

A TECHNIQUE FOR
AUDITING AND ANALYZING
WORK PRACTICES

Richard W. Prugh
Consultant, Engineering Section
Safety and Fire Protection Division
Employee Relations Department
E. I. Du Pont de Nemours & Co. (Inc.)
Wilmington, Delaware 19898

Abstract

The major cause of injuries in the Du Pont Company is unsafe work practices. By auditing the work practices of employees (1) basic causes of unsafe practices can be identified and corrected, to avoid recurrence, (2) the extent of injury exposure can be measured, and (3) safety posture and trends in performance can be determined. This report details a method developed and used by survey engineers to evaluate the performance of Company sites in this important aspect of safety.

August, 1976

TABLE OF CONTENTS

SUMMARY	1
CONCLUSIONS	1
DEFINITIONS	2
OBJECTIVES	4
PHILOSOPHY	4
BASIC CAUSES OF UNSAFE ACTS	5
BASIC CAUSES OF EMPLOYEE-CREATED UNSAFE CONDITIONS	8
PROCEDURE FOR REDUCING UNSAFE PRACTICES	8
MEASUREMENT OF SAFETY POSTURE AND TRENDS	10
TECHNIQUES FOR SPECIAL-EMPHASIS AUDITS	11
APPENDIX	
A - EMPLOYEE WORK PRACTICES SPECIAL-EMPHASIS SURVEY	12
FIGURES	
1 - SERIOUS INJURY FREQUENCY vs. UNSAFE ACTS INDEX	16
2 - RECORDABLE INJURY RATE vs. UNSAFE ACTS INDEX	17
TABLE	
I - SAFETY PERFORMANCE DATA	18

SUMMARY

At the present level of safety in the Du Pont Company, the single cause most responsible for serious injuries is the unsafe action of the victim or a co-worker. This is in contrast to other major causes of injury, such as loss of control of a process; deterioration of structures or equipment; emergency actions such as fire-fighting; inadequate control of toxic, corrosive, flammable, radioactive, or explosive materials; crowded or congested conditions causing tripping or falling hazards; faulty design leading to improper construction or absence of important facilities; or improper control of the actions of outsiders, such as contractors or vendors.

Thus, if the frequency of unsafe acts can be reduced, the frequency of serious injuries also will decline.

The relative safety or lack of safety involved in work practices is an indicator of safety attitude and awareness in employees, and indirectly indicates the effectiveness of supervision and management -- thus reflecting on the overall administration of safety at a site. Attitude, awareness, supervisory effectiveness, and administration can be most effectively evaluated, and corrected where necessary, by frequent and thorough audits of work areas, with emphasis on the actions of employees.

CONCLUSIONS

Many of the direct causes of unsafe work practices are readily correctible, provided that the act itself is observed and if, through discussion with the employee involved, the reason for the unsafe act can be determined. The causes which may be readily correctible include lack of suitable equipment or facilities, lack of training, inadequate rules or procedures, and misunderstandings or misinterpretations concerning rules or procedures. Other causes which may be less-readily correctible are employee relations problems, inadequate supervision (ineffective communications or insufficient observations), or an unsatisfactory management attitude toward safety (deficiencies in the administration of safety).

Observations have demonstrated that there are very significant differences in employees' degree of exposure to injury, as expressed by frequencies of unsafe acts. Maintenance and engineering employees working "in the field" commit unsafe acts at a much greater frequency than these same employees when in their shops, or in comparison to employees working in production operations or laboratories. Office workers commit relatively few unsafe acts. Unsafe acts occur at higher frequencies during nonroutine operations, such as vessel entry, during process upsets or "turn-arounds" and on shifts (as opposed to normal day work). The effects of unsafe acts also differ: unsafe acts of operating employees, particularly in control rooms, may seriously affect other employees, whereas the unsafe acts of maintenance employees frequently have the greatest effect on their own safety.

Corrective measures include audits of work areas, directed primarily at employee work practices; studies of jobs having high injury potential; communication of findings through safety meetings, bulletin boards, and publications; use of training aids to improve perception of unsafe work habits; development of procedures to "handle" observed unsafe acts; and improved "feedback" to management, particularly to assure awareness of the consequences of changes in priorities (that is, the position of safety with respect to production rates and costs, product quality, and employee relations or morale). Frequent observations for unsafe acts or work habits provide useful indicators of safety attitude, job knowledge or training, priorities imposed by supervision, and the standards expected by supervision and management.

The frequency of unsafe acts, expressed as a ratio of acts to employees observed at work (Unsafe Acts Index), can serve as an indicator of safety posture of one site relative to other Company plants, of one area relative to other areas, of one shift relative to other shifts, and to indicate trends in performance of these employee groups and in the effectiveness of safety programs. This Index also correlates with injury frequency (See Appendix A) and thus may serve as an indicator of future safety performance. The observations of survey engineers indicate that Company employees commit substantial numbers of unsafe acts (and thus are exposed to injury) and that a very significant improvement in employee work practices is possible.

DEFINITIONS

Unsafe Practices

An unsafe practice is defined (for the purposes of this study) as any action of an employee which creates a hazard to himself or others. Thus this definition would include unsafe acts and employee-created unsafe conditions.

Unsafe Acts

An unsafe act may be defined as an unsafe work practice directly observed by the inspector, supervisor, or auditor, or an unsafe work practice for which the responsibility can be assigned without question to a particular individual (such as a loading operator's failure to attend the filling of a tank truck, with subsequent overflow).

Unsafe Acts of Employees (Wage-Roll and Supervision)

1. Violations of safety rules, including failure to wear specified protective equipment, such as eye protection, life belts, acid suits, etc.; failure to follow motor-vehicle rules; running, smoking in prohibited areas, horseplay, and other violations of the General Safety Rules normally included with each site's safety manual.
2. Violations of safety procedures, such as lock, tag, clear and try; vessel entry, flame permits, and other hazardous-work permits; restrictions on electrical equipment in classified areas; improper use of metal- and wood-working machinery and hoists; and inadequate shoring of excavations.
3. Failure to use good safety judgement, including unsafe climbing or other hazardous work positions; misuse of, or failure to use, safety devices such as respiratory protection, guard rails, chocks, grounding cables, safety

cans, and safety tags; using defective, uninspected, or overdue-for-inspection equipment; and working in a disorderly area.

4. Hazardous control-room practices, such as disabling process alarms; bypassing interlocks essential to process safety; operating above alarm points; and failure to monitor hazardous processes adequately.

Unsafe Acts of Management and Supervision

①. Setting a poor example, such as failure to follow safety rules, or to use good safety judgement.

②. Failure to correct unsafe acts or conditions, by failing to be observant or condoning unsafe work practices.

③. Failure to detect process hazards, such as use of unsuitable or deteriorating equipment, employee exposures to toxic materials, and fire and explosion hazards of which operating employees may be unaware.

Evaporative Unsafe Act

An "evaporative" unsafe act is an omission or commission which can be (or is) corrected quickly when the employee becomes aware that his actions are being audited. A sudden reaction to the auditor's presence may indicate that an unsafe act has evaporated. This would include adding or adjusting personal protective equipment, attaching grounds or lock-outs, changing position, replacing machine guards, rearranging the work, and stopping work or leaving the job.

Unsafe Acts Index

An "Unsafe Acts Ratio" can be calculated from the results of work practice audits, by dividing the number of unsafe acts observed (if any) by the number of employees observed working (and then multiplying by 100, to obtain a percentage). "Working" would include normal assignments, where actions are guided by rules and/or procedures, and other activities where the use of good safety judgement is required to avoid injury. Thus several aspects of work would not be included in this definition, including walking from one building to another, taking a "break" in an area specially provided for this purpose, attending safety meetings, etc. In order to adequately observe an employee working, his actions must be studied long enough to determine not only what he is doing but whether he is doing the job safely. This may require an observation period of 30 seconds or so.

The "Unsafe Acts Ratio" may serve a useful purpose as an indicator of the frequency at which unsafe acts are committed. To indicate exposure to injury, however, the Ratio should be modified to account for different degrees of injury exposure. For example, a rule violation without injury exposure (not wearing safety glasses in an eye-protection area where there is no process or mechanical activity at that moment) may usefully be assigned a value of 1/3. A very serious act (such as jumping from the top of one tank car to another) should be considered a significantly more serious deficiency than a "normal" unsafe act, and a value of 3 may be assigned to such acts. A "normal" unsafe act, where there is a rule violation or failure to use good safety judgement with exposure to injury (such as running downstairs or going upstairs two steps at a time) would have a value of 1. Dividing the total weighted number of unsafe acts by the number of employees observed at work, and then multiplying by 100 to obtain a percentage, yields the Unsafe Acts Index.

Employee-Created Unsafe Conditions

An employee-created unsafe condition is evidence of an employee's failure to create or leave safe working conditions for fellow employees and frequently can be considered a "booby trap". A high frequency of this type of unsafe condition (measured in deficiencies observed per day, per hour, per 100 employees, or per 1000 square feet) thus is an indication of employee safety attitude.

Examples of employee-created unsafe conditions are: disorderly conditions, with falling, tripping, or fire hazards; failure to store tools, gas cylinders, pipe, and process implements properly; obstruction of exits and safety equipment; blocking fire doors open; improperly made-up piping connections; unsecured planks on scaffolds; unlabeled containers; failing to replace guards over moving equipment; inadequate inspections of equipment or placing defective equipment in service; slippery or toxic residues from process spills or leakage; breached fire walls, and closed fire main valves.

OBJECTIVES

Since a high percentage of injuries is caused by unsafe acts, there is a need for a technique which is strongly directed toward identifying and correcting unsafe acts. However, rather than merely correcting the unsafe act, which only maintains the existing safety standards, it is necessary to determine the basic cause or causes to prevent recurrence and thus raise the safety standards and reduce the frequency of injury. Among the possible causes for unsafe acts are inadequate training, prior toleration of the unsafe act, conflict of work priorities, deteriorating equipment or implements, and inappropriate design of facilities -- all of which indicate an unsatisfactory safety administration.

The objectives of this report are to raise the standards of work-practice safety and safety administration by presenting methods for observing, interpreting, and quantifying the frequency and seriousness of unsafe acts.

PHILOSOPHY

It is generally recognized that employees at all levels conduct their jobs in a manner that they have found to be acceptable to their supervision. Stated in another way, the maximum standards of an employee generally are the minimum standards of his supervisor. It follows then that those unsafe acts and conditions which are not corrected will continue, and employees would presume that the then-existing level of unsafe acts and conditions is acceptable.

It is likely that there would be "tests" of the existing level of safety, as expressed by the frequency and character of unsafe acts and the prevalence of unsafe conditions. Uncorrected unsafe practices would cause deterioration of the level of safety, and any unsafe practices observed and corrected would merely return the standards of safety to the former level. Similarly, a supervisor's attempts at improving the level by studying employee work practices and requiring correction on-the-spot, without determining the basic cause, would be unlikely to raise the level of safety, because the former practices probably would be resumed when the supervisor left his area of responsibility.

Thus it is essential to determine the basic cause of each unsafe act, and correct the basic cause, to remove the "justification" or incentive for recurrence. If the frequency of unsafe acts can be decreased, through use of this technique, the standards of safety will be raised. However, it first is necessary to observe the unsafe act, and this can be accomplished only by frequent and thorough study of employee work practices. This should occur not only on safety audits, STOP tours, and other types of safety inspections, but on each tour by a supervisor through his area of responsibility.

An employee's actions are a better indicator of attitude and job knowledge than other methods of attitude appraisal, such as evaluations of the conditions in his area, performance in other aspects of safety, responses to questions raised in discussions or appraisals, or questionnaires. Typically, an employee will generally follow the safety rules (of which he is knowledgeable) as closely as possible or act in as safe a manner as reasonably practical, while being observed. If unsure of the safety of his actions, he may stop work or leave the area; the auditor should take action to determine the reasons for any sudden reaction to his presence.

A basic presumption is that experience gained by study of incidents both within and outside the Company can and should be used to guide the actions of personnel (through rules, procedures, or example) who may be exposed to hazards. This would be in contrast to learning "the hard way" on each site, or within each operating unit, with the attendant possibility of injury.

BASIC CAUSES OF UNSAFE ACTS

Wage-Roll

An unsafe act should be approached with a questioning attitude, since the act is a symptom of a more-serious deficiency, as opposed to merely requiring immediate correction or imposing discipline. To reduce the probability of recurrence, it is essential to determine why the act was committed. Among the questions which could be asked are:

1. Can you tell me the main requirements of this procedure?
2. Why do you find it necessary to do the job this way?
3. If you were planning this job again, how could you do it more safely?
4. If you knew that would happen, how would you do this job differently?

The questions should be directed toward determining why a particular procedure or rule was not being followed, or whether an improved procedure is needed or should be used, and should be worded so that the answer is not "yes" or "no".

Short-Cuts or Improvising

Among the many reasons which may be offered as justification or excuses for unsafe acts such as "short-cuts" or improvising are:

1. Inoperative, defective, deteriorated, or malfunctioning equipment: indicating that greater maintenance effort may be needed.
2. Inadequate, insufficient, undersized, or incomplete equipment; inadequate storage facilities for tools or process implements: indicating that design or equipment-acceptance procedures may need to be improved.
3. Pressures to maintain or increase production; not enough man-power; too little time to do the job properly: indicating that more attention to scheduling, closer supervision or coordination of operations, or revision of priorities may be needed.
4. "Others" did not prepare, maintain, or inspect equipment properly: indicating that better communications and cooperation may be needed between different shifts or crafts.
5. Not aware of high-temperature, toxicity, corrosivity, flammability, radioactivity, or explosibility hazards; did not know that protective equipment, grounding, special handling, or barricading was required; materials or equipment not marked to show the hazards or requirements: indicating that better education concerning materials, hazards and procedures may be needed.

Forgetfulness

In some cases, an unsafe act may be explained as being the result of "forgetting" the applicable rule or procedure, indicating an unsatisfactory "safety state of mind". Among the possible causes for this condition are:

1. Distraction, because of nearby operations, construction, other unusual conditions, or noise.
2. Tiredness, as a result of overtime, double shifts, or personal activities or problems.
3. Lack of concentration, because of uncertain labor relations or future of operation, imminent shutdown, or personal problems.

4. Lack of experience -- Company or job.
A prime objective of safety training is to instill good work habits, with close supervision while job experience is gained, so that it becomes less necessary to "remember" to work safely. More emphasis on work-related subjects, such as rules and procedures, in safety meetings is indicated where "forgetfulness" is a recurring excuse for unsafe acts.

No Rule or Procedure

Where the response to a questioning approach is that there is no rule or procedure to cover the specific act observed, or that the action is not considered unsafe, the basic cause may be:

1. Lack of adequate guidance. Decisions as to appropriate protective equipment, rules, and procedures were left up to the employee, and the employee may have used poor judgement.

2. Failure to recognize as an unsafe act. Not all actions or work practices can be formalized in rules or procedures. Consequently, good safety judgement must be used to avoid hazards and injury. Also, safety rules at most sites are intended to compensate or allow for unexpected incidents or unexpected behavior of others, and thus require a higher standard of safety than might be expected by employees unfamiliar with Du Pont practices.

In some cases, where work is repetitive and unsafe acts occur frequently, it may be advisable to formulate specific rules or procedures to guide the actions of employees.

Non-Conformity

Occasionally the response to a questioning approach may be defensive, negative, or non-responsive. Excuses may be offered such as the poor examples presented by outside contractors, vendors, or employees in other work groups; the ability to "take care of himself" without getting hurt; that the work can't be done if constricted by safety rules, etc. Characteristics not frequently encountered in Du Pont are continual laziness, hot-headedness, disobedience, insubordination, or the practical joker or show-off. However, where an employee frequently acts unsafely as a result of these unfavorable and non-conforming characteristics, it may be necessary to rely on the principle that safe performance is a condition of employment in Du Pont, and failure to follow safety rules is a basis for dismissal at most Company sites. A procedure for handling any employee who declines to work safely should be formulated at each site, and all members of supervision should be trained in this procedure.

Supervision

Unsafe acts of supervisors and members of management are generally those of omission, such as: setting poor examples, failure to perceive or identify unsafe practices, condoning or tolerating unsafe practices, failing to recognize process hazards, co-existing with prevailing standards in spite of poor safety experience, or failing to follow-up on reported deficiencies. The basic cause of the above acts generally is inadequate safety training and, to counteract these unsafe acts, training (particularly in safety observation) is needed, possibly using a course such as STOP. Each of the above types of unsafe acts reflects unfavorably on the safety administration at the site; little improvement in the safety-performance-of-wage-roll personnel can be expected without first correcting the unsafe acts of supervisors.

Management

In addition to the unsafe acts presented under Supervision, above, unsafe acts of management are:

1. Alteration of priorities concerning production, maintenance, and safety, without providing for (or being guided by) feedback from safety audits, incident reports, injury frequencies, or property losses.

2. Failure to be aware of serious deficiencies in major aspects of safety, such as process hazards reviews, fire protection, and industrial hygiene.

A basic cause for the above failures in safety administration would be inadequate training in the fundamentals of safety. Also, it is unlikely that the Central Safety Committee is fulfilling its responsibilities in setting standards and establishing policy, if deficient safety administration is not brought to the attention of the site manager and a correction program initiated.

BASIC CAUSES OF EMPLOYEE-CREATED UNSAFE CONDITIONS

Responsibility for an employee-created unsafe condition generally cannot be assigned to a particular individual -- the employee committing the unsafe act which resulted in the unsafe condition may have been working alone, or fellow employees observing the act may be reluctant to discuss details of the incident.

Of course, it is necessary to correct the unsafe condition promptly, but mere correction is unlikely to raise the standards of safety in the area. It is necessary, to prevent recurrence, to determine the basic cause, and then publicize (1) the number of unsafe conditions on a time (frequency) or area (density) basis, (2) the character of the deficiencies, (3) corrective measures applied, and (4) the basic causes. Safety meetings or bulletin boards are appropriate methods for publicizing these safety efforts.

Among the basic causes for employee-created unsafe conditions are those listed under Short-Cuts or Improvising or Non-Conformity, above. Again, as with unsafe acts, the unsafe condition should be viewed as a symptom, and it is essential to determine the basic cause to prevent recurrence.

Since many unsafe conditions can be regarded as "booby traps" to unwary employees, passersby, or subsequent users of equipment, employees may need to develop a better "brother's keeper" attitude while gaining job experience. That is, employees should become aware (through the feedback of safety audit findings) that their actions or failures to act may create hazards for other employees. Improvement in this aspect of safety depends to a great extent on the effectiveness of communications.

PROCEDURES FOR REDUCING UNSAFE PRACTICES

In order to reduce the frequency of unsafe acts and the number of employee-created unsafe conditions, it is necessary to observe and correct the symptom (act or condition) and then identify and correct the basic cause.

Observation Techniques

Frequent inspection of areas of responsibility is one of the acknowledged duties of supervisors and managers. These general inspections should include observations for any safety deficiencies and, periodically, an inspection primarily for safety should be planned. If the objective is to reduce the frequency of unsafe acts, these inspection tours should be directed toward studying employees at work, looking especially for evaporative unsafe acts. In order to accomplish this, coffee breaks, lunch periods, meeting times, and shift changes should be avoided (unless observations have indicated that these are periods of unusual hazard or stress). All portions of the area of responsibility should be included, particularly those areas where maintenance or housekeeping standards may be low because of access restrictions or personal-protective-equipment requirements.

A familiarity with general and area safety rules, and operating and maintenance procedures, is essential to a proper evaluation of the actions of employees, and the pertinent rules and procedures should be reviewed prior to audits and inspections. Similarly, familiarity with the process is essential to an evaluation of operating and control-room practices, to assure that alarms and interlocks have not been disabled or bypassed, that operating limits are not exceeded, and that sequential operations are being performed properly.

Periodic audits by management or by the safety office are useful in establishing uniformity of standards throughout a site and should be included as a part of the safety effort. However, the supervisor should not rely excessively on these outside audits to inform him of a need for greater safety effort in his area of responsibility.

It is not essential that all areas be covered at a particular frequency -- areas where few employees work or where there is little activity or equipment do not warrant the attention which should be given to areas of greater employee exposure to hazards. In contrast, however, special attention should be given to exposures to powered equipment, and special planning or scheduled re-visits may be needed to observe this equipment in use.

Special attention also should be given to non-routine jobs (such as clean-up of spills, excavation, rigging and lifting, and unplanned shut-downs) and routine infrequent work (such as vessel entry, equipment cleaning, acid-line breaks, work on powered equipment, jobs involving cumbersome protective equipment, and catalyst changes), to assure that proper procedures are being used. These observations also may be used to evaluate the adequacy of job line-up and work permits.

Two programs in use in the Company are directed toward improved observation of work practices. The Safety Training Observation Program (STOP) is recommended for all members of supervision, to improve their ability to detect unsafe work practices. Job-Cycle Checks are recommended for study of repetitive jobs where inadequate or incorrect procedures, or use of the hands or fingers instead of appropriate tools, could lead to repeated, unnecessary exposures to injury. A third program, based on STOP, has been developed by the Applied Technology Division for wage-roll employees, to improve their alertness to unsafe practices and conditions.

Special techniques have been developed to detect deficiencies or incorrect operating procedures in manufacturing processes, using check lists or other more-sophisticated methods. Refer to Safety Bulletin No. 505 "Guide for Process Hazards Reviews" for further details.

After-the-fact techniques for identifying unsafe practices are Injury and Serious Potential Incident investigations. The primary goal of these investigations should be to prevent recurrences by identifying the basic cause(s).

Some type of record should be kept concerning the type of each unsafe act or condition observed (and location), so that a frequency can be established. A ratio based on the total number of employees observed (Unsafe Acts Index, defined above) has been found to be useful in evaluating posture and trends; therefore a count or tally of employees observed (for at least 30 seconds each) should be kept for each observation tour.

Identification of the Basic Cause

An observation of an unsafe act should be accompanied by a discussion with the employee involved, in an attempt to determine the basic cause. When an unsafe act is seen at a distance, it may be necessary to initiate a more-or-less formal investigation to identify the employee involved, keeping in mind that the unsafe act is likely to recur (possibly resulting in injury) if corrective action is not taken. Several of the more-common causes for unsafe acts are described in Basic Causes of Unsafe Acts, above.

Correction of Basic Causes

Methods for correction of several causes of unsafe acts are discussed in Basic Causes for Unsafe Acts, above. Correction of a basic cause has more-lasting effects and has the least-detrimental effect on employee relations, as compared to disciplinary measures, and the latter method should be used only as a last resort for repetitive offenders.

* Developing, maintaining, and improving safety attitude or state of mind are important parts of each employee's work assignment. Accordingly, these subjects are appropriate for discussion during periodic performance appraisals. Several plants (such as Louisville) have well-formulated programs for wage-roll safety appraisals.

MEASUREMENT OF SAFETY POSTURE AND TRENDS

The frequency with which unsafe acts are observed can be used to determine the safety posture of a particular site, relative to several other plants in the Company, or the unfavorable trends in performance. The Unsafe Acts Index, which is a ratio of unsafe acts (weighted by factors of 1/3, 1, or 3, according to severity of exposure) to the total number of people observed at their assigned workplaces may be used for this purpose. It is important that the number of employees audited be sufficient to assure statistical validity of the results; a minimum of 25 employees (studied carefully) should be sufficient.

Figure 1 shows the relationship between Serious Injury Frequency (major plus sub-major injuries per million man-hours of exposure) and the frequency of unsafe acts as measured by the Unsafe Acts Index (the weighted percentage of employees observed committing unsafe acts). Similar relationships between unsafe acts and minor injuries have been observed at the Rochester Photo Products Plant and the Washington Works of the Plastics Department. Thus the Unsafe Acts Index may be used to estimate the future safety experience at a site.

The Company's current major injury frequency goal is 0.15 or less, at present, and the ratio of sub-major injuries to major injuries recently has been about 2.6, inferring a Serious Injury Frequency goal of 0.55. Thus an Index of 12%, although about average for many plants in the Company and corresponding to a Serious Injury Frequency of 2.00, indicates that additional safety effort is needed in reducing unsafe acts. An Index of 3% or less may be considered good or satisfactory, on the basis of present Company goals, and Indexes above 15% should be considered poor.

TECHNIQUES FOR SPECIAL-EMPHASIS AUDITS

A technique which has been used by Safety and Fire Protection survey engineers for special-emphasis surveys which concentrate on work practices is presented in Appendix A. Surveys of this type are warranted for plants having exemplary rules and procedures, process hazards reviews, fire protection facilities, and programs for inspections and tests; in such plants, more-sophisticated approaches (such as the one described in Appendix A) may be needed to detect areas where additional safety emphasis is warranted or needed.

Richard W. King

APPENDIX AEMPLOYEE WORK PRACTICES SPECIAL-EMPHASIS SURVEYIntroduction

For the purposes of this survey, presume that another survey engineer has preceded you (by less than an hour or so), and that he has thoroughly inspected the area for deficiencies in design, construction, maintenance, and other environmental hazards and has found none. The preceding engineer also has discussed the process, evaluated process controls and the hazard-review program, has surveyed for industrial hygiene deficiencies, and has found no problems. The safety organization was previously found to be good, as were safety programs and activities, rules and procedures, the inspection and test program, and all emergency preparedness aspects. Fire protection facilities have been evaluated, inspected, and tested, with satisfactory results, and all aspects of fire and explosion control were found to be good. Security also is good at this site.

The following aspects of safety remain to be evaluated:

1. Employee work practices -- which may be subdivided into
 - a. Unsafe acts, and
 - b. Employee-created unsafe conditions
2. Safety administration.

Preparation

The survey time, for day-shift observations, should be apportioned according to the number of wage-roll employees working on the day shift. If possible, prior to the survey, obtain from the Plant a listing of each of the operating and maintenance areas, together with an estimate of the number of wage-roll employees in each area. Typically, for around-the-clock operations, each area will have a "day group" equivalent in size to a shift crew, plus the four shift crews. Thus, for observations on the day shift, a survey engineer or auditor could not reasonably expect to audit more than 2/5 of the operating area's wage-roll personnel. However, 60% to 70% of the maintenance crews will work on the day shift (with about 10% on each shift); thus about 65% of these employees could be audited on the day shift. As a general guideline, observations should continue until the auditor has seen about 1/2 of the "available" personnel, or about 1/10 of the total wage-roll employees in a particular area or at a site.

Auditing Procedure

When entering a room, building, or operating area, immediately go to the area(s) where employees are working, and look for "evaporative" unsafe acts. Casually observe each employee to assure that he is wearing the proper protective equipment and to determine the safety of his actions. Consult with your escort, if necessary, to determine the type of work being done and the materials being used, to aid in your evaluation of work practices.

In areas where there appears to be no direct exposure to injury (as in control rooms), it may be advisable to question the operator regarding operating ranges, alarms, interlock systems or bypasses, analytical systems or sampling techniques, etc., to determine if his actions are safe or unsafe.

Unless an unsafe act is observed immediately, attempt to observe each employee for at least 30 seconds. It is not necessary that the 30-second period be continuous. If employees stop working or leave the area, these employees should not be counted as employees observed at work (but such actions may indicate lack of knowledge concerning how a job should be done safely). If there are other reactions to the presence of the auditors, attempt to investigate the cause(s) for the reactions, which may be correction of an unsafe act or an employee-created unsafe condition (such as an incomplete lock-out, for example).

If one or more unsafe acts are observed, evaluate your escort's response to the observation; in particular, whether his response may be expected to lower, maintain, or improve the standards of safety performance in his area (by ignoring, merely correcting, or determining the basic cause of the unsafe act, respectively). If the escort does not consider that the alleged unsafe act is unsafe, try to resolve the difference in opinion by brief discussion.

The examples set by your escort(s) also should be evaluated. This should include proper use of protective equipment, stairs, walkways, and vehicles; following proper procedures regarding entry to operating or barricaded areas; and responses to unsafe acts or conditions encountered during the survey.

Area Inspection

After the actions of employees have been evaluated, an inspection of the area and facilities should be made, to determine the number and character of any employee-created unsafe conditions which may be present. The following aspects should be included: orderliness, proper use of lock-out and vessel-entry procedures, chocking of trucks and rail cars, identification of containers, maintenance and inspection standards, any bypassing of interlocks or removal of guards, failure to correct unsafe environmental or industrial-hygiene conditions or other deficiencies, etc.

Evaluation

Unsafe acts and employee-created unsafe conditions are indicators of attitude and knowledge (and/or training). The frequency of unsafe acts also is an indicator of direct exposure to injury.

Deficiencies in work practices can be categorized as follows:

- a. Operations or maintenance
- b. Day shift or evening shifts
- c. Different operating areas
- d. Management, supervisory, or wage-roll
- e. Rule violations or failure to use good judgement.

Frequencies of work-practice deficiencies can best be measured by dividing the number of unsafe acts (weighted according to seriousness) by the number of

employees observed at work, and by dividing the number of employee-created unsafe conditions by the number of employees in the appropriate area. An accurate count of employees is essential. For unsafe acts, a frequency of 15% or more should be considered poor, about 10% is average or fair, and less than 5% is satisfactory. For employee-created unsafe conditions, more than 20 per 100 employees is poor, 10 per 100 is about average or fair, and fewer than 5 per 100 is good. Using these standards, it generally is possible to quantitatively evaluate the performance of different operating areas, shifts, or plants.

The graph (Figure 1) which correlates Serious Injury Frequency and Unsafe Acts Index may aid in demonstrating these relationships and values to members of management and supervision. The line through each point indicates the statistical validity of each point, by showing the effect of one more and one less serious injury on the Serious Injury Frequency. (The horizontal and vertical scales correspond to the equation $N=5\sqrt{UAI}$ and $N=5\sqrt{SIF}$, where N is the number of 1/4-inch divisions.)

The Serious-Injury-Frequency graph shows rather poor correlation for those sites which have incurred no major or sub-major injuries; that is, unsafe acts are observed even though no serious injuries are experienced. The contrary behavior has been observed where the vertical scale is Minor Injury Frequency; that is, minor injuries occur even though no unsafe acts are observed by auditors. Thus it might be expected that a graph incorporating major, sub-major, and minor injuries might yield a better correlation. Figure 2 was constructed in attempting a better correlation and is a plot of OSHA Recordable Injury Rate (approximately equivalent to Recordable Injuries per 200,000 man-hours of exposure) versus Unsafe Acts Index. The data suggests that there may be considerable differences in definition of OSHA Recordable Injuries; when this is resolved, the correlation may be improved.

An unsafe act generally reflects unfavorably on the safety attitude of the employee committing the act. However, if the employee commits the act because of inadequate knowledge or training, or because the act has been condoned in the past, the responsibility for the act may be assigned to supervision or management. Examples of management-condoned acts would be use of assembly presses without adequate guards, exposure to materials of known (or unknown) toxicity, failure to alter electrical equipment to conform to the proper electrical classification of an area, or permitting operation with inadequate procedures or fire protection. Examples of supervision-condoned acts would be permitting vessel entry or welding without completion of the appropriate permit, permitting continued operation under alarm conditions, permitting operation with interlocks bypassed, and failing to require employees to wear the appropriate protective equipment. Sufficient information should be obtained, when an unsafe act or condition is observed, to determine the level of responsibility for the act or condition.

Failure to perform inspections and tests properly should be considered an employee-created unsafe condition, and the appropriate area of responsibility should be determined.

Safety Administration

From the observations of work practices, an evaluation of safety administration can be made. This would include (1) management interest in work practices as expressed by audits of practices and audits of inspection reports, (2) awareness of

problem areas regarding rules, procedures, practices and facilities, (3) personal examples set by management and supervision (on and off the job), (4) corrective actions taken and ultimate effects of such actions, and (5) the response of management and supervision to programs and activities. Trends in performance in the various categories of safety and fire protection also reflect on the adequacy and effectiveness of safety administration.