THE SUPERVISOR'S ROLE IN SAFETY: A STUDY OF LEADERSHIP REINFORCEMENT

by

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Thesis submitted to the Graduate Faculty of the

Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

Business Administration

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ACKNOWLEDGEMENT

I wish to express my gratitude to those people who helped make this study possible. To the training director and training instructors in the subject installation, I express my sincere appreciation for their time and interest in allowing me to conduct this study. I am also grateful to the members of the thesis committee, Dr. David Moment, Dr. Thirwall W. Bonham, and Dr. James W. Robinson, for their many valuable suggestions regarding the various mechanical and conceptual problems encountered. Finally, I wish to thank my wife and son for their support and understanding, without whose help this thesis would not have been completed.

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Chapter 1

INTRODUCTION

Morton Corn, Assistant Secretary of Labor for Occupational Safety and Health, in an interview with the Bureau of National Affairs, said that there is probably no more controversial issue in industry today than occupational safety and health.[1] Recent experience in the chemical industry bears this out. Allied Chemical, manufacturers of the industrial pesticide Kepone, had for years expelled the waste products from their Hopewell plant into the atmosphere and the James River.[2] In September of 1975 the effects of this polution reached disastrous proportions resulting in the closing of the plant, the discharge of hundreds of employees, and the banning of commercial fishing in a large portion of the James River. Of even greater potential significance is the long range effects that Kepone poisoning will have on the health of those people exposed to the chemical.

On moral grounds alone, the necessity for industrial safety and health programs appears fully justified. However, corporate morality is but one of many factors considered when making business decisions. Statutory requirements to provide a safe and healthful workplace are another important factor. But the degree of compliance with statutes can range from disregard through passive, minimal effort programs to fully implemented, creative programs.

While convinced of the virtue and correctness of instituting

industrial safety and health programs, professionals in the field often disagree on the effectiveness of various approaches. At different times, accident proneness, pre-employment testing and evaluation, employee-management safety committees, human factors engineering, etc., have been given special emphasis but none has resulted in the dramatic reduction in occupational injuries that had been predicted.*

Fortunately, this lack of agreement has not resulted in a feeling that significant advances are not possible. While disagreeing on the methods of effecting improvements, safety professionals do not generally disagree on the causes of accidents. The Heinrich Ratio of Accident Causes,[3] 88-10-2 (human error, environmental defect, and non-preventable, respectively), is still widely accepted as true. As such, the potential for achieving significant reductions in accident rates remains great as long as human error continues to be the dominant factor in accident causation.

PURPOSE

The purpose of this study is to examine the effect that leader reinforcement of safety behavior of supervisors has on the implementation of an effective safety and health program. More specifically, it is to investigate the degree to which supervisors perceive leaders as reinforcing behaviors conducive to accident prevention and to determine if

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* For a more complete discussion of the problem of accident prevention and implementing corrective measures, see Joseph A. Page and Mary-Win O'Brien, Bitter Wages: Ralph Nader's Study Group Report on Disease and Injury on the Job (New York, N. Y.: Grossman Publishers, 1973)

factors such as age, education, and supervisory level have any effect on these perceptions.

SCOPE OF THE STUDY

This study was conducted with a sample group of military and civilian supervisors at a large federal installation. As such, the study was limited in scope since any conclusions cannot be generalized to supervisors as a whole. In addition, the supervisors were being studied only in regard to their perception of what behaviors relevant to safety and health were reinforced by their superiors and not to what behaviors they reinforced in their subordinates. Consequently, the conclusions reached in this investigation may or may not be valid in regard to the behavior of subordinates. However, these limitations should not seriously impair the value of the study as little research has been done in this area of accident prevention. This study should be regarded as a preliminary step in the field and hopefully will yield some insights upon which future research can be conducted.

THE LOSS PREVENTION PROBLEM

In the Williams-Steiger Occupational Safety and Health Act of 1970,[4] the Congress of the United States states that each employee should be afforded a safe and healthful workplace. Yet, despite the efforts of thousands of safety professionals and the expenditure of hundreds of millions of dollars on loss prevention programs, overall industrial accident rates have remained relatively stable over the past 13 years.[5] See Table I.

TABLE I

DEATHS AND INJURIES FROM
ALL WORK ACCIDENTS*

Year	Workers (000)	Deaths	Death Rate (per 100,000)	Injuries (000)	Injury Rate (per 100,000)
1945	50,200	16,500	32.9	2,000	3,984
1950	56,400	15,500	27.5	1,950	3,457
1955	59,400	14,200	23.9	1,950	3,283
1960	64,400	13,800	21.4	1,950	3,028
1962	65,200	13,700	21.0	2,000	3,067
1964	67,600	14,200	21.0	2,050	3,033
1966	72,600	14,500	20.0	2,200	3,030
1968	76,900	14,300	18.6	2,200	2,861
1970	79,300	14,300	18.0	2,200	2,774
1971	80,000	14,200	17.8	2,300	2,875
1972	82,300	14,100	17.1	2,400	2,916
1973	85,300	14,200	16.7	2,500	2,930

* National Safety Council, "Accident Facts" (Chicago, Ill.: National Safety Council Press, 1974), p. 23.

From the number of people involved in occupational accidents and the amount of money needlessly wasted each year, the magnitude of the problem is readily evident. Society should not have to absorb losses of such size. Neither, however, should industries embark on costly programs of environmental control when more cost-effective solutions may be available. Therefore, it is necessary to reduce both the cost and number of industrial accidents in the most economical fashion available regardless of the sourse of the solution.

THE RESEARCH PROBLEM

The problem which must now be addressed is why, with all the technology currently available, the rate of decline of work death and injury rates has apparently leveled off. The proposed answer to this problem, and the basic theme of this study, is that the human element in accident prevention has not been adequately exploited.

The author is not aware of any major research studies that deal specifically with behavior reinforcement and safe performance. However, there are a number of behavioral theories and research findings available in areas which closely relate to the subject area. It must be assumed that these theories and research findings are adequate for use as background material for this study.[6]

In order to begin this study, it is necessary to understand the relationship between personality concepts and safe and unsafe behavior.

Attitudes, Values, and Emotions

The behavior of adults is caused by many factors. Included in

the factors which develop and alter patterns of behavior are attitudes, values and emotions, as well as past experience and habits. Virtually all behavior patterns involve at least one of these intervening factors; and, through their involvement, consistent patterns of response develop.

When a situation develops in which a person has had previous experience, this experience will help determine and direct the response. When the experiences are repeated, the person may develop a readiness to respond to the stimulus in a particular manner. This readiness to respond is an attitude. Thus, an attitude is a predisposition to perform, perceive, think, and feel toward something or some object in the environment.[7] An example of an attitude having relevance to safety may be evidenced in an individual's usage of hard hats. If the individual had been witness to an injury which could have been prevented through the use of a hard hat, the individual may be predisposed to wear a hard hat if he is placed in a similar situation as that in which the injury occured.

Values involve the beliefs and opinions of the individuals as he perceives various situations in society.[8] When compared with attitudes, values are more enduring and take their place at the highest level of behavior control. That is, they are more encompassing than attitudes and, when a conflict between them occurs, the individual's value structure will overcome well-established attitudes in order to preserve the prevailing value. An example of a value having relevance to safety may be evidenced in an individual's beliefs concerning various occupations. If required to perform in an occupation he considers as being

socially demeaning, his attention to safe work practices may be less than that which is called for.

Emotion is another aspect of human behavior having an effect on human performance. Everyone is familiar with some of the symptoms of emotion; the pounding heart, sweaty hands, dry throat, and others. However, of more direct concern to this study is an examination of another aspect of emotion.

Anxiety is a reaction to environmental and/or psychological stresses which impose demands upon an individual or which interfer with the satisfaction of his motives.[9] Environmental sources of stress include such things as fatigue, temperature extremes, pain, hunger, and thirst. In addition, there are more strictly mental sources of environmental stress such as concern over one's status, worry about family illness, traffic, the inadequacies of other persons, and many others. Often the most disturbing of all stresses, however, is that situation in which the individual is caught in conflict between his own motives. He may desire two goals which are incompatible. If he is strongly motivated toward each one, he finds it extremely difficult to give up either. There are other times when two alternatives are both undesirable. For example, an individual may become very emotional over the alternatives of performing a hazardous job or facing the possibility of being reprimanded. On other occasions, the same goal may appear both attractive and repulsive. An example may be in accomplishing an extremely hazardous task and thus receiving the recognition of superiors while realizing that serious personal harm may result if any error is made during accomplishment. In any case, such combinations of moti-

vational conflict frequently result in indecision, uncertainty, and/or intense emotional distress.

As was seen in the preceding section, motivation plays a very important part in determining the behavior of individuals. The question that must now be asked is, are people "motivated" to behave safely or unsafely?

Motivation

Central to the study of safety behavior is a basic understanding of motivation. Abraham H. Maslow opened up the possibility of a multi-dimensional approach to motivation by proposing a theory of motivation based on a "hierarchy of needs." He determined that the human being is motivated by a number of basic needs which are species-wide and apparently unchanging.[10] Further, he postulated that those needs occur in a hierarchy--that some needs must be reasonably well satisfied before others can emerge. He determined that an unmet need, a need that is substantially unfulfilled, will cause the person to behave is such a manner that he will satisfy that need.[11]

Frederick Herzberg proposes a slightly different theory of motivation. He contends that there are two sets of needs which exist simultaneously, each of which must be attended to regularly.[12] Specifically, his research has indicated that those factors which tend to make an individual satisfied on the job are qualitatively different from those which produce dissatisfaction:[13] the former he refers to as the "motivator" needs--those which satisfy the individual's need to express his capabilities and consequently produce satisfaction--and to the latter

as "hygiene" needs--those which reduce the pain that is inherent in the environment and thereby either reduce or produce dissatisfaction.

Herzberg believes that most jobs are not very stimulating and that external pressure, either positive or negative, is normally applied to get people to perform to an acceptable level. However, when the job itself provides an opportunity for personal satisfaction or growth, a powerful intrinsic motivating force is introduced. Herzberg holds that there is no conflict between the environmental approach and the approach which centers on the work itself. However, the environmental approach is inherently limited in its capacity to influence behavior or provide movement. In contrast, the work approach seems capable of more lasting and significant effects on both behavior and efficiency.

The significance of these two theories is that they provide a framework for gaining an understanding of why people behave as they do with regard to safety. In the context of this study it can be assumed that the individuals sampled have their lower level or "hygiene" needs at least partially satisfied and are attempting to satisfy their higher level or "motivator" needs. This being the case, the individuals sampled would be seeking to satisfy their needs to achieve recognition, approval, and acceptance.

A dilemma appears! Is not "physiological safety" a lower level or hygiene need which must be satisfied before higher level or motivator needs can be attended to? The answer is yes. But all needs do not necessarily have to be absolutely satisfied before they are replaced as motivators by other needs. In the context of this study it must be assumed that the individuals' needs for "physiological safety" have been

satisfactorally met. That is, the individuals do not perceive the potential for injury as being high enough to involve their values concerning pain and serious injury. Thus, like man's denial of the "inevitability of mortality", failure to adhere to proven safe work practices can be assumed to stem from the individuals' feelings that their behavior will not lead to an accident or injury.

Expectancy

In the preceeding section, "needs" theories of motivation, as proposed by Maslow and Herzberg, were discussed. In this section another aspect of motivation, expectancy theory, will be examined.

Leavitt, in his book Managerial Psychology, presents a model of behavior based on the satisfaction of need, the reduction of tension, and the easing of discomfort.[14] He proposes that much of man's behavior is motivated by the desire to reach a state of equilibrium between his "motives", "needs", or "drives", and "tensions" or "discomforts".

In the industrial setting, Leavitt addresses a number of issues dealing with incentives and what influence various incentives have on behavior. He states that incentive plans will prove beneficial in eliciting the desired behavior if the expectance of reward is of such magnitude to justify the additional effort necessary to earn the incentive. If the achievement of the incentive (reward) is dependent upon the recommendation of a superior, Leavitt implies that behavior patterns will tend to reflect the position of the superior.[15] This reflection of the superior's position is understandable as it serves to reduce the tension inherent in a superior/subordinate relationship, leads to an

increased possibility of gaining the superior's attention and recognition, and maximizes the potential approvals and rewards available from the superior.

Robert J. House, in his article, "A Goal-Path Theory of Leader Effectiveness," states that expectancy theories of motivation hold as a central concept that the force on an individual to engage in a specific behavior is a function of (1) his expectations that the behavior will result in a specific outcome; and (2) the sum of the valences, that is, the importance or value to the person in his life, that he derives from the outcome.[16] Thus, according to expectancy theories of motivation, an individual chooses the behaviors he engages in on the basis of (1) the valences he perceives to be associated with the outcomes of the behavior under consideration; and (2) his subjective estimate of the probability that his behavior will indeed result in the outcomes.

House goes on to say that the behavior of the leader is an influential factor in determining the behavior of subordinates. The leader, at least in part, determines the extrinsic rewards which will be available for work-goal accomplishment. For example, he has some influence over the extent to which work-goal accomplishments will be recognized as a contribution and whether it will be rewarded. As such, he influences the sum of the personal outcomes available. Secondly, through his interaction with the subordinate, the leader can increase the subordinate's perception of which behaviors will be rewarded as a result of work-goal accomplishment. Thus, if he consistently rewards achievement, this will most probably increase the frequency of

occurrence of rewarded behavior. Third, through his own behavior, the leader can provide support for the subordinate's efforts toward work-goal achievemnet. Finally, the leader can increase the net intrinsic valence by reducing frustrating barriers, being supportive in times of stress, permitting involvement in a wide variety of tasks, and being considerate of the subordinate's needs.

Ezra Stotland, in The Psychology of Hope, states that an organism's motivation to achieve a goal is, in part, a positive function of the perceived probability of attaining the goal and of the perceived importance of the goal.[17] Stotland hypothesized that the greater the expectation of attaining a goal, the more likely the individual will act to attain it. Stotland goes on to say that attitudes and habits will continue to exist and be acted upon if there is hope of achieving a reinforcement or reward but will be extinguished when hope ceases.

The question arises, then, is "safe behavior" goal-oriented? The answer would appear to be that, in itself, "safe behavior" is not a goal. Rather, "safe behavior" is a sub-element of task accomplishment. The research findings of Keenan, Kerr, and Sherman appear to support this position. In a study of 7,103 personnel working in a tractor factory for the 1944-48 five-year period it was determined that the reward system within a particular department or plant is undoubtedly critical.[18] They determined that if management uses incentives for volume or speed and not for safety, it is unlikely that simple verbal appeals or publicity campaigns will reduce the number of accidents. Thus, if an individual knows he will be rewarded

for meeting production goals or reprimanded for not meeting production goals, unless safety behavior is made an important component of his evaluation, he is less likely to enforce safety regulations which may slow up production.

HYPOTHESES

From this partial review of literature it should be clear that reinforcement of behavior plays an important part in determining the behavior of individuals.

Hypothesis 1

In the context of this study, the evidence presented leads to the proposition that if safe behavior is reinforced, individuals will tend to develop positive safety attitudes and will tend to display safe behavior. As the first step in conducting the study, it is necessary to determine if safety behavior is being reinforced. From the theory and research presented to this point, along with the stated intentions of safety programs, the following hypothesis is derived:

Hypothesis 1 - Leaders are perceived by their subordinates as reinforcing their safety behavior.

Hypothesis 2

The next problem to be discussed is one having special significance to the area of loss prevention. The first hypothesis assumes that the behavior of supervisors is perceived as being reinforced by their leaders. The question, then, is appropriate safety behavior being reinforced?

Steven Kerr, in his article, "On the Folly of Rewarding A, While Hoping for B",[19] proposes that many reward systems instituted by management actually serve to reinforce behavior opposite from that which is hoped for. Kerr attributes this phenomenom to these causes:

1. Fascination with an "objective" criterion[20]

> Most "objective" measures of productivity are objective only in that their subjective elements are (1) determined in advance, rather than coming into play at the time of the formal evaluation; and (2) well concealed in the rating instrument itself. Thus, industrial firms seeking to devise objective rating systems first decide, in an arbitrary manner, what dimensions are to be rated, . . . usually including some items having little to do with organizational effectiveness while excluding others that do. Such efforts may be successful in highly predictable areas within an organization, but are likely to cause goal displacement when applied anywhere else.

2. Overemphasis on highly visible behaviors[21]

> Difficulties often stem from the fact that some parts of the task are highly visible while others are not. For example, publications are easier to demonstrate than teaching . . . . Team-building and creativity are other examples of behaviors which may not be rewarded simply because they are hard to observe.

3. Hypocrisy[22]

> In some instances the rewarder may be getting the desired behavior, notwithstanding claims that the behavior was not desired. This may be true, for example, of management's attitude toward apple-polishing (a behavior which subordinates often feel is rewarded, despite management's avowed dislike of the practice).

4. Emphasis on morality or equity rather than efficiency[23]

> Sometimes consideration of other factors prevents the establishment of a system which rewards behaviors desired by the rewarder. The felt obligation of many Americans to vote for one candidate or another, for example, may impair their ability to withhold support from politicians who refuse to discuss the issues.

It should be noted that only with respect to the first two causes are reward systems really paying off for other than desired behaviors. In the case of the third and fourth causes the system is

rewarding behaviors desired by the rewarder, and the systems are "fouled up" only from the standpoint of those who believe the rewarder's public statements (cause 3), or those who seek to maximize efficiency rather than other outcomes (cause 4).

Based on the Kerr article, it is clear that the effectiveness of a safety and health program is dependent upon the types of behavior actually being reinforced, in contrast to verbal campaigns and slogans. Therefore, in order to test if appropriate behavior is being reinforced, the following hypothesis is proposed:

Hypothesis 2 - Leaders are perceived as reinforcing all appropriate safety behavior to a similar degree.

For the purpose of this study, safety behaviors will be grouped into two categories; personal safety behavior and interpersonal safety behavior. The first category is concerned with how the individual performs himself, i.e., does he wear protective equipment? does he follow safety rules? does he actively participate in safety meetings? etc. The second category is concerned with how the individual directs and controls the safety behavior of subordinates, i.e., does he require subordinates to wear protective equipment? does he discipline subordinates who fail or refuse to follow safety rules? does he correct unsafe work practices of subordinates? etc.

Each of the eight questions used in the questionnaire expresses a principle of accident prevention that is appropriate for studying the behavior of supervisors. Further, each question relates to one of the two categories of behavior previously mentioned. The responses to these questions will determine if all appropriate safety behavior is perceived

as being reinforced to a similar degree.

The final aspect of the problem to be discussed is that having to do with changes in perceptions which occur with changes in age, education, and level. This aspect is important as older, higher level supervisors can be assumed to occupy positions having more potential for exercising authority than do younger, lower level supervisors and, thus, have greater potential for influencing subordinates' behavior.

Hypothesis 3

In the context of this study, it is assumed that supervisors of differing age and supervisory level would hold differing assumptions concerning the implementation of a safety and health program. While no direct evidence could be found to support this assumption, a number of related behavioral studies have found that the assumptions of supervisors differ between age and hierarchial level groups. A study by Porter and Henry[24] dealing with personality traits of managers is representative of this type of study. Porter and Henry found that older, higher level managers differed significantly from younger, lower level managers in regard to their attitudes towards employees and production. Older, higher level managers tended to express more unfavorable attitudes towards employees and more favorable attitudes toward production than did younger, lower level managers.

Based on this analysis, the following hypothesis is proposed:

Hypothesis 3 - The perceptions by older, higher level supervisors of the reinforcement of their safety behavior will differ from the perceptions of younger, lower level supervisors of the reinforcement of their safety behavior.

OUTLINE OF THESIS

This chapter has been devoted to providing a broad introduction to the problem, a review and analysis of some pertinent literature, and the stating of the hypotheses to be tested. Chapter 2 presents a complete description of the methodology to be used in analyzing the data. Chapter 3 is devoted to the presentation of the results, while the final chapter includes conclusions and discussions.

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Chapter 2

METHODOLOGY

The purpose of this chapter is to describe the methodology used in gathering and analyzing the data used in this study. The chapter includes a description and explanation of the questionnaire used to gather the data as well as the statistical methods used in testing the hypotheses stated in Chapter 1.

Collection of Data

As indicated in Chapter 1, the data for this study were gathered from a single large federal installation. The installation studied is located in the eastern part of the United States and employs approximately 11,000 people. A wide variety of operations are conducted including maintenance of heavy equipment, construction, aircraft flight and maintenance, port and depot operations, and skill training.

The training director of the installation agreed to provide five training classes for the study. Consequently, eighty questionnaires were prepared and distributed. Each of the five classes was given a proportionate share of the questionnaires to distribute in a random manner. While it was not possible for the author to oversee the exact distribution procedure within the various classes, it is believed that the questionnaires were distributed on a random basis. Of the 80 questionnaires distributed, 76 usable ones were returned and form the basis for this study. Of the four questionnaires not usable, one was

not distributed and three were incomplete.

This sample cannot be considered a completely random sample in the strict sense of the term since judgement was used in selecting training classes to begin with. Training classes were selected because they were readily available; the personnel enrolled were all supervisors; the classes were sufficiently large; and the potential for determining who any specific individual was based on the personal data was minimal.

It is also possible that completely random selection was not followed within every class, although there is no evidence that this was the case. Thus, the sample is a combination of judgment and random sampling, which means that there is a possibility of some bias. However, it appears that the sample approaches randomness since there is no particular reason to believe that the individuals selected to complete the questionnaires were personally selected either by the author or by those administering the questionnaire.

In order to protect the anonymity of the respondents, no personal identification was required on the questionnaire. The respondents were asked only to indicate their rank or grade, approximate age, and their educational level. While the actual number of supervisory levels is over twenty, they were all included in eight categories to facilitate analysis. The eight supervisory levels are sergeants (from lowest to highest: E-5, Sergeant; E-6, Staff Sergeant; E-7, Sergeant First Class; E-8, Master or First Sergeant), foremen, lead foremen, inspectors (GS5-GS8), and functional managers (GS9-GS11, the lowest management levels).

Regarding the categorization of supervisors by age group, the

questionnaire contained six age groups consisting of 26 to 30, 31 to 35, 36 to 40, 41 to 45, 46 to 50, and 51 and over.

The educational categories were from 9 to 17 years with 12 being a high school diploma, 14 a college associate of arts degree, 16 a four-year college degree, and 17 a graduate degree. However, the Department of the Army has a program where servicemembers can receive both high school diplomas and one or two years of college credit by examination. As a result, 63 out of the 76 respondents indicated a high school education, 5 indicated less than a high school education, 7 indicated at least one year of college, and 1 indicated a college degree. The distribution of responses yields too few responses in other than the high school category to use education as an analytical variable.

The Questionnaire

The questionnaire used in this study consists of eight statements, each of which has five possible responses. The five responses to each statement are intended to represent a response scale ranging from strongly agree to strongly disagree. This scale of responses includes two agree responses, two disagree responses, and one response, designated as "undecided", which indicates neither agree nor disagree. Thus, the response pattern for each statement may be visualized as a continuum along which lie the various responses as follows:

Symbol	A_2	A_1	U	D_1	D_2
Meaning	Strongly Agree	Mildly Agree	Neither Agree nor Disagree	Mildly Disagree	Strongly Disagree

The subscripts used above are necessary to distinguish the degree of A or D from a general A or D response. For example, regardless of whether a response is D_1 or D_2, it is considered a D response. This means that the total number of D responses is the total of the D_1 and D_2 responses, while the number of Not-D responses is the total of U, A_1 and A_2.

This kind of scale is known as a bipolar rating scale because it represents a continuum from opposite extremes.[1] Among the psychometric methods in which human judgement is involved, rating scales are the most frequently used. While there is no standard requiring a five-point scale, it appears to be customarily used in studies of this type. However, the key to determining how many responses to use is the degree of discrimination that is desired or reasonably possible. If too few responses are provided, the degree of discrimination on the part of the respondent may not be meaningful. On the other hand, if too many responses are available, the respondent may not be able to distinguish between them. For this study, a five-point scale is believed to be best.

The mid-response of "undecided" is used in order to allow the respondent a choice in those cases where he cannot make a clear decision between the A or D response. By providing this alternative, it is assumed that distortion of results is prevented by not forcing a respondent to choose a response about which he is not completely certain. Thus, the response "undecided" provides an outlet for those respondents who are not sure which response to choose.

In order to demonstrate clearly how the questions are constructed and how they relate to the referenced material, one of the questions is presented with the responses and the appropriate descriptive symbols.

The question is as follows:

Question 4 - ... determine if you are favorably recognized by your supervisor for correcting all major and minor safety hazards in those areas under your control.

The responses are as follows:

A_2	a.	Strongly agree
A_1	b.	Mildly agree
U	c.	Undecided
D_1	d.	Mildly disagree
D_2	e.	Strongly disagree

This series of responses is designed to demonstrate if correcting safety hazards is encouraged and if individuals know how their personal performance will affect their overall performance rating. An A response indicates that the respondent reports that he perceives a proven safety principle as being effectively reinforced, while a D response indicates that he perceives it is not being reinforced. Each of the other seven questions is constructed in a similar manner.

A brief description of each of the remaining seven questions and the reason for its inclusion in the questionnaire follows:

Question 1 - having an outstanding personal safety record. To determine if the individual is reinforced for, if nothing else, not having an accident.

Question 2 - participation in safety meetings. To determine if the individual is reinforced for his interest in helping solve problems.

Question 3 - initiative in implementing the safety program. To determine if the individual is reinforced for being a self-starter.

Question 5 - disciplining subordinates who fail to follow safety rules. To determine if the individual is reinforced for exercising his authority to enforce safety practices.

Question 6 - stopping a mission if personnel are endangered. To determine if the individual is reinforced for protecting personnel over production or mission accomplishment.

Question 7 - reporting all accidents. To determine if the individual is reinforced for keeping superiors aware of accidents even though the report may create work for both the supervisor and his superior.

Question 8 - requiring that subordinates wear safety equipment. To determine if the individual is reinforced for exercising his authority to enforce safety practices.

Tabulation of Data

This section is devoted to a discussion of the procedures used to compile and tabulate the raw data collected from the questionnaires. For each sample group considered, the total number of responses falling within each response category is tabulated. This tabulation results in a frequency distribution of responses whose relative frequencies indicate the percentage response for that category. The frequency distributions for the various sample groups are presented in tabular form as follows:

	A_2	A_1	U	D_1	D_2
Total Number of Responses					
Relative Frequency (Per cent)					

The frequency distributions for the various sample groups are then used as the basis for the statistical analysis which is explained later.

A second method of tabulation is also employed. This method amounts to combining the overall frequencies of each sample group into two frequencies which are designated D and Not-D. The D (disagree) category, as explained previously, is the total of the D_1 and D_2 responses, while the Not-D category is the total of the U, A_1, and A_2 (undecided and agree) responses. The purpose of this type of categorization is to determine whether a particular sample group is predominantly A or not.

Method of Analysis

As an aid to analyzing the data gathered from the questionnaires and a representation of the theoretical basis of the study, the Safety Behavior-Reinforcement Model presented on the following page is proposed. For the purpose of analysis, only that interaction between the Leader and the Supervisor is considered. However, if taken to completion, the model demonstrates that the safety behavior the Leader reinforces in the Supervisor influences the safety behavior that the Supervisor reinforces in the "Worker" and, thus, significantly effects the safety behavior of the "Worker". In simpler terms, the safety behavior that the Leader reinforces in the Superior indirectly determines the safety behavior of the "Worker". This process was described in Zaleznik and Moment's analysis of the Ohio State leadership studies. It was found that each foreman's behavior was more strongly influenced by the behavior of his superiors than by the content of the training program.[2]

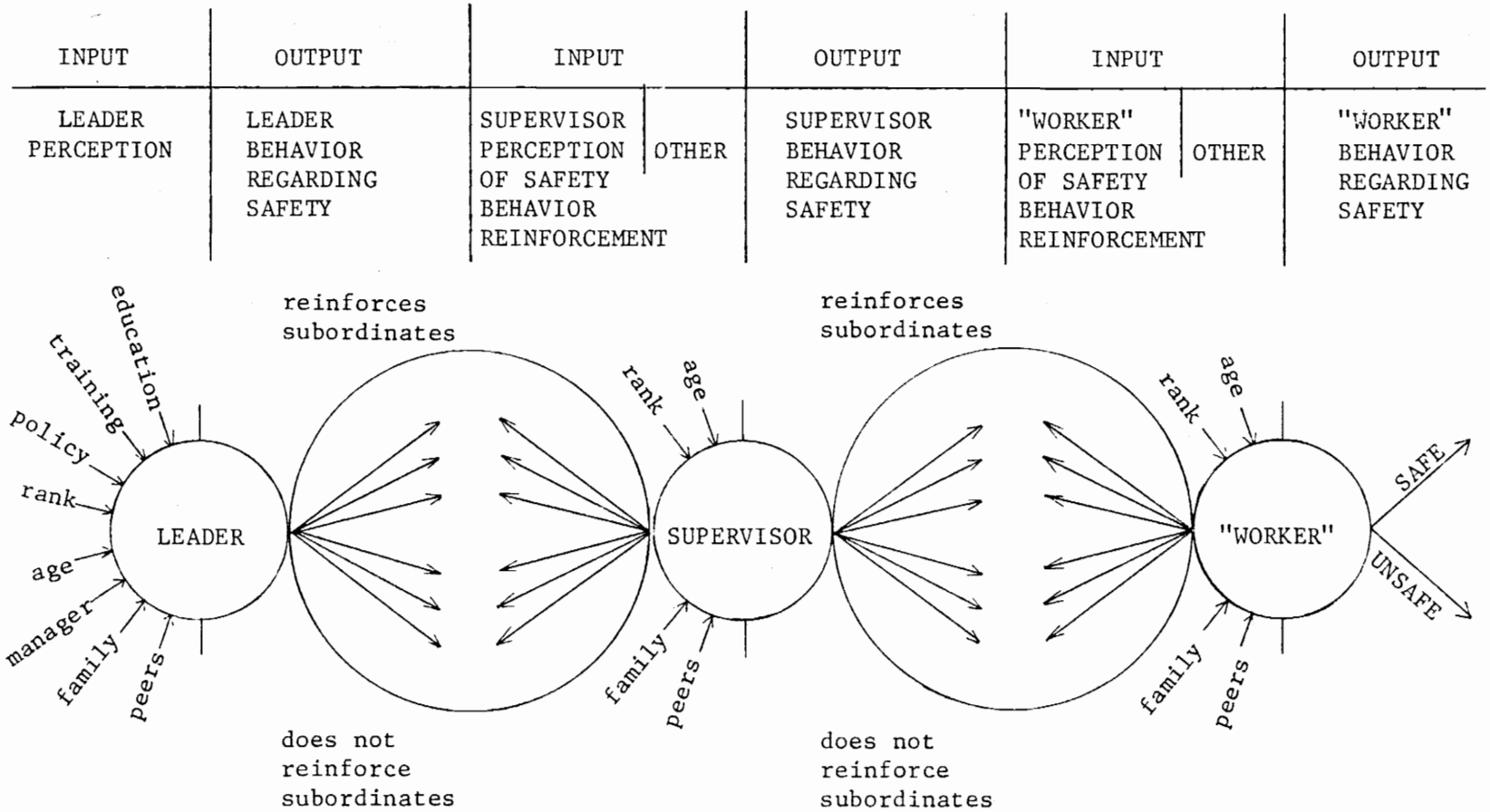

FIGURE 1

THE SAFETY BEHAVIOR--REINFORCEMENT MODEL

For example, if the Leader reinforces the Supervisor for participating in safety meetings and the Supervisor perceives the Leader as reinforcing this behavior, the Supervisor would tend to reinforce the "Worker" for participating in safety meetings. If the "Worker" perceives the Supervisor's behavior as reinforcing, the "Worker" would tend to become active in safety meetings. If the reverse were true and the Leader did not reinforce the Supervisor for participating in safety meetings, carried through, the "Worker" would not tend to participate in safety meetings.

Statistical Analysis

The appropriate statistical test for making inferences about discrete categories is the chi-square test.[3] Two kinds of chi-square tests--the chi-square test of goodness of fit and the chi-square test of independence--are used in analyzing the data in this study.[4] Each of these tests will be discussed in relation to the hypothesis tested.

Hypothesis 1 - Leaders are perceived by their subordinates as reinforcing their safety behavior.

The null hypothesis to be tested is that the percentage of Not-D responses is no greater than 50 per cent.

The chi-square test of goodness of fit is used in testing the null hypothesis. The data are tabulated so that there are two response categories, D and Not-D, and, consequently, two frequencies. The purpose of the chi-square test of goodness of fit is to compare the observed frequencies to the expected frequencies to determine how closely they resemble each other. Since the null hypothesis in this

case is that the frequency of Not-D responses is no greater than 50 per cent, the two hypothetical frequencies are 50 per cent and 50 per cent.

Although rejecting or not rejecting the null hypothesis is determined by the test just outlined, an additional analysis is made to provide further insight into the response pattern for the sample group. The response frequencies for each question are shown and the same chi-square test is applied to indicate whether or not the sample group answered all of the questions the same way. The null hypothesis in this case is that the percentage of D responses is no greater than the mean percentage of D responses for the total sample group.

Hypothesis 2 - Leaders are perceived as reinforcing all appropriate safety behavior to a similar degree.

The null hypothesis to be tested is that the percentage of Not-D responses to questions 1, 2, 3, and 7 (each dealing with individual behavior) will be similar to the percentage of Not-D responses to questions 4, 5, 6, and 8 (each dealing with supervisory behavior) The null hypothesis will be tested by using the chi-square test of goodness of fit.

Hypothesis 3 - The perceptions by older, higher level supervisors of the reinforcement of their safety behavior will differ from the perceptions of younger, lower level supervisors of the reinforcement of their safety behavior.

In testing this hypothesis there are really two questions to be answered. First, do the percentage responses in each category vary with the particular factor being considered (i.e., age or rank)? Secondly,

if there is variation, is this variation random? That is, do older individuals tend more toward either D or Not-D responses than do younger individuals, and; do higher level individuals tend more toward either D or Not-D responses than do lower level individuals? If there is no difference between the percentage responses of the groups, then there is no need to account for variation. However, if there are differences between the percentage responses of the groups, then the variation has to be tested for statistical significance.

The null hypothesis for age difference is that there is no difference between the percentage of D or Not-D responses of the various age groups. The null hypothesis for supervisory level is that there is no difference between the percentage of D or Not-D responses of the various supervisory level groups.

The chi-square test of independence is used to compare the frequency distributions of the samples to determine whether or not they are the same. The principle here is the same as in the chi-square test of goodness of fit except that, instead of two frequencies, there are five. Thus, the chi-square test of independence is aimed toward testing the homogeneity of k sample frequencies each consisting of r categories. The theoretical distribution upon which this is based can be thought of as a multinomial, rather than a binomial, distribution.

If the chi-square test of independence indicates no difference between sample, the null hypothesis cannot be rejected. If, on the other hand, the test indicates variation, the second question is answered by using the chi-square test of goodness of fit to determine which sample groups gave a significant number of D responses and which did not.

The null hypothesis for age in this case is that the percentage of D responses for each age group is no greater than the mean percentage of D responses for the total sample group. The null hypothesis for supervisory level in this case is that the percentage of D responses for each supervisory level group is no greater than the mean percentage of D responses for the total sample group.

REFERENCES

1. For an extensive discussion of rating scales see J. P. Guilford, Psychometric Methods (New York, N. Y.: McGraw-Hill, 1959), pp. 263-299.

2. Abraham Zaleznik and David Moment, The Dynamics of Interpersonal Behavior (New York, N. Y.: John Wiley & Sons, 1964), p. 423 citing E. A. Fleishman, E. F. Harris, and H. E. Burtt, Leadership and Supervision in Industry (Columbus, Ohio: Personnel Research Board, Ohio State University, 1955).

3. For an extensive discussion and explaination of chi-square tests, see Jerome C. R. Li, Statistical Inference I (Ann Arbor, Mich.: Edwards Brothers, Inc., 1964), pp. 443-501.

4. Statistical computations for the various analyses are presented in Appendixes C through E.

Chapter 3

PRESENTATION OF DATA

This chapter is devoted to a presentation of the findings in regard to the three hypotheses stated in Chapter 1 and 2. The chapter is divided into sections so that the findings relating to each hypothesis are treated separately. For each hypothesis, the data are tabulated in the manner discussed in Chapter 2. In most cases, the sample sizes are not equal and, consequently, the various frequency distributions of responses can be compared on a relative basis only. Each section also includes a brief discussion aimed toward explaning the data, the results of the statistical analysis, and the conclusions reached in regard to the hypothesis being tested.

To avoid confusion, it should be pointed out that the sample size in a particular case is not the number of responses but, rather, the number of responses (perceptions) given by the respondents. Thus, while the total number of respondents is 76, the total number of perceptions is 608 since there are 76 respondents each making eight perceptual responses. The five per cent probability of randomness value is used throughout this study in determining statistical significance.

Data Pertaining to the Total Group

The data presented in this section deals with the hypothesis

that leaders are perceived as reinforcing safety behaviors by their subordinates. Table II on page 35 is intended to provide an overall view of the questionnaire results. It indicates that the respondents gave a large number of both A and D responses but very few U responses. On a total basis, there were more Not-D responses than D responses, which tends to substantiate the hypothesis. The right side of Table II provides a breakdown of D and Not-D responses in terms of percentage. It can be seen that 59.4 per cent of the total of 608 responses fell into the category of Not-D as opposed to 40.6 per cent in the D category. The chi-square test of goodness of fit shows that 59.4 per cent is significantly greater than 50 per cent ($\chi^2=21.37$, $p < .001$), therefore, the null hypothesis that the percentage of Not-D responses is no greater than 50 per cent must be rejected.

While the total of Not-D responses is significantly greater than the number of D responses, it is apparent that this is not true for questions 5 (disciplining subordinates), 6 (stopping a mission), and 8 (requiring protective equipment). Table II also provides a breakdown of the total D and Not-D responses for each question in the questionnaire.

Of the five questions to which the respondents gave predominantly Not-D answers, none of them involves a principle of accident prevention which requires influencing someone else's behavior or exercising authority. An interpretation of this is difficult to achieve but the finding may be explained by the fact that these five questions involve elements of individual effort but do not require the exercise of authority.

TABLE II

RESPONSES BY QUESTION FOR THE TOTAL SAMPLE GROUP

Question	Number Responding to Each Response					Totals			
	A_2	A_1	U	D_1	D_2	Not-D Response		D Response	
						Number	Per cent	Number	Per cent
1 (personal record)	7	40	5	22	2	52	68.4	24	31.6
2 (safety meetings)	9	34	5	22	6	48	63.2	28	36.8
3 (safety program)	8	30	2	27	9	40	52.6	36	47.4
4 (correcting hazards)	13	27	8	25	3	48	63.2	28	36.8
5 (discipline subordinates)	4	28	5	28	11	37	48.7	39	51.3
6 (stopping a mission)	5	20	10	28	13	35	46.1	41	53.9
7 (reporting accidents)	27	35	2	11	1	64	84.2	12	15.8
8 (protective equipment)	5	27	5	21	18	37	48.7	39	51.3
Total	78	241	42	184	63	361	--	247	--
Overall Per cent	--	--	--	--	--	--	59.4	--	40.6
*Expected per cent if hypothesis is to be rejected							50.0		50.0

$\chi^2 = 21.37$ $p < .001$

Of the three questions to which the respondents gave predominantly D answers, the chi-square test of goodness of fit indicates that the response is significantly greater than 40.6 per cent for question 6 (χ^2=5.45, $p < .02$) and not significantly greater than 40.6 per cent for questions 5 and 8 (each, χ^2=3.47, $p < .10$). While the responses on question 3 are not predominantly D, they are greater than 40.6 per cent (χ^2=1.37, $p < .30$). The fact that questions 5, 6, and 8 involve principles of accident prevention where the exercise of authority is called for tends to indicate that leaders are not perceived as reinforcing those safety behaviors which call for the subordinate to make decisions on his own. Or, stated another way, the subordinates tend to see their superiors as engaging in safety oriented personal behavior, but not trying to influence their subordinates' behaviors.

Of greatest significance to the author are the answers given in response to question 6, that question dealing with the relative importance of personnel versus mission accomplishement. 53.9 per cent of the respondents gave D answers to what the author feels is the most important question on the questionnaire. The reason for this feeling being that when the immediacy of injury is most accute, the correction must be made before the accident occurs. In addition, if subordinates believe that their lives are valued less than production or mission accomplishment, their safety behavior may be adversely effected.

Data Pertaining to Equal Reinforcement

The data in this section with the hypothesis that leaders reinforce all appropriate safety behavior to a similar degree. The

data presented in Table III indicates that leaders are perceived as reinforcing the two categories of safety behavior, but not to a similar degree. Although both groupings are rated Not-D, the difference between 67.1 per cent and 51.6 per cent is significant (χ^2=9.98, $p < .01$) as it tends to indicate, once again, that leaders reinforce behaviors of subordinates which do not involve the application of authority more than they do behaviors which require that authority be exercised.

Data Pertaining to Age

The data in this section deals with the hypothesis that older supervisors will tend to perceive leaders as reinforcing their safety behavior to a greater degree than will younger supervisors. Table IV presents the response patterns of the six age group frequencies in both absolute and relative terms. A comparison of the six age group frequencies reveals relatively large differences in some of the response categories. The 26 to 30 age group is the only group which gave predominantly D responses. The next age group, 31 to 35, displays the most uniform distribution of responses with only 6 more D responses than A responses out of 130 Non-U responses.

The chi-square test of independence (χ^2=117.41, $p < .001$) shows a significant difference between the frequency distributions of the six age groups. This indicates that the scale of responses for the groups are not all the same and that the responses vary with age. In order to determine whether or not the variation is significant in all age groups, the chi-square test of goodness of fit is applied to each group. The data for this analysis are presented in Table V. The chi-square test

TABLE III

D AND NOT-D RESPONSES BY GROUPING

Questions	D Responses		Not-D Responses		Total	
	Number	Per cent	Number	Per cent	Number	Per cent
1, 2, 3, and 7 (Personal Behavior)	100	32.9	204	67.1	304	50
4, 5, 6, and 8 (Exercising Authority)	147	48.4	157	51.6	304	50
Totals	247	40.6	361	59.4	608	100
*Expected per cent if hypothesis is to be rejected				59.4		

$\chi^2 = 9.98$, $p < .02$

TABLE IV

ABSOLUTE AND RELATIVE FREQUENCIES
OF RESPONSES BY AGE GROUP
(Relative Frequencies Expressed as Percentages)

Age Group	Responses					Total
	A_2	A_1	U	D_1	D_2	
26 to 30						
Number	9	65	13	66	31	184
Per cent	4.9	35.3	7.1	35.9	16.8	30.3
31 to 35						
Number	21	41	14	53	15	144
Per cent	14.6	28.5	9.7	36.8	10.4	23.7
36 to 40						
Number	11	50	8	33	10	112
Per cent	9.8	44.6	7.2	29.5	8.9	18.4
41 to 45						
Number	23	38	0	16	3	80
Per cent	28.7	47.5	0.0	20.0	3.8	13.1
46 to 50						
Number	2	30	5	15	4	56
Per cent	3.6	53.6	8.9	26.8	7.1	9.2
51 and over						
Number	12	17	2	1	0	32
Per cent	37.5	53.1	6.3	3.1	0.0	5.3
Total						
Number	78	241	42	184	63	608
Per cent	12.8	39.6	6.9	30.3	10.4	100.0

TABLE V

D AND NOT-D RESPONSES BY AGE GROUP

	D Responses		Not-D Responses		Total	
Age Group	Number	Per cent	Number	Per cent	Number	Per cent
26 to 30	97	52.7	87	47.3	184	30.3
31 to 35	68	47.2	76	52.8	144	23.7
36 to 40	43	38.4	69	61.6	112	18.4
41 to 45	19	23.7	61	76.3	80	13.1
46 to 50	19	33.9	37	66.1	56	9.2
51 and over	1	3.2	31	96.8	32	5.3
Total	247	40.6	361	59.4	608	100.0
* Expected per cent if hypothesis is to be rejected		50.0		50.0		

$\chi^2=117.40$, $p<.001$

shows that 52.7 per cent of D responses for the 26 to 30 age group is significant (χ^2=10.89, p<.001) and that 47.2 per cent of D responses for the 31 to 35 age group is not significant (χ^2=2.89, p<.10). The other four groups all have D responses of less than 40.6 per cent. However, the trend appears to be that the higher the age, the greater the percentage of agreement that leaders reinforce the safety behavior of their subordinates.

Data Pertaining to Education

As stated in Chapter 2, no analysis will be made based on the level of education. However, this area may have been significant if the sample groups included sufficient numbers of non-high school graduates, high school graduates, and college graduates. In future research of this type, only formal education should be considered.

Data Pertaining to Supervisory Level

With respect to supervisory level, it is hypothesized that higher level supervisors will perceive their leaders as reinforcing safety behavior to a greater degree than will lower level supervisors. Following the same procedure as for age, the absolute and relative frequency distributions of responses for supervisory level were tabulated and are presented in Table VI.

The chi-square test of independence (χ^2=163.49, p<.001) shows a significant difference between the frequency distributions of the eight supervisory categories. In order to determine whether or not the variation is significant for all supervisory groups, the chi-square

TABLE VI

ABSOLUTE AND RELATIVE FREQUENCIES
OF RESPONSES BY SUPERVISORY LEVEL
(Relative Frequencies Expressed as Percentages)

Supervisory Level	Responses					
	A_2	A_1	U	D_1	D_2	Total
E-5						
Number	2	7	0	9	14	32
Per cent	6.3	21.9	0.0	29.1	43.7	5.3
E-6						
Number	5	78	19	76	22	200
Per cent	2.5	39.0	9.5	38.0	11.0	32.9
E-7						
Number	28	64	4	39	9	144
Per cent	19.4	44.4	2.8	27.1	6.3	23.7
E-8						
Number	10	20	0	9	1	40
Per cent	25.0	50.0	0.0	22.5	2.5	6.6
WL						
Number	1	24	6	36	13	80
Per cent	1.3	30.0	7.5	45.0	16.2	13.1
WS						
Number	28	41	10	13	4	96
Per cent	29.2	42.7	10.4	13.6	4.1	15.8
GS5-8						
Number	1	5	2	0	0	8
Per cent	12.5	62.5	25.0	0.0	0.0	1.3
GS9-11						
Number	3	2	1	2	0	8
Per cent	37.5	25.0	12.5	25.0	0.0	1.3
Total						
Number	78	241	42	184	63	608
Per cent	12.8	39.6	6.9	30.3	10.4	100.0

test of goodness of fit is applied to each group. The data for this analysis are presented in Table VII. The test shows that there is a significant difference for E-5 (χ^2=12.96, p<.001), E-6 (χ^2=6.00, p<.02), and WL (χ^2=15.05, p<.001). An examination of the personal data for these categories of respondents indicates that they are similar in age; while an examination of job descriptions indicates similar supervisory responsibilities. While the three categories are considered as separate for the purpose of this study, a good case could be made for including them all in one category.

Data Pertaining to Age and Supervisory Level

The data presented in this section deals with the hypothesis that the combination of age and supervisory level will result in differing perceptions of leader reinforced safety behavior. The data presented in Table VIII show that the frequency distribution of respondents is such that insufficient numbers of high age, lower level and low age, high level respondents were tabulated to perform any statistically significant analysis. However, for the total population, it was found that the difference between the expected and the actual distribution was significant (χ^2=44.29, p<.001).

Based on an examination of the relative frequency of responses for both age and supervisory level, the null hypotheses that the percentage of D responses for both age and supervisory level will not be greater than the mean percentage of D responses for the total total sample group must be rejected. Therefore, this finding supports the hypothesis that the perceptions by older, higher level supervisors

TABLE VII

D AND NOT-D RESPONSES BY SUPERVISORY LEVEL

Supervisory Level	D Responses		Not-D Responses		Total	
	Number	Per cent	Number	Per cent	Number	Per cent
E-5	23	52.7	9	28.1	32	5.3
E-6	98	49.0	102	51.0	200	32.9
E-7	48	33.3	96	66.7	144	23.7
E-8	10	25.0	30	75.0	40	6.6
WL	49	61.3	31	38.7	80	13.1
WS	17	17.7	79	82.3	96	15.8
GS5-8	0	0.0	8	100.0	8	1.3
GS9-11	2	25.0	6	75.0	8	1.3
Total	247	40.6	361	59.4	608	100.0
*Expected per cent if hypothesis is to be rejected		50.0		50.0		

$\chi^2=163.49$, $p<.001$

TABLE VIII

ABSOLUTE AND EXPECTED FREQUENCIES
OF AGE AND SUPERVISORY LEVEL
(Expected Frequency in Paranthesis)

	Supervisory Level Low	Supervisory Level Medium	Supervisory Level High	Total
Age Level High	0 (8.0)	8 (7.7)	13 (5.3)	21
Age Level Medium	9 (11.8)	17 (11.4)	5 (7.8)	31
Age Level Low	20 (9.2)	3 (8.8)	1 (6.0)	24
Total	29	28	19	76

$\chi^2 = 44.29$, $p < .001$

of the reinforcement of their safety behavior will differ from the perceptions of younger, lower level supervisors of the reinforcement of their safety behavior.

Chapter 4

SUMMARY AND CONCLUSIONS

The first part of this chapter includes a summary of the findings presented in Chapter 3. In those cases where the hypotheses were not confirmed, the findings are related to the literature cited previously, and an attempt is made to explain some possible reasons for the rejection of the hypothesis. The remainder of the chapter is devoted to a presentation of conclusions, some additional observations, and implications for management practice and additional research.

SUMMARY OF FINDINGS

Summary of Findings with Regard to the Total Sample Group

Hypothesis 1 - Leaders are perceived by their subordinates as reinforcing their safety behavior.

Hypothesis 2 - Leaders are perceived as reinforcing all appropriate safety behavior to a similar degree.

With respect to the total sample group, it was hypothesized that they would hold that they perceive their leader as reinforcing their safety behavior. Consequently, the null hypothesis is that no more than 50 per cent of their responses would be Not-D responses. The actual percentage of Not-D responses was found to be 59.4 per cent, which the chi-square test showed to be significantly greater than 50 per cent.

However, it was found that the respondents did not give predom-

inantly Not-D responses to every question. There was a majority of Not-D responses on only five of the eight questions. The interpretation of these responses in terms of question content is indicated below, along with the percentage majority in each case. A majority of Not-D responses indicates a tendency for the total sample group to perceive that they are favorably recognized by their direct supervisor for:

Question 1 - having an outstanding personal safety record (68.4 per cent).

Question 2 - participation in safety meetings (63.2 per cent).

Question 3 - their initiative in implementing the unit safety program (52.6 per cent).

Question 4 - correcting all major and minor safety hazards in those areas under their control (63.2 per cent).

Question 7 - reporting all accidents as soon as possible (84.2 per cent).

The sample group gave a majority of D responses to the remaining three questions. Interpreting the responses to these questions in the same manner as above, it appears that the respondents perceived that they were not favorably recognized by their direct supervisors for:

Question 5 - disciplining subordinates who repeatedly refuse or fail to follow safety rules (51.3 per cent).

Question 6 - stopping the mission if the safety of personnel is endangered (53.9 per cent).

Question 8 - requiring that subordinates utilize all necessary personal protective equipment (51.3 per cent).

As pointed out in Chapter 3, of the five questions where a

majority of Not-D responses were given, none of them involves a principle of accident prevention which requires the exercise of authority; they involve personal action only. In the case of the three questions where a majority of D responses were given, each of them involves a principle of accident prevention where the exercise of authority is necessary; other people would have to be corrected or disciplined. Thus, it appears that the system of reinforcements for safety behavior is limited to that behavior which applies only to one's self.

In attempting to explain this finding, the article by Steven Kerr referenced in Chapter 1 may be of some help. Kerr proposes that one of the reasons for the difference may be that management is often overly concerned with "objective" measures of performance. If this is the case, it is possible to see that one's boss may see what one does himself, but does not see or recognize what one does through other people. In other words, personal behavior is more easily observed and quantified than is supervisory or leadership behavior.

Another area of possible contradiction occurs when the responses to questions 5 (reporting accidents), 6 (disciplining subordinates), and 8 (requiring protective equipment) are compared to the responses given to question 4 (correcting safety hazards). Questions 5, 6, and 8 were given predominantly D answers while question 4 was given predominantly Not-D answers. However, all four questions deal with the reinforcing of behaviors concerning the correction of physical hazards or unsafe acts. The only explanation that can be given is that question 4 was perceived to deal primarily with the physical environment (structures, equipment, etc.) while questions 5, 6, and 8 were perceived to deal

primarily with the control of people. If true, this explanation is significant as one of the basic principles of accident prevention is that supervisors must be able to make on-the-spot corrections of the unsafe acts of their subordinates.

To recapitulate the findings in regard to the total sample group, the question-by-question analysis of the responses indicated that the respondents gave significant majorities of Not-D responses to four of the questions, a not significant majority of Not-D responses to another question, not significant majorities of D responses to two questions, and a significant majority of D answers to one question. Based on the total number of responses, the null hypothesis that leaders are not perceived as reinforcing the safety behavior of their subordinates must be rejected. However, caution must be exercised in not rejecting the theoretical hypothesis as the answers to four of the eight questions will not support the hypothesis that leaders are perceived as reinforcing the safety behavior of their subordinates.

In regard to the second hypothesis, it was found that significant differences exist in the pattern of responses to the various questions. For this reason, the null hypothesis that all appropriate safety behavior is reinforced to a similar degree must be rejected. This finding is significant as it indicates that some principles of an effective safety and health program are not being fully implemented.

Summary of Findings with Regard to Age and Supervisory Level

Hypothesis 3 - The perceptions of older, higher level supervisors of the reinforcement of their safety behavior will differ from the

perceptions of younger, lower level supervisors of the reinforcement of their safety behavior.

The null hypothesis regarding age was that there would be no difference between the perceptions of the various age groups. The findings of the study indicate that there are significant differences, thus, the null hypothesis must be rejected. The null hypothesis regarding supervisory level, likewise, must be rejected as significant differences were found between the perceptions of safety behavior reinforcement of the various supervisory levels. Further, the chi-square tests of goodness of fit applied to each age and supervisory level group showed that younger, lower level supervisors tended more toward D responses than did older, higher level supervisors.

The implications which can be drawn from the findings concerning difference in age and supervisory level perceptions of the reinforcement of safety behavior may have a serious effect on implementing safety and health programs in the future. As the perceptions, and ultimately the behavior, of the younger, lower level supervisors change in a positive direction with incresed age and supervisory level, the desired change may occur sooner than expected if the number of reinforcements given younger, lower level supervisors for appropriate safety behavior is increased.

While no evidence is presented dealing specifically with changes in perceptions of the reinforcement of safety behavior which take place with increased age and supervisory level, it is assumed that there is some relationship. It is evident that higher level supervisors have similar perceptions of the reinforcement of safety behavior as do older supervisors. Unfortunately, in regard to age and level, it was found that

there was an insufficient number of both older, lower level supervisors and younger, higher level supervisors to perform any valid statistical analysis. This was found to be due to the promotion policies of the federal government in that military promotions are based, in part, on time-in-service and time-in-grade requirements. While not completely true of civil service promotions, seniority does influence the promotion process of civilian employees.

Interpretations

The stated purpose of this study was to determine to what degree rewarding safety behavior affects the implementation of an effective safety and health program. This was accomplished by an analysis of data gathered by the use of a questionnaire. In very general terms, it was found that the effectiveness of a safety and health program should not be measured solely on the basis of accident statistics, but that the behavioral aspects of accident prevention should also be studied. If it is found that supervisors are not perceiving their safety behavior as being reinforced, the effectiveness of a safety and health program will be less than that which could be achieved. Therefore, it is necessary to insure that supervisors are rewarded for their contributions to the safety and health program if overall program effectiveness is to be maximized.

IMPLICATIONS FOR MANAGEMENT

The finding of this study reveal that management has not fully exploited the important part that supervisors can play in implementing

an effective safety and health program. The data show that younger lower level supervisors, those normally closest to the performance of work, do not perceive their safety behavior as being reinforced by their supervisors. This being the case, an important part of safety and health program management is being underutilized. The problem facing management, then, is how to bring this element of safety and health program management to bear on the problem of reducing the number of industrial accidents.

The proposed answer to this problem is that management must establish or strengthen systems of reinforcing supervisors for their contributions to and implementation of the organization's safety and health program. In order to accomplish this, it may be necessary to modify the performance appraisal system to place more emphasis on the individual's behavior relative to safety and health, institute programs of paying incentives or bonuses for reductions in accidental losses, discipline supervisors who repeatedly fail to implement safe work practices, or transfer supervisors whose negative values regarding safety are such that positive change is not predicted.

As is most cases dealing with changes in management practices, there are costs involved. Unlike engineering solutions to accident reductions, the cost benefits to be derived by changes in management practice are often hard to determine. However, if it can be assumed that an accidental injury to an employee costs the same whether it arose from an environmental defect or human error, the Heinrich Ratio of Accident Causes referenced in Chapter 1 would tend to indicate that greater potential for effecting significant reductions rests in the

area of behavior control than in the area of environmental control.

IMPLICATIONS FOR RESEARCH

Critique of Methodology

The conclusions reached in this study lead to some rather perplexing implications. The first relates to the whole matter of measuring human perceptions through the use of a questionnaire. It is possible that the individuals sampled in this study did not give completely honest answers to every question. If, in fact, this did occur, the reason may be that each of the individuals has had a considerable amount of safety related training throughout his federal service career as a part of his skill training. Thus, he may give the "proper" answer even though he may not implement the safety principle.

Certainly, the questionnaire used in this study is not completely without fault. One can never be sure, for example, that rating scales are sufficiently balanced or that the questions are completely understood by the respondents. Thus, in any study employing questionnaires, there is always some error built in. However, the questionnaire was the same for all respondents, therefore, the error can be assumed to be equally distributed throughout the sample group.

A second implication is that the responses to a number of the questions contained a sufficiently large number of U answers that analyzing A and Not-A instead of D and Not-D would have had a significant affect on the outcome of the analysis. While A responses outnumbered Not-A responses by 319 to 289 (52.5 to 47.5 per cent, respectively) this difference is not significant. However, the outcome of the

analysis of a number of questions would have changed and it may have been possible to make a stronger case for accepting Kerr's proposal if the U responses had been considered as Not-A responses.

A third implication deals with the matter of the interaction of factors in influencing the perceptions supervisors hold about safety. In this study, age and supervisory level were treated separately. However, it is possible that a thorough analysis of the interaction of these two variables taken from a larger sample size could prove significant. Unfortunately, in this study the number of respondents in high age, lower level and low age, higher level categories was too small to perform statistically significant analysis.

A final implication deals with difference within populations in regard to skill specialty. It is possible, for example, that vehicle mechanics hold differing perceptions of appropriate safety behavior than do aircraft mechanics. It would be interesting, and hopefully significant, to determine if differences in skill specialties have any effect on the perceptions of appropriate safety behavior.

Design of Additional Research

Of greatest interest to the author is the possibility of conducting an extensive research project based on the reinforcement of supervisors' safety behavior. This project would have to take place over a span of at least two years and be conducted within a manufacturing plant that has an active safety program and has an accident rate not exceeding the industry average.

As the first step in the program, all safety material not

required by statute would be removed from the facility and all safety meetings, councils, and non-job essential training brought to an end. At this time, all functional supervisors would be assembled and the safety behavior reinforcement program presented to them.

The elements of the program are:

1. Each supervisor will be trained in safety program management, safety principles, and accident investigation.

2. Each supervisor will be made aware that safety behavior will be made an important part of the performance appraisal system.

3. A budget will be prepared for each supervisor based on the number of personnel under his direct supervision. This budget will include provisions for monetary rewards, days-off, and safety awards. The budget will be used to regulate the number of rewards that the supervisor can use to formally reinforce the safety behavior of his subordinates.

4. A bonus plan will be initiated based on a combination of productivity and safety performance. The maximum bonus can only be earned if productivity is high and accident rates are low. Reductions in the amount of the bonus will be made for deviations from program objectives, i.e., high production, low safety or low production, high safety.

The safety staff will be retained to act as supervisor trainers and program consultants. The staff members will only intervene in the supervisor's program when the physical well-being of an individual is in imminent danger.

At the end of the first six months and at additional six month

intervals, the program will be evaluated on the basis of productivity, loss reduction, and cost effectiveness.

It is hoped, and believed probable, that a significant reduction in accident rates will occur under this plan. Further, it is anticipated that the program will prove to be cost effective and, thus, return more in benefits than it costs in dollars spent.

CONCLUDING REMARKS

The author hopes that this study will prove beneficial in gaining an understanding of the factors which cause people to behave as they do in regard to safety. It is hoped that further research in this area will be conducted and the results serve to effect a significant advance in the field of accident prevention and loss control.

APPENDIX A

THE COMPLETE QUESTIONNAIRE

SUPERVISORY INVENTORY ON SAFETY

APPROXIMATE AGE:	26 to 30	____	EDUCATION: (circle one)
	31 to 35	____	9 10 11 12 13 14 15 16 17
	36 to 40	____	
	41 to 45	____	RANK/GRADE: _____
	46 to 50	____	
	51 and over	____	

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DIRECTIONS

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For each question below, circle the answer (a, b, c, d, or e) which comes closest to reflecting your opinion. Please keep in mind that the questions pertain only to your present position, supervisor, and organization.

You are to read each statement and indicate whether you:

a. Strongly agree

b. Mildly agree

c. Neither agree nor disagree

d. Mildly disagree

e. Strongly disagree

You may not be as sure about some statements as you are about others. However, it is important that you answer each question. Do not let one experience (either positive or negative) overly influence your answer, but answer each question as truthfully as possible.

FOR EACH STATEMENT DETERMINE IF YOU ARE FAVORABLY RECOGNIZED BY YOUR DIRECT SUPERVISOR FOR:

STATEMENT	Strongly agree	Mildly agree	Undecided	Mildly disagree	Strongly disagree
1. having an outstanding personal safety record.	a	b	c	d	e
2. your direct participation in safety meetings.	a	b	c	d	e
3. your initiative in implementing the unit safety program.	a	b	c	d	e
4. correcting all major and minor safety hazards in those areas under your control.	a	b	c	d	e
5. disciplining subordinates who repeatedly refuse or fail to follow safety rules.	a	b	c	d	e
6. stopping a mission if the safety of personnel is endangered.	a	b	c	d	e
7. reporting all accidents as soon as possible.	a	b	c	d	e
8. requiring that subordinates utilize all necessary personal protective equipment.	a	b	c	d	e

APPENDIX B

METHOD OF COMPUTATION

Formulas and Computations

For the chi-square test of goodness of fit the statistic is:

$$\chi^2 = \sum \frac{(f - h)^2}{h}$$

where: χ^2 = chi-square

f = observed frequency

h = hypothetical frequency

The computation is accomplished by the following steps:

1. For the sample or sub-sample involved, the frequencies of D responses and Not-D responses are compiled.
2. For each frequency, the value of $\frac{(f - h)^2}{h}$ is computed.
3. The values for each $\frac{(f - h)^2}{h}$ are added together to arrive at χ^2.
4. The computed value of χ^2 is the compared to the 5% probability of randomness value for χ^2 to test for significance.

For the chi-square test of independence the statistic is:

$$\chi^2 = \sum^{kr} \frac{(f - h)^2}{h}$$

where: ^{2} = chi-square

f = observed frequency

h = hypothetical frequency

k = number of samples

r = number of categories

The short-cut method of computation is used instead of the above statistic in order to simplify the process. The statistic for the short-cut method is:

$$\chi^2 = (\sum n)\left[\frac{R_1}{n_1} + \frac{R_2}{n_2} + \cdots + \frac{R_4}{n_4} - 1\right]$$

where: χ^2 = chi-square

n = total number of responses

R = a statistic computed for each sample and described by the following equation:

$$R = \frac{f_1^{\,2}}{f_{r_1}} + \frac{f_2^{\,2}}{f_{r_2}} + \cdots + \frac{f_4^{\,2}}{f_{r_4}}$$

where: f^2 = the square of the observed frequencies for the five categories

f_r = the total frequencies of the corresponding categories

The computation is accomplished by the following steps:

1. A contingency table is constructed to show the frequency distribution of the k samples.
2. For each sample, R is computed.
3. The computed R's are then fitted into the short-cut formula to derive χ^2 for the total sample.
4. The computed value of χ^2 is then compared to the 5% probability of randomness value for χ^2 to test for significance.

APPENDIX C

COMPUTATIONS FOR THE TOTAL SAMPLE GROUP

Chi-square test of goodness of fit for the total sample group (Total number of responses = 608)

Hypothesis: The number of D responses is no greater than 50%.

h (hypothetical frequencies):

D responses = 304

Not-D responses = 304

f (observed frequencies):

D responses = 247

Not-D responses = 361

$$^{2}= \frac{(f - h)^2}{h} = \frac{(247 - 304)^2}{304} + \frac{(361 - 304)^2}{304} = 21.37$$

5% probability of randomness with 1 degree of freedom = 3.84

Chi-square test of goodness of fit by question for total sample group (Total number of responses for each question = 76)

Hypothesis: The number of D responses is not greater than the mean (40.6%).

Therefore: h (hypothetical frequencies):= 31 in every case

In those cases where the D response is less than 40.6% (i.e. 31) the hypothesis is accepted without testing.

Question 1

f (observed frequencies):

D responses = 24

Not-D responses = 52 Not tested

Question 2

f (observed frequencies)

D responses = 28

Not-D responses = 48 Not tested

Question 3

f (observed frequencies)

D responses = 36

Not-D responses = 40

$$\chi^2 = \sum \frac{(f - h)^2}{h} = \frac{(36 - 31)^2}{31} + \frac{(40 - 45)^2}{45} = 1.36$$

5% probability of randomness with 1 degree of freedom = 3.84

Question 4

f (observed frequencies):

D responses = 28

Not-D responses = 48 Not tested

Question 5

f (observed frequencies):

D responses = 39

Not-D responses = 37

$$\chi^2 = \sum \frac{(f - h)^2}{h} = \frac{(39 - 31)^2}{31} + \frac{(37 - 45)^2}{45} = 3.47$$

5% probability of randomness with 1 degree of freedom = 3.84

Question 6

f (observed frequencies):

D responses = 41

Not-D responses = 35

$$\chi^2 = \sum \frac{(f - h)^2}{h} = \frac{(41 - 31)^2}{31} + \frac{(35 - 45)^2}{45} = 5.45$$

5% probability of randomness with 1 degree of freedom = 3.84

Question 7

f (observed frequencies):

D responses = 12

Not-D responses = 64

Not tested

Question 8

f (observed frequencies):

D responses = 39

Not-D responses = 37

Same test as 5

$\chi^2 = 3.47$

5% probability of randomness with 1 degree of freedom = 3.84

APPENDIX D

COMPUTATIONS FOR AGE

Chi-square test of independence for age

$$R_1 = \frac{9^2}{78} + \frac{65^2}{241} + \frac{13^2}{42} + \frac{66^2}{184} + \frac{31^2}{63} = 61.25$$

$$R_2 = \frac{21^2}{78} + \frac{41^2}{241} + \frac{14^2}{42} + \frac{53^2}{184} + \frac{15^2}{63} = 38.13$$

$$R_3 = \frac{11^2}{78} + \frac{50^2}{241} + \frac{8^2}{42} + \frac{33^2}{184} + \frac{10^2}{63} = 20.95$$

$$R_4 = \frac{23^2}{78} + \frac{38^2}{241} + \frac{0^2}{42} + \frac{16^2}{184} + \frac{3^2}{63} = 16.31$$

$$R_5 = \frac{2^2}{78} + \frac{30^2}{241} + \frac{5^2}{42} + \frac{15^2}{184} + \frac{4^2}{63} = 5.86$$

$$R_6 = \frac{12^2}{78} + \frac{17^2}{241} + \frac{2^2}{42} + \frac{1^2}{184} + \frac{0^2}{63} = 3.15$$

Degrees of freedom = $(k - 1)(r - 1) = (6 - 1)(5 - 1) = 20$

$$\chi^2 = (608)\left[\frac{61.52}{184} + \frac{38.13}{144} + \frac{20.95}{112} + \frac{16.31}{80} + \frac{5.86}{56} + \frac{3.15}{32} - 1\right] = 117.40$$

5% probability of randomness with 20 degrees of freedom = 31.4

Chi-square test of goodness of fit for age

Hypothesis: The number of D responses is not greater than the mean (40.6%).

In those cases where the D response is less than 40.6% the hypothesis is accepted without testing.

<u>26 to 30 age group</u> (Total number of responses = 184)

h (hypothetical frequencies):

D responses = 75

Not-D responses = 109

f (observed frequencies):

D responses = 97

Not-D responses = 87

$$\chi^2 = \sum \frac{(f - h)^2}{h} = \frac{(97 - 75)^2}{75} = \frac{(87 - 109)}{109} = 10.89$$

5% probability of randomness with 1 degree of freedom = 3.84

<u>31 to 35 age group</u> (Total number of responses = 144)

h (hypothetical frequencies):

D responses = 58

Not-D responses = 86

f (observed frequencies):

D responses = 68

Not-D responses = 76

$$\chi^2 = \sum \frac{(f - h)^2}{h} = \frac{(68 - 58)^2}{58} + \frac{(76 - 86)^2}{86} = 2.89$$

5% probability of randomness with 1 degree of freedom = 3.84

<u>36 to 40 age group</u> (Total number of responses = 112)

h (hypothetical frequencies)

D responses = 45

Not-D responses = 67

f (observed frequencies):

D responses = 43

Not-D responses = 69 Not tested

41 to 45 age group (Total number of responses = 80)

h (hypothetical frequencies):

D responses = 32

Not-D responses = 48

f (observed frequencies):

D responses = 19

Not-D responses = 61 Not tested

46 to 50 age group (Total number of responses = 56)

h (hypothetical frequencies):

D responses = 23

Not-D responses = 33

f (observed frequencies):

D responses = 19

Not-D responses = 37 Not tested

51 and over age group (Total number of responses = 32)

h (hypothetical frequencies):

D responses = 13

Not-D responses = 19

f (observed frequencies):

D responses = 1

Not-D responses = 31 Not tested

APPENDIX E

COMPUTATIONS FOR SUPERVISORY LEVEL

Chi-square test of independence for supervisory level

$$R_1 = \frac{2^2}{78} + \frac{7^2}{241} + \frac{0}{42} + \frac{9^2}{184} + \frac{14^2}{63} = 3.81$$

$$R_2 = \frac{5^2}{78} + \frac{78^2}{241} + \frac{19^2}{42} + \frac{76^2}{184} + \frac{22^2}{63} = 73.23$$

$$R_3 = \frac{28^2}{78} + \frac{64^2}{241} + \frac{4^2}{42} + \frac{39^2}{184} + \frac{9^2}{63} = 36.98$$

$$R_4 = \frac{10^2}{78} + \frac{20^2}{241} + \frac{0}{42} + \frac{9^2}{184} + \frac{1^2}{63} = 3.40$$

$$R_5 = \frac{1^2}{78} + \frac{24^2}{241} + \frac{6^2}{42} + \frac{36^2}{184} + \frac{13^2}{63} = 12.99$$

$$R_6 = \frac{28^2}{78} + \frac{41^2}{241} + \frac{10^2}{42} + \frac{13^2}{184} + \frac{4^2}{63} = 20.58$$

$$R_7 = \frac{1^2}{78} + \frac{5^2}{241} + \frac{2^2}{42} + \frac{0}{184} + \frac{0}{63} = .34$$

$$R_8 = \frac{3^2}{78} + \frac{2^2}{241} + \frac{1^2}{42} + \frac{2^2}{184} + \frac{0}{63} = .18$$

Degrees of freedom = $(k - 1)(r - 1) = (8 - 1)(5 - 1) = 28$

$$\chi^2 = (608)\left[\frac{3.81}{32} + \frac{73.23}{200} + \frac{36.98}{144} + \frac{3.40}{40} + \frac{12.99}{80} + \frac{20.58}{96} + \frac{.34}{8} + \frac{.18}{8} - 1\right] = 163.49$$

5% probability of randomness with 28 degrees of freedom = 41.3

Chi-square test of goodness of fit for supervisory level

The hypothesis for each supervisory level is that the number of D responses is not greater than 40.6%.

In those cases where the D response is less than 40.6%, the hypothesis is accepted without testing.

E-5 level group (Total number of responses = 32)

h (hypothetical frequencies):

D responses = 13

Not-D responses = 19

f (observed frequencies):

D responses = 23

Not-D responses = 9

$$\chi^2 = \sum \frac{(f - h)^2}{h} = \frac{(23 - 13)^2}{13} + \frac{(9 - 19)^2}{19} = 12.96$$

5% probability of randomness with 1 degree of freedom = 3.84

E-6 level group (Total number of responses = 200)

h (hypothetical frequencies):

D responses = 81

Not-D responses = 119

f (observed frequencies):

D responses = 98

Not-D responses = 102

$$\chi^2 = \sum \frac{(f - h)^2}{h} = \frac{(98 - 81)^2}{81} + \frac{(102 - 119)^2}{119} = 6.00$$

5% probability of randomness with 1 degree of freedom = 3.84

<u>E-7 level group</u> (Total number of responses = 144)

h (hypothetical frequencies):

D responses = 58

Not-D responses = 86

f (observed frequencies):

D responses = 48

Not-D responses = 96 <u>Not tested</u>

E-8 level group (Total number of responses = 40)

h (hypothetical frequencies):

D responses = 16

Not-D responses = 24

f (observed frequencies):

D responses = 10

Not-D responses = 30 <u>Not tested</u>

<u>WL level group</u> (Total number of responses = 80)

h (hypothetical frequencies):

D responses = 32

Not-D responses = 48

f (observed frequencies):

D responses = 49

Not-D responses = 31

$$\chi^2 = \sum \frac{(f - h)^2}{h} = \frac{(49 - 32)^2}{32} + \frac{(31 - 48)^2}{48} = 15.05$$

5% probability of randomness with 1 degree of freedom = 3.84

<u>WS level group</u> (Total number of respondents = 96)

h (hypothetical frequencies):

D responses = 39

Not-D responses = 57

f (observed frequencies):

D responses = 17

Not-D responses = 79 <u>Not tested</u>

<u>GS5 to 8 and GS9 to 11 level groups</u> (Total number of responses = 16)

These two groups were not tested as the sample size of 1 was too small.

VITA

Charles Edmond Brambley was born April 29, 1944 in Baltimore, Maryland. He attended public schools in Abington, Pennsylvania, Kwajalien, Marshall Islands, and Kailua, Hawaii, and graduated from Kailua High School in June, 1962.

After graduation from high school, the author attended the Pennsylvania State University and Temple University. In December, 1971, he received his Bachelor of Business Administration degree from Temple University and was subsequently employed as a safety manager by the Department of the Army.

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Charles E. Brambley

THE SUPERVISOR'S ROLE IN SAFETY: A STUDY OF LEADERSHIP REINFORCEMENT

by

Charles Edmond Brambley

(ABSTRACT)

Occupational safety and health is an important element of management responsibility. The number of accidental deaths and injuries is substantial and the cost of accidents is a serious drain on the economy. Safety professionals do not agree on the most effective method of achieving a significant reduction in accident rates, but most agree that human error is the dominant factor in accident causation.

Behavioral theorists contend that man is motivated by his desire to satisfy his needs and that the degree of expectation of his being able to satisfy these needs will influence his behavior. Theorists further contend that if a particular behavior is reinforced it will tend to be repeated. However, these theorists do not specifically relate their contentions to the field of accident prevention. The study was undertaken to help clarify the situation by determining if supervisors perceived their safety behavior as being reinforced by their superiors.

The data for this study were collected by means of a questionnaire administered to a group of military and civilian supervisors at a large federal installation. The questions were constructed using sound

safety principles as a guide and the responses were based on a bipolar rating scale ranging from strongly agree to strongly disagree.

A statistical analysis of the data using the chi-square tests of independence and goodness of fit indicated that, for the installation studied, the supervisors gave a significant majority of agree answers. However, the supervisors did not give a majority of agree answers to every question. It was found that safety behaviors dealing with the exercise of authority and the correction or disciplining of subordinates were reinforced to a lesser degree than was personal safety behavior. The findings also indicated that age and supervisory level did have a significant effect on supervisor's perceptions of the reinforcement of their safety behavior. It was found that older, higher level supervisors perceived their safety behavior as being reinforced to a greater degree than did younger, lower level supervisors.