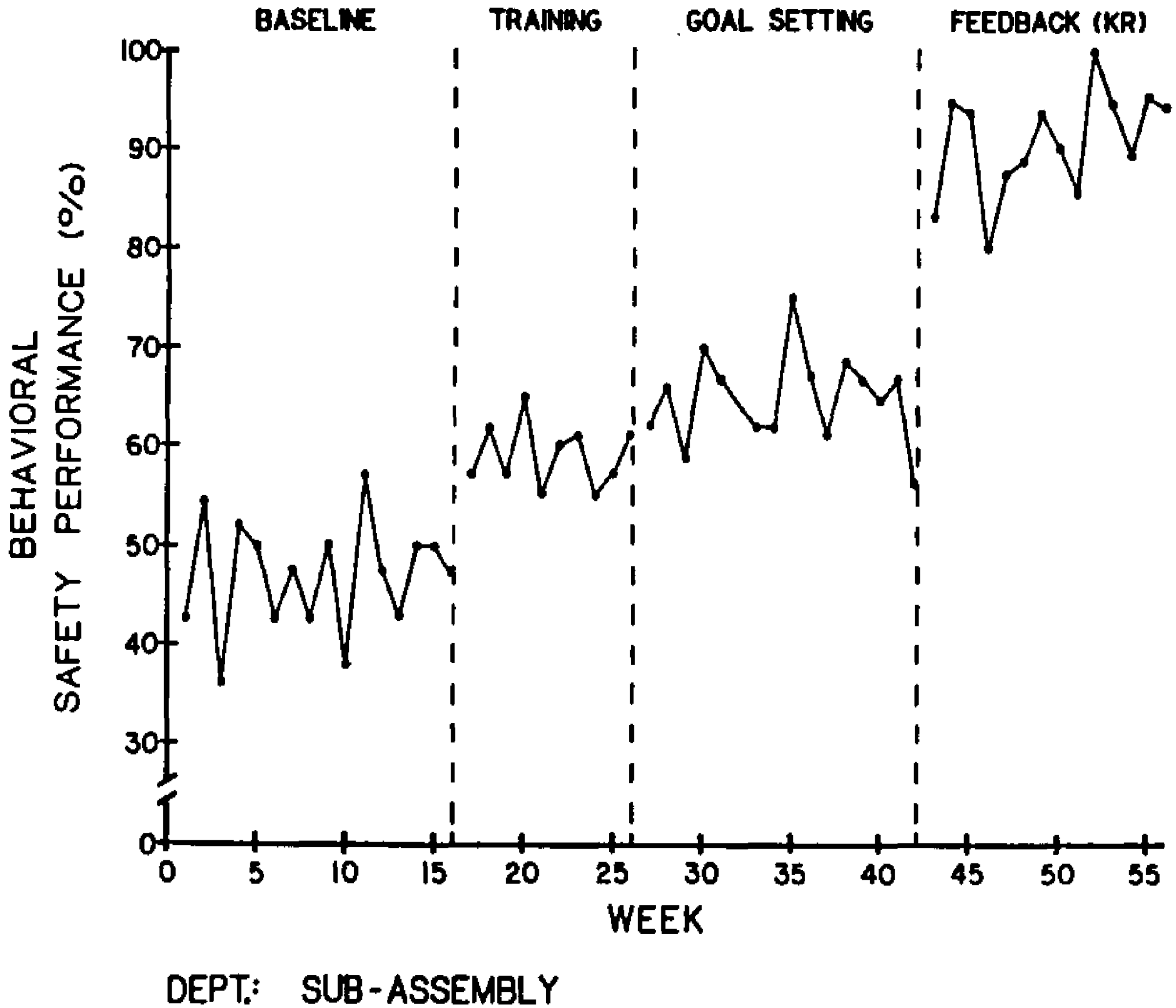



Figure 2g. Average weekly safety performance for sub-assembly.

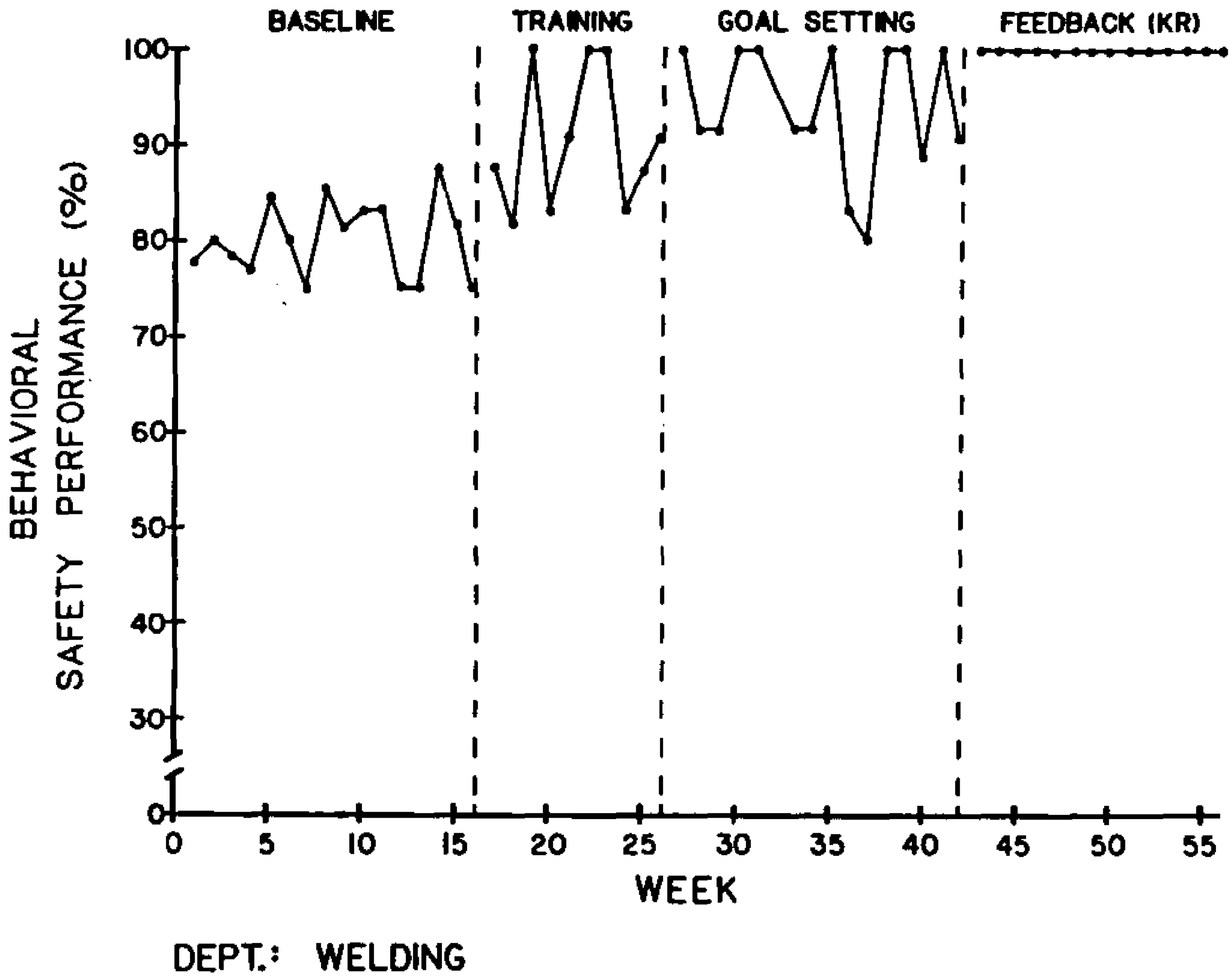



Figure 2h. Average weekly safety performance for welding.

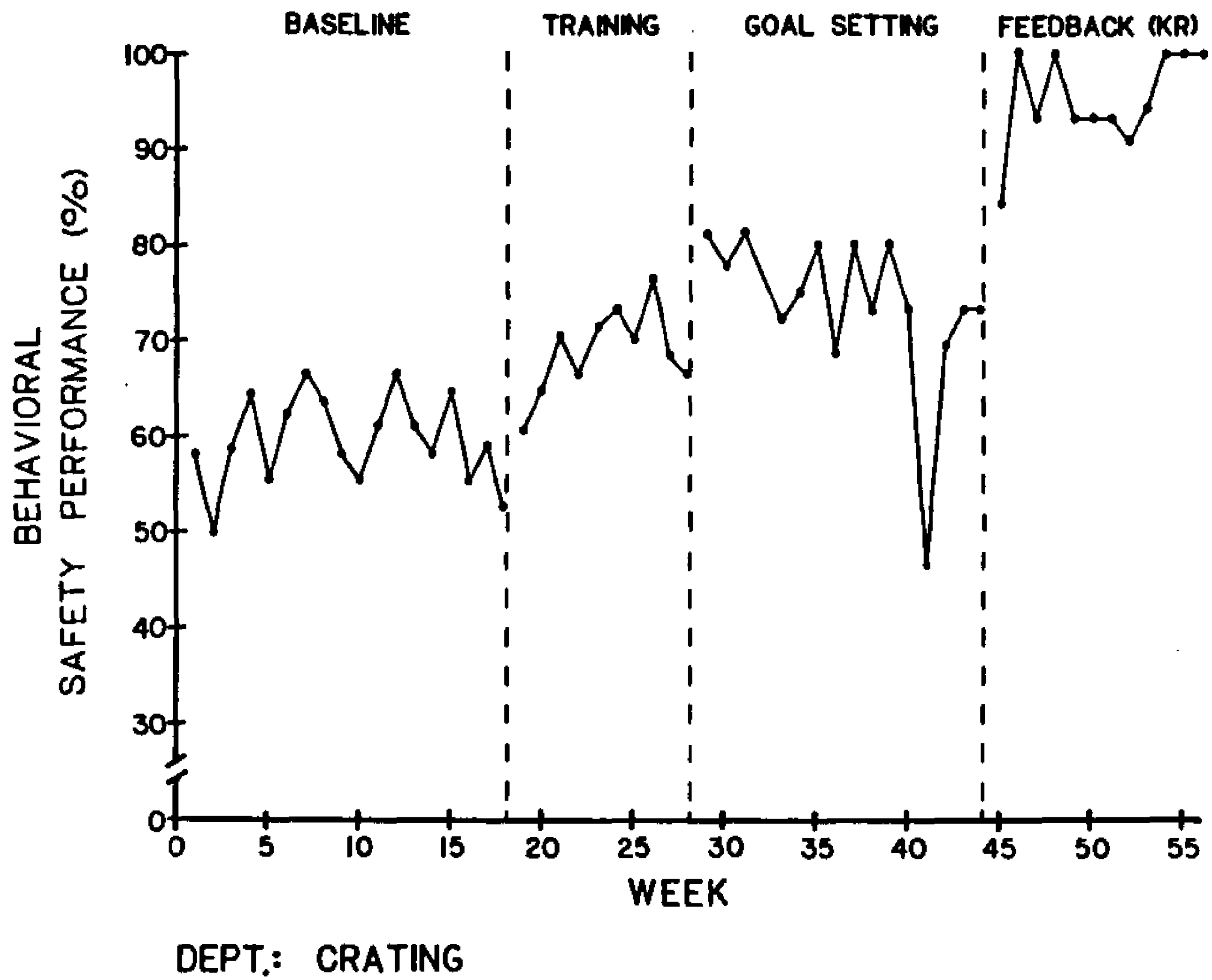



Figure 2i. Average weekly safety performance for crating.

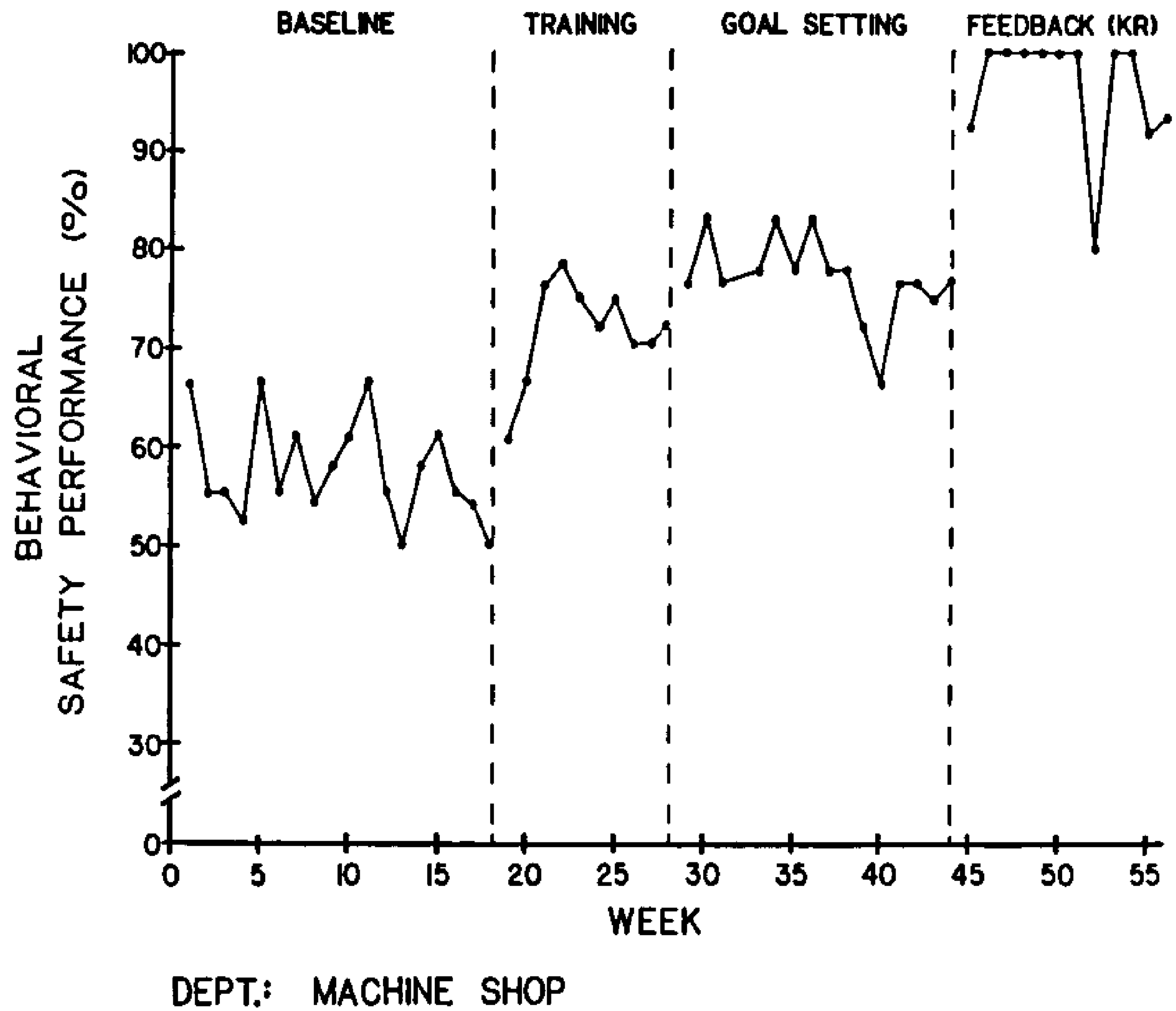



Figure 2j. Average weekly safety performance for machine shop.

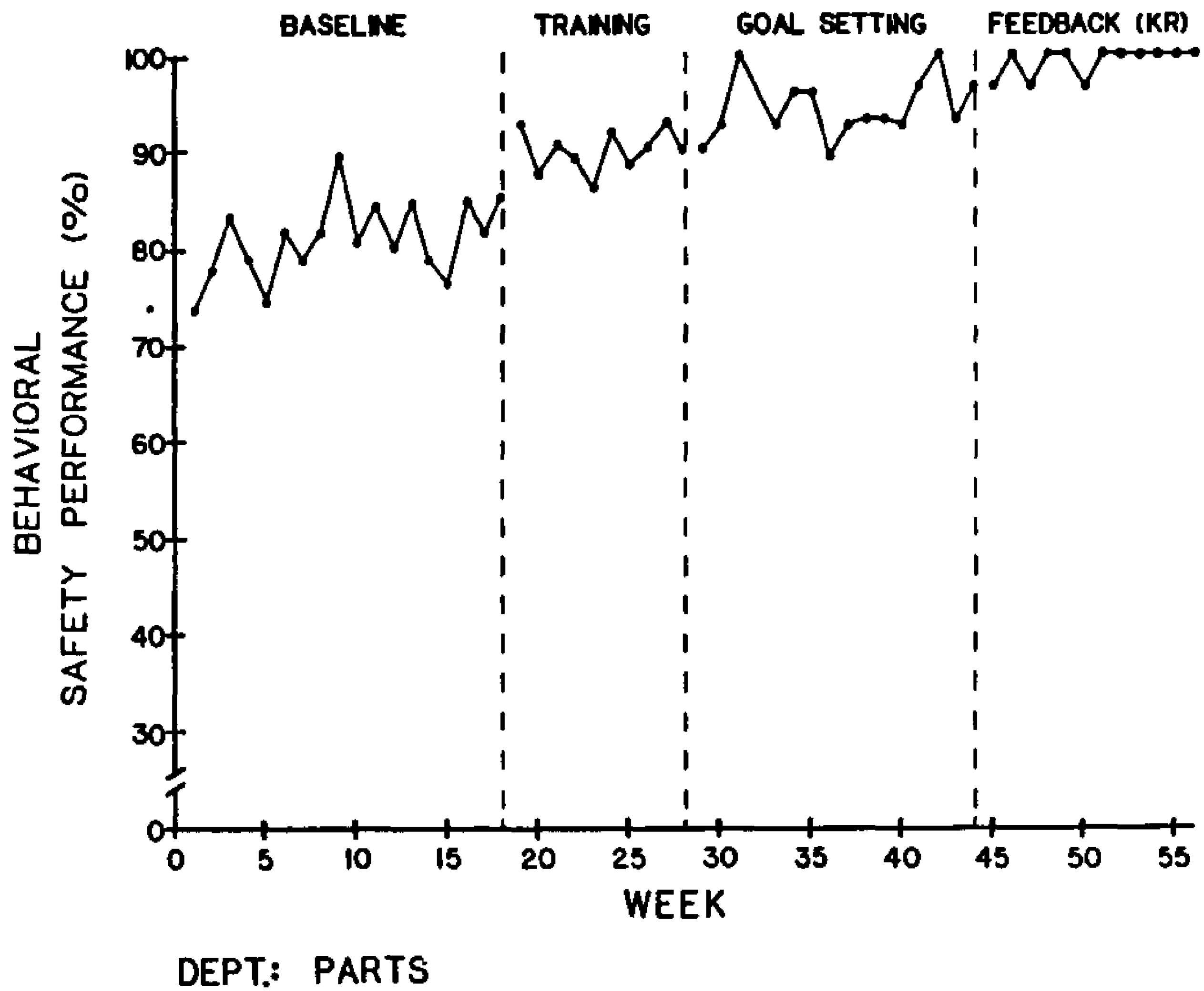



Figure 2k. Average weekly safety performance for parts.

# VITA

Robert Allen Reber was born in Morgantown, West Virginia on September 15, 1955. After graduating from Parkersburg South High School in 1973, he enrolled in Parkersburg Community College, Parkersburg, West Virginia where he majored in psychology. In the fall of 1974 he entered West Virginia University, Morgantown, West Virginia with a double major of psychology and sociology. He received his Bachelor of Arts degree, magna cum laude, in May, 1977. He was also initiated into Phi Beta Kappa and Phi Kappa Phi. In August, 1977, he enrolled in the Graduate School of Louisiana State University, Baton Rouge, Louisiana, majoring in industrial-organizational psychology and minoring in management. He received his Master of Arts degree from LSU in December, 1979. He is married to the former Debra Lee Hoffman and is a candidate for the Doctor of Philosophy degree at the spring commencement, 1982.

## EXAMINATION AND THESIS REPORT

**Candidate:** Robert A. Reber

**Major Field:** Psychology

**Title of Thesis:** The Effects of Training, Goal Setting, and Knowledge of Results on Safe Behavior: A Component Analysis

**Approved:**

Major Professor and Chairman

Dean of the Graduate School

**EXAMINING COMMITTEE:**

**Date of Examination:**

April 23, 1982