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TECHNICAL APPENDIX TO
A NATIONWIDE SURVEY OF THE
OCCUPATIONAL SAFETY AND HEALTH WORK FORCE

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SECTION I

INTRODUCTION

A. SCOPE OF THE TECHNICAL APPENDIX

This Technical Appendix is a supplement to the Nationwide Survey of the Occupational Safety and Health Work Force. Its purpose is to detail the approach, assumptions, and limitations of the survey and to document the methodologies used in the collection, classification, and analysis of the survey data. Herein, the reliability of the survey data is examined, the estimation and forecasting techniques are detailed, and avenues for further research are explored.

Section I presents a brief history of the project. In Section II, the survey methodology is reviewed, focussing on the sample selection, contact strategy, and survey instruments. Section III details the development of the job classification scheme used to partition the survey results. In Section IV, the methodology for estimating the size of the current occupational safety and health work force is presented along with a discussion of the limitations of the data. The forecasting model is explained in Section V by specifying the mechanics of the alternative futures concept, the attrition scheme, and the computation of new hires.

B. HISTORY OF THE PROJECT

In passing the Occupational Safety and Health Act of 1970, Congress recognized the importance of making provisions for skilled occupational safety and health personnel to implement the Act as expeditiously and efficiently as possible. Government standards and inspection schedules, established as a result of the Act, created pressure in both the public and private economic sectors to employ more occupational safety and health specialists. The potential impact on demand for these types of personnel generated concern that a manpower deficit might now exist or soon develop. Various estimates of that potential shortage have been made by public and private officials. These published shortage estimates have been widely divergent. The results of two such presentations are presented on Table 1.

In anticipation of such diverse estimates and with regard to the inherent difficulty that such a wide variation would generate for planning, NIOSH decided in 1971 to investigate the feasibility of undertaking a nationwide survey

personnel. To that end, NIOSH awarded John Short & Associates, Inc., a contract in 1973 to prepare the "Feasibility Study Concerning the Nationwide Occupational Safety and Health Manpower Survey. (HEW Publication No. (NIOSH) 75-138). The Feasibility Study was completed in 1974, published in February 1975, and given wide circulation to gain input on its findings and recommendations.

Table 1: Reported shortages of occupational safety and health personnel.

Position Title	Seagle*	Ashford/Lynch**
Safety Professionals (Specialist)	5,000 to 10,000	18,400
Industrial Hygienist	1,000	5,000
Occupational Nurse	10,000	8,400
Occupational Physician	3,000	4,200

* E.F. Seagle, "Manpower for Occupational Safety and Health", Occupational Health Nursing, Vol. 2, 1972.

** Nicholes A. Ashford, "Manpower Requirements", Presented at the Conference on Environmental Disease and Nutrition Health Policy, August 7, 1975. (J. Lynch of NIOSH was listed as author of the manpower data).

The principal findings of the Feasibility Study were that:

- Data could be collected via telephone and by in-person survey instrument on:

  1. the incidence of occupational safety and health-related personnel in an organization (areas of emphasis, primary activities, amount of time spent on the activity);

  2. the characteristics of the job role filled by occupational safety and health personnel;

  3. the employee characteristics (age, education, prior experience);

  4. the characteristics (training activities, safety committee, inspection activity) of the respondent's safety and health program.

- A sample capable of generating statistically valid inferences to the national work force would require 3,454 interviews stratified among eight Standard Industrial Classifications (SIC) and two firm sizes (100-499 employees and 500 or more employees).

- A refined job classification system which was both exhaustive and computerized would be required. The initial survey, done in conjunction with the Feasibility Study, generated 124 job titles in 328 interviews. Significant debate between professional societies, project staff, and NIOSH over an appropriate job classification system capable of clustering the 127 job titles into analogous groups precluded finding an appropriate system.

- The following four specific survey instruments would have to be refined:

  1. An Organization Questionnaire, to be completed by an organization's safety director or other upper level management, would focus on the existing employment level, nature and frequency of occupational safety and health training, injury and illness rates (OSHA 102 responses), occupational safety and health inspection activity, and the number and title of occupational safety and health job roles currently employed in the organization.

  2. A Job Role Questionnaire, which would be completed by the individual responsible for the Organization Questionnaire, would solicit information regarding the roles (activities) and responsibilities of individuals in a particular position. One form would be completed for each job role (or title) in a given firm.

  3. An Employee Characteristics Questionnaire, to be completed by clerical or other appropriate staff, which would gain data regarding the demographic characteristics of individual occupational safety and health employees.

  4. An Insurance Carrier Questionnaire which would address the unique status of loss prevention and control carriers to acquire data comparable to the responses of organizations in other industries.

- An appropriate manpower forecasting model based on the Bureau of Labor Statistics long-range forecasting methodology was recommended. The model would acquire calibration by the national survey and would generate short- and long-run forecasts of occupational safety and health manpower requirements. Comparing the forecasts with supply projections would yield estimates of manpower shortages and surpluses by occupation and industry.

As a result of the numerous suggestions and recommendations generated by the publication of the Feasibility Study, NIOSH issued a contract to John Short & Associates, Inc., in January 1976 to formalize a Data Collection Plan for the anticipated nationwide survey. The purpose of the Plan was to:

- finalize the four survey instruments;
- prepare a "Supporting Statement" for Office of Management and Budget (OMB) clearance for the survey instruments;
- pretest the Insurance Carrier Questionnaire among nine insurance companies;
- pretest a revised contact strategy which relied on telephone contact, mail-out/mail-in survey with telephone and personal interview follow-up where necessary;

- revise the Job Classification System, relying on a computerized clustering format based on the description of area of responsibility and activities assigned;

- complete the necessary computer software, including test programs necessary to tabulate, cluster, and analyze the data; and,

- develop periodic updating mechanisms for modifying future survey plans and instruments and calibrating the manpower forecasting model to reflect future demand.

The Data Collection Plan was completed and presented to NIOSH in May 1976. NIOSH submitted the Plan and Supporting Statement to OMB and, having received clearance, issued the current contract to implement the nationwide survey in accordance with the Data Collection Plan to John Short & Associates, Inc., in September 1976.

SECTION II

DATA COLLECTION METHODOLOGY

A. INTRODUCTION

The data collection methodology used in the Nationwide Survey of the Occupational Safety and Health Work Force was the product of extensive development and testing during the Feasibility Study and Data Collection Plan efforts. These prior studies resulted in the specification of the:

- sample size and selection criteria;
- contact strategy; and,
- the survey instruments.

This section of the Technical Appendix discusses the data collection methodology, focussing on each of the above points.

As reported in the Feasibility Study, the relevant universe of work places included all firms employing 100 or more in mining, construction, manufacturing and transportation, communication and utilities, and non-occupational safety and health-related state and local government. The firms employing less than 100 (or less than 500 in the trades, services, and non-occupational safety and health-related state and local government) were excluded due to the extremely low incidence of occupational safety and health personnel found in the smaller organizations by the Feasibility Study survey. The incidence of persons spending 20 percent or more of their time in occupational safety and health-related activities was so low in these organizations (less than .2 per firm) that the acquisition of extensive, statistically valid data would become extremely expensive. Furthermore, none of the individuals initially contacted in these small firms spent more than 50 percent of their time on occupational safety and health-related activities (see the Feasibility Study pages 44-45 for additional discussion on this point).

B. SAMPLE SIZE AND SELECTION CRITERIA

The Feasibility Study, based on the initial pilot survey of 274 firms, proposed a national survey matrix containing a universe of 53,233 firms and organizations stratified by 8 Standard Industrial Classifications (SIC) and 2 firm size categories (see Table 2). Based on the sample parameters generated from the pilot survey, a national sample of 3,454 reporting units, as distributed in Table 2, was recommended.

Table 2: Proposed national survey matrix indicating universe of reporting units, optimal sample sizes and sampling ratios.

Industry Sectors	Employee Size		
	100-499	500+	Total
Mining			
Universe	880	152	1,032
Proposed Sample	41	12	53
Sampling Ratio (%)	4.7%	7.9%	5.1%
Construction			
Universe	3,678	196	3,874
Proposed Sample	171	13	184
Sampling Ratio (%)	4.6%	6.6%	4.7%
Manufacturing			
Universe	29,812	5,857	35,669
Proposed Sample	2,357	179	2,536
Sampling Ratio (%)	7.9%	3.1%	7.1%
Trans., Comm. and Utilities			
Universe	4,405	863	5,268
Proposed Sample	287	105	392
Sampling Ratio (%)	6.5%	12.2%	7.4%
Trades, Services & Non-OSH Government			
Universe	0	7,306	7,306
Proposed Sample	0	205	205
Sampling Ratio (%)	-	2.8%.	2.8%
Insurance			
Universe	Est. 24*		24
Proposed Sample	24		24
Sampling Ratio (%)	100.0%		100.0%
State Government - OSH-Related			
Universe	50**		50
Proposed Sample	50		50
Sampling Ratio (%)	100.0%		100.0%
Federal Government			
Universe	Est. 10		10
Proposed Sample	10		10
Sampling Ratio (%)	100.0%		100.0%
Total Firms and Organizations			
Universe			53,233
Proposed Sample			3,454

* This would represent virtually all large loss-prevention carriers in the country.

** Based on interviewing the 50 State Industrial Commissions throughout the country.

Source: Feasibility Study

The sample of private sector firms was selected from Dun & Bradstreet's Marketing Service Division database, which is a continually updated file of businesses within the United States. Dun & Bradstreet estimated that this source containes 95-99 percent of the universe of firms in the mining, construction, manufacturing, and trades and services categories for employee size 100 and above. This source also contains 70-80 percent of the U. S. firms associated with transportation, communication and utilities.

Dun & Bradstreet, Inc., agreed to provide a systematic sample of organizations, including alternates, for each cell in the matrix at a minimal cost as part of a subcontract which included using Dun & Bradstreet personnel for a majority of the telephone interviews (see subsection C below). An advantage of this sample source was that telephone numbers, names of chief executives, and the names and addresses of parent companies were included with the sample.

The sampling matrix also specified inclusion of 24 worker's compensation insurance carriers. A.M. Best & Company, of New Jersey, publisher of lists of insurance companies by underwriting experience, supplied the Contractor with data from the publication Best's Aggregates and Averages. All companies writing or specializing in worker's compensation with net premiums written in excess of $25,000,000 were considered for the survey.

Last, the matrix specified that 60 occupational safety and health-related federal and state government agencies or departments be included in the survey. Two publications by the U. S. Department of Labor, Occupational Safety and Health Administration, entitled Directory of Field Locations and the Occupational Safety and Health Directory (NIOSH publication 77-162) list all state and local agencies responsible for their own occupational safety and health programs. Also, there are nine regional offices of the Occupational Safety and Health Administration charged with responsibility for the thirty states that do not have responsibility for their own programs. After discussions with NIOSH and OSHA, a sample of 23 state agencies was selected randomly from the Occupational Safety and Health Directory. In addition, eight federal agencies containing the vast majority of occupational safety and health personnel were included in the survey. The selected agencies were:

- Occupational Safety and Health Administration;
- National Institute for Occupational Safety and Health;
- U. S. Postal Service;
- Environmental Protection Agency;
- Tennessee Valley Authority;
- Mining Enforcement and Safety Administration;
- Department of Defense;
- Energy Research and Development Administration.

Data on federally employed occupational safety and health personnel were also solicited from the U.S. Civil Service Commission to supplement the above primary data collection effort.

Having completed the sample selection process, the actual survey activity was undertaken jointly by John Short & Associates, Inc., and its subcontractor Dun & Bradstreet. John Shrot & Associates, Inc., was responsible for interviewing all insurance carriers, government agencies, and approximately 30 private firms.

Dun & Bradstreet's Marketing Service Division provided telephone interviews and data processing support for the remaining interviews. A three day training course was provided by John Short & Associates, Inc., staff for Dun & Bradstreet's interviewer team. In addition, John Short & Associates, Inc., monitored Dun & Bradstreet's progress throughout the survey period, furnishing technical assistance and resolving problem issues when they arose. Central to the success of the survey effort was the contact strategy (described below) which had been developed and tested during the pilot survey (see the Feasibility Study report and the Data Collection Plan development).

C. CONTACT STRATEGY

The difficulties encountered during the Feasibility Study in obtaining demographic characteristics of occupational safety and health personnel in large firms resulted in the recommendation that it would be necessary to conduct personal interviews in these firms for the national survey. However, during the development of the Data Collection Plan, the pretest of a questionnaire consisting of a single form which could be completed by clerical personnel proved to be sufficient for obtaining individual demographic data. Based on the findings that large firms had completed the questionnaires without the necessity of a personal interview, a revised contact strategy was implemented which utilized a mail-out survey (with enclosed pre-addressed, stamped, return envelopes) and an appropriate telephone follow-up for both large and small firms.

Specifically, the following procedures were utilized for the nationwide survey:

1. Trained telephone operators (employed by Dun & Bradstreet) were given contact sheets obtained from sampling procedures similar to those specified in the Feasibility Study. These sheets contained the name, location, size, and SIC code of the organization to be contacted, with an alternate sheet to be used in the case of non-respondents. Telephone workers were also given several days of instructions concerning the purpose of the survey, the meaning and intent of the questionnaires in general, and each questionnaire item in specific.

2. Telephone workers, upon receiving the telephone number of each firm to be contacted, telephoned each firm in an effort to:

   - establish that the employment size and SIC code met the matrix specification;
   - identify the name and title of the individual most responsible for the safety and health activities at the organization;
   - verify the exact address; and,
   - explain briefly the nature and purpose of the survey, and indicate that the survey instruments and a definitive letter would be mailed to the participants.

3. Each individual identified above as most responsible for safety and health activities was mailed an introductory letter stating the purpose of the survey and soliciting cooperation (see Exhibit 1). Enclosed were the survey questionnaires and a prestamped, return-envelope.

4. A follow-up telephone call was made after sufficient time had elapsed (one or two weeks) to ensure that the responsible individual had received the correspondence.

5. Whenever it became necessary to acquire more complete cooperation, mail and telephone contacts were made with supervisors, parent company representatives, etc., to acquire approval for completing the instruments.

6. If questionnaires were not returned by mail, further follow-up telephone calls were made (up to three per firm). In firms employing only a minimal number of occupational safety and health personnel, it was possible to complete the questionnaires by telephone interviews. In fact, telephone callers were prepared at any time during the process described above to complete the forms by telephone if the respondent so desired or if it appeared advantageous to do so.

7. If firms did not wish to cooperate in completing all forms, the telephone caller attempted to gain as much information as possible by telephone. At a minimum, the interviewer tried to verify the size and SIC of the firm and to ask for total number of occupational safety and health personnel.

The essence of the contact strategy centered on acquiring a formidable set of responses from each firm at a minimum of cost. Hence, the survey instruments were designed to permit the respondent to complete the instrument with a minimum of assistance from the interviewer.

D. THE SURVEY INSTRUMENTS

The survey instruments evolved into their present configurations from information generated by the pilot survey and the Data Collection Plan. The core form— the Organization Questionnaire (see Exhibit 2) was sent to those individuals identified during the initial telephone contact as the person most responsible for the safety and health activities at the responding organization (such as a safety director, plant manager, or personnel director). The definition of an "organization" specified that it included the responding individual's administrative unit and all personnel reporting to that unit. Generally, this included all personnel within a specific area who were directly or indirectly engaged in the responding organization's production and/or services. It was further stipulated that if the respondent's administrative unit was part of a larger organization or parent company, those offices not directly under the supervision of the respondents were requested to provide information solely concerning the occupational safety and health personnel and programs under their immediate control.

The Organization Questionnaire contained questions regarding:

- the major activity (SIC) and current total and production employment levels;
- the organization's training activities, sources of occupational safety and health assistance and the presence of a safety committee;
- presence and impact of occupational safety and health-related inspection activities;
- OSHA Form 102 data for the past reporting year or, if a mining company, requests for similar data (since mining companies are not under OSHA's jurisdiction);
- estimates of the amount of work time spent on occupational safety and health-related activities by the person with major responsibility for the organization's occupation safety and health program and whether or not there were additional employees who specialized (spend more than 50% of their work time) in the treatment or prevention of occupational injuries, illness or fire;
- a list of the job titles and the number of occupational safety and health personnel who were identified in the above question (this question served as a trigger question, in that a Job Role Questionnaire - see Exhibit 3 was required for each job role -or title- listed, and an Employee Characteristics Questionnaire see Exhibit 4 was required for each employee identified under each reported job title);
- the need for any additional occupational safety and health roles not listed in the response to the above question. This was to identify the organization's demand for new job titles (e.g., hiring the firm's first industrial hygienist). If prospective job titles were listed, then a Job Role Questionnaire was requested for each of those listed job titles.

To minimize confusion, the Job Role Questionnaire was printed on tan paper to distinguish it from the white Organization Questionnaire. For each job title specified on the Organization Questionnaire, responses were solicited via the Job Role Questionnaire on the following areas:

- job title - to cross-reference with the Organization Questionnaire;
- distribution of time spent on occupational safety and health activities between the following four basic areas:

  prevention or treatment of occupational injury,
  prevention or treatment of occupational illness due to radiation,
  prevention or treatment of occupational illness due to other causes,
  prevention of fire;

- selection, from a list of 27, of at most five occupational safety and health-related activities that best describe the job;
- demand for additional personnel to fill existing or proposed vacancies at that organization;
- education, certification, and experience requirements currently being used to screen candidates for any existing or potential vacancy;
- minimum salary offered and current method of advertising used in conjunction with any existing or potential vacancies for this job role.

Again, the function of the Job Role Questionnaire was to solicit information concerning the actual positions held by various occupational safety and health personnel in the responding organization. Data concerning the employees themselves were requested on the third form, the Employee Characteristic Questionnaire (color coded yellow). Items requested on the Employee Characteristics Questionnaire included:

- job title - given to cross-reference the response with both the Organization and Job Role forms;
- employee characteristics:

  Age;
  Years on job;
  Prior experience;
  Education;
  License or certification (by type);
  Related academic degree.

A detailed description of the origin and rationale for each of the survey instruments used in the nationwide survey can be found in the Feasibility Study and the Data Collection Plan. Readers interested in a more in-depth discussion, containing the development of the questionnaires and the subsequent testing process, are referred to those documents.

SECTION III

JOB CLASSIFICATION SYSTEM

A. INTRODUCTION

An overview of the design and operation of the job classification system is presented in the text of the report (see pages 3-6). As indicated there, the development of a job role classification scheme was motivated by the apparently inconsistent and arbitrary array of professional and technical occupational safety and health job titles currently existing throughout industry and government. This point was underscored during the Feasibility Study survey when 124 different occupational safety and health titles were identified for the 328 safety and health employees contacted (Exhibit 5 lists these titles).

This section of the Technical Appendix begins by reviewing the development of the classification system and by citing several alternative sets of classification criteria which were investigated during its evolvement. The statistical basis of the classification system is then presented along with an analysis of the performance and validity of the system. Note, that since the classification of job roles into basic areas of responsibility is clearly defined in the text (see page 4), this section centers only on the classification of job roles into position levels.

B. DEVELOPMENT OF THE JOB CLASSIFICATION SYSTEM

The results of the Feasibility Study indicated that many types of employees with wide-ranging backgrounds and education levels undertook diverse job roles in the safety and health field. The development of a classification scheme which would create some order out of the apparent chaos associated with the newly emerging and rapidly expanding occupational safety and health field was a major challenge to the study. In exploring potential avenues of job role taxonomy, several sets of classification criteria were investigated. The initial attempts focussed on apriori models; apriori in the sense that the classification standards represented criteria which professional employment position classifiers determined as necessary to define a particular job class. This normative specification of the job role classes describes what the occupational structure of the target work force should ideally be. Unfortunately, application of the apriori classification criteria to the survey responses resulted in a very large percentage of the job roles which could not be placed into an appropriate category, and which were subsequently labelled as "unclassified". Since the estimated future demand for unclassified personnel is of little value for planning purposes, a statistically generated clustering scheme was therefore derived which identified the "observed" occupational structure of the safety and health work force.

The success of any taxonomy scheme is constrained by the nature of the input data; in this case, the classification criteria are bound by the available question sets in the Job Role Questionnaire (see Exhibit 3). Figure 1 is a replication, from that instrument, of the 27 occupational safety and health-related activities, the patterns of response to which serve as the primary classification criteria for the various schemes investigated during the study. Two apriori schemes were initially tested and are described below.

1. Apriori Task Analysis

The Data Collection Plan details the rationale of a classification scheme designed jointly by Ms. Minerva Math of NIOSH and by the Contractor's staff. The scheme was developed to reflect the pattern of activities expected to be performed by various levels of personnel. Its authors did not have the advantage of extensive empirical task analyses which would indicate the frequency of tasks actually being performed by occupational safety and health personnel. Table 3 lists the position titles and the required activities as outlined by this classification scheme. (Numbers correspond to the activity list in Figure 1). Note that no other requirements are used in this scheme.

Table 3: Job role classification criteria (Apriori Task Analysis).

Job Title	Required Occupational Safety and Health Activities	Other Requirements
Director/Manager	22 and 23 and either 10 or 24	None
Professional I	at least 5 of the following consisting of between 3 and 5 of: 1,4,8,9, 10,20,21,22, and between 0 and 2 of: 3,5,13	None
Professional II	at least 5 of the following consisting of between 3 and 5 of: 3,5,7,11, 12,13 and between 0 and 2 of: 2,6, 14,15,16	None
Technician	at least 5 of the following consisting of between 2 and 3 of: 17,18,19 and between 2 and 3 of: 2,6,14,15, 16,27	None
Physician	25	None
Nurse	26	None

Table 3 suggests that to be classified as a director/manager, that job role's activities must include (from Figure 1):

Figure 1 : Occupational safety and health-related activities included in the job role questionnaire.

Here is a list of occupational safety and health-related activities. Please read through it and choose at most the five that best describe this job. Do not mark minor activities.

( ) 1. Inspects work place to identify existing or potential hazards

( ) 2. Performs tests or measurements

( ) 3. Analyzes results of tests or measurements

( ) 4. Analyzes proposed plans or specifications to identify potential hazards

( ) 5. Investigates to determine cause of illness, injury or fire

( ) 6. Prescribes personal protective equipment

( ) 7. Develops operating procedures to eliminate or control hazards

( ) 8. Designs protective or other equipment

( ) 9. Recommends and/or conducts research related to identification, prevention or control of hazards

( ) 10. Advises top level management

( ) 11. Directs fire fighting

( ) 12. Directs evacuation procedures

( ) 13. Prepares occupational safety and health instructional material

( ) 14. Provides education and training to employees through personal contact

( ) 15. Provides education and training to employees through personal contact

( ) 16. Provides education and training to employees by other means (bulletins, posters, memos)

( ) 17. Inspects equipment for compliance with established OSHA regulations and standards

( ) 18. Maintains and repairs equipment

( ) 19. Adapts or modifies existing equipment to meet a specified requirement

( ) 20. Attends professional meetings and reviews pertinent scientific findings and studies to determine significance to organization

( ) 21. Interprets current occupational safety and health laws, regulations and standards in terms of the impact on organization and the action necessary to assure compliance

( ) 22. Plans and develops programs in the area of occupational safety and health

( ) 23. Administrates (directs, manages)

( ) 24. Supervises three or more occupational safety and health personnel

( ) 25. Practices medicine

( ) 26. Practices nursing

( ) 27. Gives first aid

(22) plans and develops programs in the area of occupational safety and health;

(23) administrates (directs, manages); and either

(10) advises top level management; or,

(24) supervises three or more occupational safety and health personnel.

The two "professional" classifications and the technician level positions are a bit more complicated to classify with respect to their activity criteria, but the procedure is similar. Unfortunately, in applying these suggested patterns to the actual responses recorded in the Job Role Questionnaires, over 80 percent of the job roles did not fall into a defined job level category. Obviously, this particular set of apriori classifiers fails to detect any relevant structure in the occupational safety and health work force.

2. Texas A & M Criteria

The Texas A & M Department of Industrial Engineering, Division of Industrial Hygiene and Safety Engineering, in a Technical Report to NIOSH*, suggested a number of qualifications for various levels of occupational safety and health positions. Since the actual requirements for that study differed somewhat from information collected in the nationwide survey, an approximation of their criteria was attempted. Table 4 is an interpretation of the Texas A & M criteria for six specific job positions**

Table 4: Job role classification criteria (Texas A & M).

Title	Required Activities	Other Requirements
Administrator	Does 24 Cannot do 25,26	Certified; at least a B.S.degree; more than 2 years experience.
Professional	Cannot do 24,25,26	Certified; at least a B.S.degree; more than 2 years experience.
Professional in Training	Cannot do 24,25,26	Cannot be certified; at least a B.S.degree; more than 2 years experience.
Technician	Cannot do 24,25,26	Cannot be certified; must have either some college or technical school or at least 2 years experience.
Nurse	26	None
Physician	25	None

* Ralph J. Vernon, et. al. Results of a Task Analysis of Selected Occupational Safety and Health Professions: Industrial Hygiene and Safety Professional, Submitted to Division of Training, National Institute for Occupational Safety and Health.

** It should be emphasized that these interpretations are solely those of the Contractor.

As indicated in Table 4, instead of being dependent upon the job role activities, the Texas A & M model is based on the minimum employment requirements of certification, education, and related experience. Administrators must be certified, have at least a B.S. degree and more than 2 years experience, and supervise three or more occupational safety and health personnel. Professionals are bound by identical employment minimums but cannot administrate occupational safety and health personnel. Professionals in training are merely professionals without certification. Technicians also are not certified; they need either some college/technical education or experience.

In terms of percentages classified, the Texas A & M scheme was considerably more successful than the Apriori Task Analysis, classifying almost 60 percent of the job roles. Technicians were most frequently identified (27.9%), followed by professionals in training (15.6%), nurses (7.5%), professionals (4.6%), physicians (2.7%), and administrators (1.4%). Intuitively, this hierarachy of job levels appears to be realistic.

Again, both sets of classification criteria reflect the behavior and/or characteristics perceived as necessary to qualify a worker for a given job level or position title. The classification scheme developed for the nationwide survey approached the taxonomy from the opposite direction. As described in the following section, the classification system was predicated on the hypothesis that job roles could be clustered into a subset of job classes as determined by the observed relationship between the various occupational safety and health-related activities. Comparing this to the previous schemes, its results indicate the observed occupational structure of the safety and health work force as opposed to the structure expected by the various professional societies and classification experts. Any gaps between the two could be used to direct the upgrading or restructuring of the current occupational safety and health work force.

C. STATISTICAL DERIVATION OF THE JOB CLASSIFICATION SYSTEM.

Given the relatively low rate of success of classifying job roles via apriori criteria, the classification challenge was re-directed toward identifying relationships and patterns of responses generated from survey results themselves. The motivating hypothesis was that definitive combinations of occupational safety and health-related activities which could be empirically detected within the data base were capable of partitioning a high percentage of the job roles into distinct occupational positions or levels. In other words, it was presumed that statistically generated clusters of occupational safety and health-related activities could be used as criteria to specify a manageable array of job classes.

The clustering mechanism was based on the conditional probabilities of responding to each of the occupational safety and health-related activities listed in Figure 1. Specifically, an estimate of $p(x|y)$ was computed for each pair of activities (x,y) from all sets of responses. Then, given β such that $0 \leq \beta \leq 1$, a pair of activities was considered mutually dependent at the level β if, and only if, $p(x|y) \geq \beta$ and $p(y|x) \geq \beta$.

Thus, given a pair of activities (x,y) which are mutually dependent at level β, we may predict the presence of each (in a typical set of responses) from knowledge of the other with at least the probability β. The higher the value of β, the more reliable is the prediction and the more representative each is of the other.

A cluster of activities is defined to exist at level β if, and only if, each pair of elements within that grouping is mutually dependent at level β. A varying number of clusters will surface given any arbitrarily chosen threshold of β. For example, at β=1, 27 clusters are expected to emerge from the survey data base where each cluster is defined as an individual occupational safety and health-related activity. At the other extreme, when β=0, only a single cluster will exist, consisting of all 27 activities. However, the cluster will be poorly represented by any single activity. It follows then that selection of the optimal β threshold requires an assessment of the trade-off between relatively many clusters with very specific activities, and a lesser number of clusters which possess a more generalized activity profile.

In the same frame of reference, there is also a trade-off between the number of job roles classified, and the level of β threshold. By lowering the β value, a greater number of activity patterns will become attached to the various clusters, thereby permiting a wider variety of job roles to be classified. But, again, as the β value is lower, the definitional boundaries of the clusters become less specific.

The optimal situation, then, is one which identifies the maximum β which generates a small number of well-defined clusters capable of classifying a high percentage of the job roles. To resolve this, it was specified that between 5 to 8 job clusters which classified approximately 90 percent of the job roles would provide an acceptible classification scheme. In a series of trial and error tests in which the β value was incremented and subsequent cluster formations identified, the value of β=.24 generated the cluster structure used for the survey. Table 5 (as replicated from the text), lists the activities assigned to each job classification.

Note that the occupational positions of physician and nurse were not derived from the classification system, but were identified as those job roles which indicated: (25) practices medicine, and (26) practices nursing, respectively.

It is obvious from the job cluster criteria in Table 5 that the individual clusters do not have mutually exclusive activity sets assigned to them. Furthermore, respondents were allowed to indicate up to five activities to define a particular job role, although only two such activities are required for classification in four of the six clusters. Both situations are resolved by a tie-breaking mechanism, again using the observed condition probabilities between activity combinations. To illustrate, suppose that the activities reported on a particular Job Role Questionnaire are (1, 4, 7, 17). Notice that the given observation has activities 1 and 17 in common with the "inspects, interprets, investigates, and plans" job cluster, and activities 4 and 7 in common with the "analyzes plans and develops procedures" cluster. A decision must be made as to which cluster the observation should be placed. The decision algorithm designed to break this tie essentially answers the following question:

Table 5: Job cluster titles by key words and occupational safety and health-related activities.

Job Cluster Titles	Occupational Safety and Health-Related Activities Taken From Job Role Questionnaire
Administrates, Advises and Interprets	(10) Advises top level management (20) Attends professional meetings and reviews pertinent scientific findings and studies to determine significance to organization (21) Interprets current OSH laws, regulations and standards in terms of the impact on organization and the action necessary to assure compliance (22) Plans and develops programs in the area of occupational safety and health (23) Administrates (directs, manages)
Inspects, Interprets Investigates, and Plans	(1) Inspects work place to identify existing or potential hazards (5) Investigates to determine cause of illness, injury or fire (10) Advises top level management (14) Provides education and training to employees by conducting training sessions (17) Inspects equipment for compliance with established OSHA regulations and standards (21) Interprets current OSH laws, regulations and standards in terms of the impact on organization and the action necessary to assure compliance (22) Plans and develops programs in the area of occupational safety and health
Analyzes Plans and Develops Procedures	(4) Analyzes proposed plans or specifications to identify potential hazards (7) Develops operating procedures to eliminate or control hazards
Provides Training	(15) Provides education and training to employees through personal contact (16) Provides education and training to employees by other means (bulletins, posters, memos)
Performs Tests and Analyzes	(2) Performs tests and measurements (3) Analyzes results of tests or measurements
Maintains and Repairs Equipment	(18) Maintains and repairs equipment (19) Adapts or modifies existing equipment to meet a specified need
Physician	(25) Practices medicine
Nurse	(26) Practices nursing

Source: Job classification results.

Which of the following is more likely?

- each job role which engages in activities 4 and 7 also engages in activities 1 and 17; or,

- each job role which engages in activities 1 and 17 also engages in activities 4 and 7.

It is, in fact, more likely that job roles which do 4 and 7, also do 1 and 17 (based on knowledge of the entire sample). Thus, the observation is classified under the "analyzes plans and develops procedures" cluster. In practice, the actual choice may be between more than two classes, but the decision process is the same: the decision will always go to the class whose attributes best explain the particular observation.

In a number of cases, a decision could not be made, and the respondent was placed in the "unclassified" position. Those not classified are then truly straddled between two job levels, (e.g., administrator and technician). Relaxing the conditional probability threshold would allow more of the unclassified job roles to be placed; however, the definitional characteritics of the job levels would also be broadened. Note that a majority of the unclassifieds were not due to unbreakable ties, but rather to the fact that the respondent selected only one or two activities and therefore did not provide sufficient information upon which to match the response with a cluster. Of the 4652 job roles submitted, 12.3 percent were not classifiable.

D. PERFORMANCE AND VALIDITY OF THE JOB CLASSIFICATION SYSTEM.

The clustering process, as described above, was tested at three intervals during the survey. An initial set of responses, made up the first 467 organizations to complete the survey, served as the original input. The second test was made using 1,928 returns (which included the first 467). The final test was made on all 3,295 responding organizations. In each of these tests, the same general clusters emerged. This would appear to substantiate the hypothesis that an occupational structure does exist within the safety and health work force and that it can be identified.

To further test whether or not the statistical clustering technique generated distinct and different job classifications, the distribution of responses to the following descriptive variables from each job cluster basic area were compared to each other using the chi-square test for independence:

- Minimum Salary Offered
- Years of Formal Education
- Years on the Job
- Employee Age
- Employee Certification

The chi-square analysis, by comparing the responses to a specific question between clusters, tests whether the response distributions were generated from the same population or from two different populations (or clusters in this case). If the distributions or responses are statistically the same (i.e., are not different enough to distinguish between two clusters), then the job clusters in question may not really be different. However, if statistically different distributions of responses to a survey question can be identified, it establishes further credence to the statistical validity and independence of the job clusters identified above. Chi-square analysis of the five question areas (age, salary, etc.) between the defined clusters indicated that most of the clusters generated distinctly different patterns of responses to the target questions at extremely high levels of confidence (virtually all exceeded 99.5%). That means that a given cluster does, in fact, contain individuals who are younger or better educated or higher paid or more experienced than individuals in the other clusters. This analysis suggests, therefore, that the job clusters specified in Table 5 have a high level of statistical integrity and do, in fact, identify some order among occupational safety and health personnel throughout the country based strictly on activities.

SECTION IV

ESTIMATION OF THE 1977 OCCUPATIONAL SAFETY AND HEALTH WORK FORCE

A. INTRODUCTION

A primary objective of the nationwide survey was to produce an estimate of the size of the current occupational safety and health work force. As documented in the Feasibility Study (see Chapter 5), it was proposed that the incidences of occupational safety and health personnel, as identified by the survey, would be applied to Bureau of Labor Statistics employment estimates to produce an assessment of the size of the targeted work force by industrial, job, and discipline classification. This section of the Technical Appendix elaborates on the methodology, assumptions, and intermediate inputs into the estimation effort, assesses the reliability of the estimates, and addresses other relevant details associated with the estimation process.

B. METHODOLOGY FOR ESTIMATING THE SIZE OF THE OCCUPATIONAL SAFETY AND HEALTH WORK FORCE IN THE PRIVATE SECTOR

In the discussion of the sampling matrix in Section II, it was noted that data describing private sector organizations and their employees were collected from a systematic sample of establishments stratified by SIC and firm size. The sampling frame for these private establishments was provided by Dun & Bradstreet's database of U.S. firms. The "non-private" sector is defined as the large loss prevention insurance carriers, and the occupational safety and health-related state and federal government agencies. This sector was not included in the Dun and Bradstreet frame. Because of this and due to the fact that each of the non-private organizations has a very high concentration of occupational safety and health personnel as compared to the private sector establishments, estimation of the size of the non-private sector targeted work force was approached differently, and is described in Subsection D of this Section.

Although the sampling units for the survey were individual establishments, most of the collected data concerned the characteristics of employees within each of these organizations. On this basis, the sampling procedure used for each of the nine private sector stratum can be viewed as a single stage cluster sample where the individual establishments represent the sampling clusters, each containing a different number of employees or elements.

Of particular importance to the survey is the estimation of the proportion of employees within each stratum who can be identified as a specific type of occupational safety and health personnel. The "incidence" of safety and

health personnel is defined as the number of targeted workers per 1000 employees in a given stratum:

$$p_{csjb} = \frac{\sum_{i=1}^{n_{cs}} a_{icsjb}}{\left(\sum_{i=1}^{n_{cs}} m_{ics}\right) / 1000}$$

where:

i = i^{th} sample establishment in the given stratum;
c = c^{th} standard industrial classification;
s = s^{th} employment size category;
j = j^{th} job cluster;
b = b^{th} basic area;
n_{cs} = number of establishments in the cs^{th} stratum;
a_{icsjb} = number of occupational safety and health personnel in a particular job cluster (j) and basic area (b) in the i^{th} organization of the cs^{th} stratum;
m_{ics} = total employment in the i^{th} establishment in the cs^{th} stratum; and
p_{csjb} = incidence coefficient

Note that Σa_{icsjb} represents not only those individuals who were identified as a specific kind of safety and health worker, but also includes the vacancies for that particular job category. These vacancies (labelled "unmet demand") were derived from items 4 and 5 of the Job Role Questionnaire:

(4) How many additional personnel in this job role does this organization need, if any? _____

(5) Are you actively trying to hire someone for this job role?

( ) Yes ( ) No ( ) Don't know

If the respondent answered "yes" to question 5, then it was assumed that the organization was actually demanding the addition personnel indicated in question 4, and that value was added to the appropriate sum. Therefore, the p_{csjb} represent the total demand (both filled and vacant) for occupational safety and health personnel per 1000 employees in each of the sample stratum.

The standard error of the estimate of the incidence of all occupational safety and health personnel in a given stratum (i.e. summing across all basic area and job classification distinctions) can be approximated by:

$$s.e.\left(p'_{cs..}\right) = \left\{ \frac{1-f}{n_{cs}\bar{m}^2_{cs}} \; \frac{\sum_{i=1}^{n_{cs}} a^2_{ics} - 2p_{cs..}\sum_{i=1}^{n_{cs}} a_{ics}m_{ics} + p^2_{cs..}\sum_{i=1}^{n_{cs}} m^2_{ics}}{n_{cs}-1} \right\}^{1/2}$$

where:

$1-f = \left(1 - \frac{n_{cs}}{N_{cs}}\right) =$ finite population correction factor, where n_{cs} and N_{cs} represent the number of sample and population firms respectively.

$\bar{m}_{cs} = \left(\sum_{i=1}^{n_{cs}} m_{ics}\right) \Big/ n_{cs}$ = average employment size of the stratum establishments.

$p_{cs..} = \left(\sum_{j}\sum_{b}\sum_{i=1}^{n_{cs}} a_{icsjb}\right) \Big/ \sum_{i=1}^{n_{cs}} m_{ics}$ for a given stratum.

Table 6 displays for each stratum the $p_{cs..}$ and their associated standard errors as determined by the survey. Note that since the sample was stratified with disproportinate allocation, the marginal $p_{cs..}$ values and their standard errors were appropriately weighted.

Table 6: Estimated incidences and standard errors of occupational safety and health employment per 1000 employees, by standard industrial classification and employment size in the private sector.

Industry	Employment Size		
	100 to 500	500 and Above	100 and Above
Mining	5.420 ± .937	3.922 ± 1.075	4.851 ± .710
Construction	3.073 ± .233	2.568 ± .756	2.942 ± .262
Manufacturing	3.728 ± .097	1.741 ± .141	2.595 ± .091
Transportation, Communication, and Utilities	4.397 ± .424	1.245 ± .171	2.568 ± .204
Trades, Services, and Non-OSH Government		.954 ± .103	.954 ± .103
All Sectors	3.821 ± .100	1.277 ± .078	1.928 ± .064

Source: A Nationwide Survey of the Occupational Safety and Health Work Force, 1977.

For example, the overall standard error was calculated as:

$$s.e.\left(p....\right) = \left\{\sum_{c}\sum_{s}\left\{\left(\frac{M_{cs}}{M_{o}}\right)^{2}\left(s.e.\left(p_{cs..}\right)^{2}\right)\right\}\right\}^{\frac{1}{2}}$$

where:

M_{cs} = population employment in the cs^{th} stratum (in thousands).
M_{o} = population employment summed over all strata

Note that the weights (M_{cs}/M_{o}) were based on employment as opposed to the number of firms involved, because the $p_{cs..}$ are employment based. Estimates of M_{cs} and M_{o} are described in the following section since they are also primary factors for estimating the size of the total occupational safety and health work force. Specifically, the national estimate of the number of occupational safety and health employees in a particular job class (j) and basic area (b) category for a given industry sector (cs), represented as A_{csjb}, is calculated as:

$$A_{csjb} = M_{cs} \cdot p_{csjb}$$

Marginal estimates are then the sum of each of the relevant cells contributing to that margin, e.g. the total occupational safety and health work force is computed as:

$$A.... = \left(\sum_{c}\sum_{s}\sum_{j}\sum_{b}\left(M_{cs} \cdot p_{csjb}\right)\right)$$

C. ESTIMATION OF THE WAGE AND SALARY EMPLOYMENT IN TARGET INDUSTRIES.

As developed above, estimation of the size of the occupational safety and health work force was formulated to be the product of the incidence of safety and health specialists ($p_{cs..}$) observed from the survey multiplied by the relevant employment from each of the respective industry sectors (M_{cs}). Since the survey was limited in scope to specific portions of the total U.S. labor force, the derivation of the relevant M_{cs} reflects these limitations. Specifically, the survey targeted on wage and salary employment within establishments in the mining, construction, manufacturing and transportation, communication, and utilities sectors with at least 100 employees, and within the trades and services sectors and non-occupational safety and health-related state and local governments with 500 or more employees. Subsequently all self-employed persons, unpaid family workers, and private household workers were excluded, as well as agriculatural employment.

The U. S. Department of Labor, Bureau of Labor Statistics (BLS), publishes estimates of wage and salary employment by industry on a monthly basis. Their Office of Economic Growth has also developed projections of the wage and salary employment for 1980 and 1985. Table 7 displays these estimates by industry and target year.

Table 7: Wage and salary employment projections (in thousands).

Industry	1977[a]	1980[b]	1985[b]	1990[c]
Mining[d]	827	1,000	1,015	1,165
Construction	3,655	4,380	5,000	5,597
Manufacturing	19,283	21,524	22,184	22,413
Transportation, Communication, and Utilities	4,550	4,958	5,153	5,345
Trades, Services, and Non-OSH Govt.	49,883	55,960	62,687	70,607

(a) Computed as the average of the first three months of 1977; Bureau of Labor Statistics, Monthly Labor Review, July, 1977, page 71.

(b) Taken from a series of tables made available by the Bureau of Labor Statistics, Office of Economic Growth, entitled Gross Duplicated Domestic Output and Employment for Selected Years and Projected 1980 and 1985; dated April 1, 1976.

(c) Derivation described below.

(d) Source described below.

Projections to 1990 were not available from the BLS. However, conversations with the authors of the BLS employment projections suggested that the 1980 to 1985 growth rate, adjusted downward by 0.4 percent to reflect a projected levelling off in the size of the labor force, would produce approximate growth rates for the 1986 to 1990 period. The last column in Table 7 displays the subsequent 1990 projections. A further modification was made in the mining sector. The original BLS projections showed employment levels of 751,000 and 786,000 for 1985, both of which were surpassed by the 1977 level of 827,000 due to the recent unexpected surge in coal mining operations. The Office of Economic Growth has indicated that mining employment is now expected to reach a million by 1980 and then will level off between 1981 and 1985. The contractor projects that mining employment will expand more rapidly after 1985, reaching a level of 1,165 by 1990, based on information accessed through the U.S. Bureau of Mines. These modifications are all included in Table 7.

In order to conform with the specified sample stratifications, the projections in Table 7 must be further partitioned by employment size. The U. S. Bureau of Census provides estimates of the number of Social Security covered wage and

salary employees within a range of employment size categories*. Table 8 displays the percentages of wage and salary employees within the survey-defined employment size categories for each target industry.

Table 8: Percentage distribution of wage and salary employment by firm size.

Industry	less than 100	100 to 499	500 and above	Total
Mining	45%	30%	25%	100%
Construction	71	19	10	100
Manufacturing	24	33	43	100
Transportation, Communication, and Utilities	38	26	36	100
Trades, Services, and Non-OSH Govt.	71		29	100

Source: 1974 County Business Patterns, U. S. Department of Commerce, Bureau of the Census.

Multiplication of employment projections by these percentages produces estimates of employment by firm size, thereby excluding employment in firms smaller than the survey limitation. Table 9 displays these estimates for each target year. It should be noted that this procedure assumes that the 1974 employment size distribution is a typical year and that this distribution will remain constant. Therefore, it is implied that no major structural shifts in employment concentration will occur between 1974 and 1990, i.e., it is assumed that no trend towards either larger or smaller firms exists or will develop.

Table 9: Wage and salary employment projections (in thousands) by industrial classification and firm size.

	1977		1980		1985		1990	
Industry Sector	100-499	500+	100-499	500+	100-499	500+	100-499	500+
Mining	248	207	300	250	305	254	350	291
Construction	682	367	788	425	883	475	970	522
Manufacturing	6,271	8,312	6,964	9,231	7,174	9,509	7,246	9,606
Transportation, Communication, and Utilities	1,184	1,636	1,293	1,786	1,343	1,855	1,370	1,892
Trades, Services, and Non-OSH Govt.	---	14,400	---	15,880	---	18,093	---	20,312

Source: Developed above.

*While BLS and Bureau of Census employment estimates are not entirely comparable, their joint usage is necessary in this case since the BLS does not account for firm size distributions.

With these wage and salary employment projections, the estimated number of occupational safety and health personnel in a given private sector stratum can be determined. Multiplication of the relevant employment figure (M_{cs}), (shown in Table 9) by the parallel $p_{cs..}$ (shown in Table 6) produces an estimate of the number of safety and health personnel for that cell. That estimate can be further disaggregated into basic area and job classification by substituting the appropriate p_{csjb} (not shown here). Estimates of the number of occupational safety and health personnel in 1977 are displayed in Tables 2 and 3 in the text.

D. ESTIMATION OF THE SIZE OF THE OCCUPATIONAL SAFETY AND HEALTH WORK FORCE IN THE NON-PRIVATE SECTORS.

A review of the sampling plan in Section II indicates that large loss-prevention insurance carriers and occupational safety and health-related state and federal agencies were not included in the Dun and Bradstreet frame. The rationale for dealing with these "non-private" organizations apart from the private sector sample centered on the significantly greater concentration of targeted personnel in the insurance, state, and federal agencies. Many of these organizations consist almost entirely of safety and health personnel, and therefore the incidence per 1000 employees (p_{csjb}) was not strictly applicable, especially since the BLS does not have employment projections for specific government agencies or for the specific types of insurance carriers.

Subsequently, the following procedures were undertaken to estimate the size of safety and health work forces within the non-private sector:

1. Loss-Prevention Insurance Carriers

Bests' Aggregates and Averages, published by A. M. Best and Company, lists insurance companies which write or specialize in workers compensation. All such organizations with net premiums in excess of $25,000,000 were asked to participate in the survey, twenty-two of which complied. An assumption that the employment of safety and health personnel in these organizations was dependent upon the level of net premiums written annually was supported by a high positive correlation between the two. On this basis, the target work force in this sector was estimated as the total net premiums written in 1976 multiplied by the sample ratio of safety and health specialists to premiums written.

2. State Agencies

A similar approach was used to estimate the size of the target work force employed in state agencies responsible for occupational safety and health programs. In this case, however, the ratio was based on total employment in each state instead of net premiums as above. Out of twenty-three states contacted, twenty responded to the survey. Note that only 30 states are responsible for their own occupational safety and health programs -- the other twenty rely on federal programs.

3. Federal Agencies

Six federal agencies responsed to the survey questionnaire:

- Occupational Safety and Health Administration
- National Institute for Occupational Safety and Health
- U. S. Postal Service
- Environmental Protection Agency
- Tennessee Valley Authority
- Energy Research and Development Administration

These agencies employ a majority of the occupational safety and health personnel in the federal government. To determine the total target work force on the federal payroll, information was obtained from the Civil Service Commission to supplement the survey results.

To assure that data generated by the non-private sector surveys were compatible with the private sector information, it was necessary to partition employee and job role responses in a fashion comparable to the private sector data, i.e., by job class and basic area. Let I_{jb} represent the number of individuals in job class (j) and basic area (b) determined to be employed in the insurance sector. Similary, S_{jb} and F_{jb} represent parallel employment categories for state and federal agencies respectively; in general, θ_{jb} represents a specific non-private sector cell where θ is replaced by I, S, or F. Let $\theta..$ represent the total number of safety and health personnel in a given non-private sector strata, estimates for which were derived as described above. Then, a distribution coefficient $d_{\theta jb}$ can be defined as:

$$d_{\theta jb} = \theta_{jb}/\theta.. \quad \text{and} \quad \sum_j \sum_b d_{\theta jb} = 1$$

where $d_{\theta jb}$ was computed from the survey responses. The term $d_{\theta jb}$ is similar to the private sector p_{csjb} in that both distribute the safety and health employment within a given stratum among the various job classes and basic areas.

E. OVERALL ESTIMATION MODEL

Estimation of the size of the total occupational safety and health work force is calculated as the sum of the private and non-private sector estimates. Specifically, for a given (jb) employment cell, the estimated total number of occupational safety and health personnel (OSH_{jb}) is determined by:

$$OSH_{jb} = \left(\sum_c \sum_s M_{cs} \cdot p_{csjb}\right) + \sum_{\theta=I,S,F} \theta.. \left(d_{\theta jb}\right)$$

Tables 2 and 3 in the text array the resulting employment estimates.

A number of minor modifications (described in Section V) in this model result in flexible forecasting mechanism for projecting future levels of safety and health work force. The modifications allow the p_{csjb} and d_{0jb} to be manipulated such that when coupled with BLS projections of wage and salary employment, $(M_{sc,t})$, at a future time (t), an assessment of impacts associated with potential changes in the structure of the safety and health work force can be determined.

F. RELIABILITY OF THE SURVEY DATA

As with most large scale surveys, a number of sources of potential errors were introduced during the data collection which may bias the results of the study. Users are therefore cautioned to qualify any inferences and/or interpretations made from the data to reflect these biases, as described below:

1. Source of Sampling Frame

Inferences concerning the size and characteristics of the occupational safety and health work force are subject to biases associated with sampling frame provided by Dun and Bradstreet. While a very large percentage of U. S. firms (over 90% in most of the relevant industry strata) are included in the Dun & Bradstreet marketing database, those that were not in the master file were not sampled. If, for some reason, these excluded firms possess significantly different occupational safety and health programs or hiring practices, their overall influence is not reflected in the survey results.

2. Non-Response

Approximately 6200 private sector firms were initially contacted to solicit cooperation in the survey. Of these, 3250 completed and returned the questionnaires, resulting in an overall response rate of 52 percent. Table 10 displays the response rate for each of the sample strata. Note that the larger sized firms responded at a much higher rate (66%) than the smaller firms (48%). It has been suggested that firms with weak safety and health programs would tend to have a higher propensity to refuse to participate in the survey, resulting therefore, in an upward bias in the estimation of the size of the target work force. Recall, however, that firms with less than 100 employees were not included in the survey, which would result in an underestimation of the total work force. It is conceivable, then, that these two sources of bias, have to some degree, cancelled out each other in the estimation of the total occupational safety and health work force.

3. Deviation from the Sampling Plan

In Table 11, a comparison between the proposed sampling plan and the actual return distribution is displayed. The deviation from the original sampling plan is in part due to the differential response rates experienced between the firm size strata. Note that the smaller sized firms were consistently undersampled, while the larger firms

Table 10: Survey response rate by sample strata.

		100-500	500+	Total
Mining	Contacts Respondents Rate	102 28 27.5%	27 15 55.6%	129 43 33.3%
Construction	Contacts Respondents Rate	391 155 39.6%	43 33 76.7%	434 188 43.3%
Manufacturing	Contacts Respondents Rate	3926 2004 51.0%	652 478 73.7%	4578 2482 54.2%
Transportation Communication and Utilities	Contacts Respondents Rate	436 157 36.0%	139 111 79.7%	575 268 46.6%
Trades, Services and Non-OSH Government	Contacts Respondents Rate	--- --- ---	511 269 52.6%	511 269 52.6%
Total Private Sector	Contacts Respondents Rate	4855 2344 48.3%	1372 906 66.0%	6227 3250 52.2%
Insurance	Contacts Respondents Rate	28 20 71%		28 20 71%
State OSH-Related Government	Contacts Respondents Rate	23 20 87%		23 20 87%
Federal Government	Contacts Respondents Rate	8 6 75%		8 6 75%

Source: A Nationwide Survey of the Occupational Safety and Health Work Force.

were oversampled. While this non-conformance to the original sampling plan should not affect any point estimates generated from the survey data, the precision of the estimates will be altered. Specifically, the small firm size estimates are less precise due to the undersampling than they would have been had the original plan been followed. Conversely, because of the oversampling, estimates concerning the larger sized firms are bounded by a smaller error. The overall weighted effect of the sampling plan deviation was to reduce the relative standard error of p.... from an estimated 4.2 percent to 3.3 percent*

Table 11: Comparison of the proposed and actual sample sizes by industry and firm size strata for the private sector.

Industry	Sample Sizes	Firm Size		
		100-500	500+	Total
Mining	Proposed	41	12	53
	Actual	28	15	43
Construction	Proposed	171	13	184
	Actual	155	33	188
Manufacturing	Proposed	2357	179	2536
	Actual	2004	478	2482
Transportation, Communication, and Utilities	Proposed	287	105	392
	Actual	157	111	268
Trades, Services, and Non-OSH Government	Proposed		205	205
	Actual		269	269
Total	Proposed	2856	514	3370
	Actual	2344	906	3250

Source: Nationwide Survey of the Occupational Safety and Health Work Force.

Comparisons of these data with related occupational safety and health work force information should be done cognizant of potential definitional differences between the two sources. This is especially relevant with respect to the job class and basic area stratifications imposed by this study's results. Similarly, this study's definition of an "occupational safety and health worker" may not strictly coincide with previous definitions.

* The relative standard error of 3.3 percent is calculated as the ratio of the standard error (.064) to the p.... estimate (1.928) as displayed in Table 6. The standard error used to calculate the 4.2 percent figure was derived by substituting the proposed n_{cs} in for the actual n_{cs} in the standard error equation on page 23.

SECTION V

METHODOLOGY FOR FORECASTING OCCUPATIONAL SAFETY AND HEALTH PERSONNEL

A. INTRODUCTION

The major components of the safety and health work force forecasting model were introduced in the preceding section. Specifically, multiplication of the projected wage and salary employment in each sample stratum by the appropriate incidence of safety and health personnel (derived from the survey), produces forecasts of the targeted work force for given periods in the future. This section of the Technical Appendix details the forecasting process and discusses the impacts of changing the incidence coefficients in order to investigate potential alternative futures.

With these projections of the "stock" of safety and health employment in the future, various aspects of the "flow" of employees into and out of the system are then considered. A method for quantifying labor force attrition is developed, and the procedure for estimating the annual number of new hires for both replacement and occupational growth is then detailed.

B. FORECASTING MODEL TO PROJECT THE SIZE OF THE OCCUPATIONAL SAFETY AND HEALTH WORK FORCE

Recall from Section IV that the incidence of occupational safety and health personnel, p_{csjb}, was calculated as the number of filled and unfilled safety and health job positions per 1,000 total employees in a given stratum. Estimates of the size of the private safety and health work force (of a particular job class and basic area) were produced by multiplying total employment (in thousands) for a specific strata by the appropriate incidence coefficients. Non-private sector work force sizes, derived independently, were then added in. The forecasting model is similar in that projected wage and salary employment figures for the target years 1980, 1985, and 1990 (see Table 9) are multiplied by the relevant p_{csjb} to produce estimates of future size of the various private safety and health work force components.

This procedure implies that the incidence of safety and health employees will remain constant through time -- a somewhat restrictive assumption, especially in light of the relative newness of the occupation. Therefore, to investigate the impacts of various growth assumptions on the size of the future target work force, an "alternative futures" provision was built into the forecasting model.

In general, let $f_{csjb,t}$ be a function indicating expected changes at some future time t in the incidence coefficients p_{csjb} due to government policy, technology, productivity of safety and health employees, etc. Then, the

forecast number of specific occupational safety and health employees in a given private sector stratum would be calculated as:

$$A_{csjb,t} = M_{cs,t} \cdot \left(f_{csjb,t}\left(p_{csjb}\right)\right) = M_{cs,t} \cdot p'_{csjb}$$

where p'_{csjb} represents the adjusted incidence coefficient. While $f_{csjb,t}$ could conceivably take on a variety of functional forms, the following linear equation was specified for this project:

$$f_{..jb,t}\left(p_{..jb}\right) = y_{jb,t} + c_{jb,t} \cdot \left(p_{..jb}\right)$$

In words, the incidences of safety and health personnel were allowed to be changed by a simple linear equation with an additive constant $y_{jb,t}$ and a multiplicative term $c_{jb,t}$. The absence of the subscripts c and s dictate that the changes were to be identically distributed over all industries and firm sizes; however, shifts specific to each job class (j) and basic area (b) combination were possible. The total private sector safety and health work force at time t, then, is the sum of the forecasts in each stratum.

Inclusion of the non-private sector safety and health employment was conveniently tied to the size of the private sector work force by assuming that the two were also functionally related. As in Section IV, let I = insurance, S = state, F = federal and $d_{\theta jb}$ is a distribution coefficient where $\Sigma\Sigma\ d_{\theta jb} = 1$ when the subscript θ is replaced by I,S or F. The $d_{\theta jb}$ were assumed to also be subject to the same influences of the alternative future function $f_{..jb,t}$ as were the $p_{..jb}$. However, the result of $f_{..jb,t}(d_{\theta jb}) = y_{jb,t} + c_{jb,t}(d_{\theta jb}) = d'_{\theta jb,t}$ not only redistributes employment between the various job class and basic area cells but also alters the size of $\theta..$ since $d_{\theta jb} \neq 1$ if disproportionate shifts are generated by $f_{..jb,t}$. The relationship between the private and non-private sectors was formulated as:

$$\theta_{jb,t} = d'_{\theta jb,t} \cdot g_{\theta t} \cdot A_{....,t}$$

where $g_{\theta,t}$ indicates the expected relative size of the specific θ sector to the private sector. Although this framework is relatively simple, it is capable of generating forecasts of the size of the targeted work force under a variety of assumptions concerning the anticipated changes in incidence coefficients and the relative sizes of the private and public sectors. The following subsection briefly discusses the inputs of two such alternative future scenarios.

C. ALTERNATIVE FUTURES ASSUMPTIONS

Given the general model framework developed above, the project's Technical Advisory Committee was asked to produce an array of potential changes in the incidence coefficients. Their expectations are displayed in Table 12. These figures represent projected percent changes in the incidences of safety and health personnel in the future. The Committee also suggested that while the insurance and federal government percentages of the total safety and health work force would increase proportionately with the private sector share, state agencies would only maintain levels constant to their 1977 employment size.

Table 12: Projected percent changes in the 1977 incidences of occupational safety and health employees.

Job Cluster	Basic Area						
	Safety	Radiation	Industrial Hygiene	Fire Protection	General	Medical	Not Classified
Administrates, Advises, Interprets	0.0%	1.0%	50.0%	14.0%	0.0%	---	0.0%
Inspects, Interprets Investigates, Plans	0.0	1.0	50.0	14.0	0.0	---	0.0
Analyzes Plans, Develops Procedures	0.0	1.0	50.0	0.0	0.0	---	0.0
Provides Training	35.0	1.0	50.0	0.0	37.0	---	0.0
Performs and Analyzes Tests	35.0	1.0	50.0	0.0	37.0	---	0.0
Maintains, Repairs, and Adapts Equipment	0.0	1.0	50.0	0.0	0.0	---	0.0
Physician	---	---	---	---	---	5.0	---
Nurse	---	---	---	---	---	5.0	---
Not Classified	0.0	1.0	50.0	0.0	0.0	---	0.0
Total	2.0%	1.0%	50.0%	10.0%	10.0%	5.0%	0.0%

Source: Derived from suggestions made by the project's Technical Advisory Committee.

Furthermore, none of these changes would occur before 1985.

This type of information can be easily translated into the functional relationship outlined above. Because these input parameters are based on assumptions of an increasing concentration of occupational safety and health personnel, forecasts produced using this alternative were labeled as "accelerated growth". To determine the impact of these assumptions, a "status quo" forecast was also produced in which the $p..._{jb}$ and the $d_{\theta jb}$ remained constant. Results of both of these forecasts are presented in Tables 18-20 of the text.

D. LABOR FORCE ATTRITION AND ANNUAL NEW HIRES

The above forecasting methodology addresses the "stock" of occupational safety and health personnel expected to be demanded for a given target year. It ignores, however, the "flow" of personnel into and out of the work force. Examination of the flow behavior is critical with respect to assessing the number of "new hires" that will be required to meet the anticipated demand levels.

A new hire is defined as the initial entry of an individual into the occupational safety and health field and can be divided between two mutually exclusive sources of demand: growth and replacement. The magnitude of growth in a particular occupation is defined as merely the difference in the number of employees between time (t) and time (t+x), where x represents an arbitrary interval (e.g., 1 year, 5 years, etc.). Obviously, in order to increase the work force to meet the level of demand at time (t+x) a number of new hires must be made.

The second category of demand for new hires is for replacement of those individuals employed in the work force at time (t) who will die, retire, become disabled or otherwise leave the labor force by time (t+x). The demand for replacement personnel was calculated by applying age-specific labor force attrition rates to each of the job class by basic area sectors of the safety and health work force. Specifically, for each job class and basic area sector, the following was determined:

$$R = \sum_{a=18}^{70} OSH_a - \sum_{a=18}^{70} \left(OSH_a \cdot \prod_{i=a}^{a+t} \left(1-Q_i\right) \right)$$

where

R = total replacements for a given occupation between 1977 and 1990.
a = subscript indicating age, ranging between 18 and 70 years.
i = subscript incrementing the attrition rate to (t) years in the future.
OSH_a = number of employees of a given age in the current work force.
Q_i = age specific labor force attrition rates published by the BLS.*

* Howard N. Fullerton and James J. Byrne, "Length of Working Life for Men and Women 1970", Monthly Labor Review, U. S. Department of Labor, Bureau of Labor Statistics, February, 1976.

This produced estimates of the number of currently employed personnel who are expected to leave the work force between now and 1990. The total estimated number of annual new hires for a specific time interval (x) was calculated as the sum of the new hires for growth and replacement divided by the number of years in the interval x. Tables 22-24 of the text display expected annual new hires generated from the survey effort. It is important to understand that these rates are concerned with labor force attrition and do not account for occupational attrition. A number of other assumptions are also implied under this attrition scheme:

- the attrition behavior of occupational safety and health personnel is similar to that of the entire U.S. labor force in 1970;
- attrition rates will remain constant throughout the forecast time-frame;
- new entrants into the labor force will not retire or otherwise leave the labor force (i.e., the attrition scheme was directed solely toward the existing work force);
- occupational safety and health personnel will not exit the occupational safety and health work force other than through attrition (i.e., occupational safety and health personnel will not change to occupations outside of the occupational safety and health purview, or if they do, this will be offset by new entrants of comparable age);

Major deviations from any of these assumptions could have significant impacts on the required number of new hires for replacement.

EXHIBITS

List of Contents

EXHIBIT 1

SURVEY INTRODUCTORY LETTER

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY, CINCINNATI, OHIO 45226

January 1977

Dear Survey Participant:

In September of 1976, the National Institute for Occupational Safety and Health (NIOSH) awarded contract #210-76-0192 to John Short and Associates, Inc., management and social research consultants, of Salt Lake City, Utah. The purpose of the contract is to conduct a nationwide survey of the occupational safety and health work force to achieve a solid data base and draw conclusions regarding the present strength, future demand for, and characteristics of that work force.

Section 21(a) of the Occupational Safety and Health Act charges NIOSH to "...conduct directly, or by grants or contracts educational programs to provide an adequate supply of qualified personnel to carry out the purposes of this Act".

This survey is being done to establish statistically accurate information which will be used as support for development and modification of new and existing programs in occupational safety and health. These programs are now being conducted by universities, government groups and private companies. The increasing need for qualified occupational safety and health professionals, to be newly trained or cross-trained from the previously mentioned sources, requires accurate data as to the numbers of people presently involved, as well as future needs for such individuals.

It is our hope that through your participation in this survey, the information, so gathered, will help in the overall NIOSH effort to insure for every worker, employment which is free of illness and injury to the greatest extent possible. Thank you very much in advance for your participation in this survey. If you have any questions, please feel free to call me at (513) 684-8222.

Sincerely,

James S. Ferguson

James S. Ferguson
Deputy Director and Project Director
Division of Training and Manpower
Development, NIOSH

EXHIBIT 2

ORGANIZATION QUESTIONNAIRE

Form Approved
OMB No. 68S76039

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in this space

1

ORGANIZATION QUESTIONNAIRE

This questionnaire is designed to be completed by administrative staff, such as a safety director, plant manager, personnel director or other individuals responsible for or knowledgeable about the safety and health program in your organization.

1. What is the major activity and/or product of your organization.

0 0 0
10 12

2. Currently, what is your average level of employment (including management, sales force, etc.)? _____

13 17

3. How many of these employees are in production, rather than in the management, clerical or sales areas? _____

18 22

4. Do management personnel not specializing in safety and health activities receive any training in occupational safety and health (OSH)?

( ) Yes ( ) No ( ) Don't Know

23

5. How frequently is safety and health training provided to workers? Check all that most closely apply.

( ) Orientation or Introductory Training ( ) Quarterly

( ) Weekly ( ) Yearly

( ) Monthly ( ) No Training

24 29

Organization: Your administrative unit and all personnel reporting to that unit. Generally this is all personnel within a specific area who are directly or indirectly engaged in your organization's production and/or service activities. If your administrative unit is part of a larger organization or parent company, do not include units or offices not directly under the supervision of your administrative unit.

Do not write in this space

6. From which of the following types of organizations does this organization use OSH-related services (inspection, training, advice, medical services)?

( ) Insurance Carriers
( ) Government Agencies
( ) Medical Personnel or Clinics
( ) Parent Company or Division of Your Organization
( ) Private Consultants
( ) Trade Organizations
( ) Professional Societies
( ) National or State Safety Councils
( ) None of the above

7. Is there a safety committee in this organization?

( ) Yes ( ) No ( ) Don't Know

8. Have the requirements of the Occupational Safety and Health Act resulted in this organization hiring or contracting with additional occupational safety and health personnel?

( ) Yes ( ) No ( ) Don't Know

9. In the last year, has this organization been inspected by a state or federal OSH agency?

( ) Yes ( ) No ( ) Don't Know

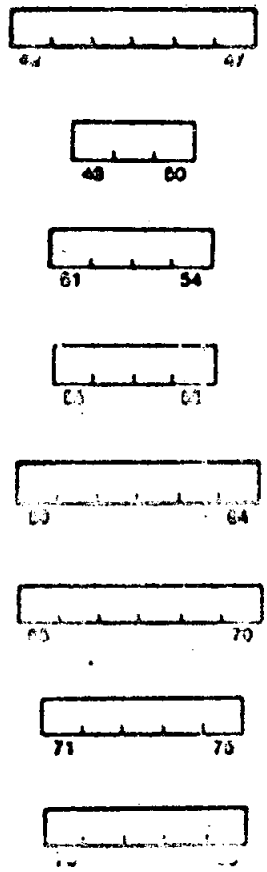
Do not write in this space

10. Please review your OSHA Form No. 102, which is the summary report of occupational illnesses and injuries, for the past reporting year.

Transcribe under columns 1 through 8.

TOTAL — OCCUPATIONAL ILLNESSES.

Please Note: Your organization may not be using the current form. If so, use spaces provided under "Expired Form No. 102".



CURRENT FORM No. 102

	TOTAL CASES	DEATHS	LOST WORKDAY CASES				INJURIES CASES WITHOUT LOST WORKDAYS	TERMINATIONS OR PERMANENT TRANSFERS
			Total Lost Workday Cases	Cases Involving Days Away From Work	Days Away From Work	Days of Restricted Work Activity		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
30								

TAL UPA- NAL SSES

EXPIRED FORM No. 102

	LOST WORKDAY CASES			Nonfatal Cases Without Lost Workdays	
Fatalities	Number of Cases	Number of Cases Involving Permanent Transfer to Another Job or Termination of Employment	Number of Lost Workdays	Number of Cases	Number of Cases Involving Transfer to Another Job or Termination of Employment
3	4	5	6	7	8

TOTAL OCCUPATIONAL ILLNESSES

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9

0 0 1
10 12

3 20

21 23

24 28

29 33

34 40

41 47

48 53

54 59

60-66 blank

10. (continued)

Transcribe under columns 1 through 8.

TOTAL — OCCUPATIONAL INJURIES AND ILLNESSES.

Please Note: Your organization may not be using the current form. If so, use spaces provided under "Expired Form No. 102".

CURRENT FORM No. 102

		TOTAL CASES	DEATHS	LOST WORKDAY CASES				NONFATAL CASES WITHOUT LOST WORKDAYS	TERMINATIONS OR PERMANENT TRANSFERS
				Total Lost Workday Cases	Cases Involving Days Away From Work	Days Away From Work	Days of Restricted Work Activity		
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TOTAL OCCUPATIONAL INJURIES AND ILLNESSES	31								

EXPIRED FORM No. 102

	Fatalities	LOST WORKDAY CASES			Nonfatal Cases Without Lost Workdays	
		Number of Cases	Number of Cases Involving Permanent Transfer to Another Job or Termination of Employment	Number of Lost Workdays	Number of Cases	Number of Cases Involving Transfer to Another Job or Termination of Employment
	3	4	5	6	7	8
TOTAL OCCUPATIONAL INJURIES AND ILLNESSES						

Do not write in this space

1

0 0 2
10 12

Skip to 13-16

17

18

11. Please estimate the amount of work time the person with major responsibility* for your occupational safety and health program spends on this activity. Place this individual's job title under question 13 below.

( ) 20% or less ( ) 50 - 75%

( ) 20 - 50% ( ) 75 - 100%

12. Are there other employees on the payroll who specialize (spend more than 50% of their work time)** in the treatment or prevention of occupational injuries, illnesses or fire?

( ) Yes ( ) No ( ) Don't Know

13. List the job titles of these specialists and the number of specialists in each of these job roles. List by line of authority, as closely as possible, beginning with the individual most responsible for the safety and health program. If no job titles are included here, skip to question 16.

	JOB TITLE	NUMBER OF SPECIALISTS
(1)		
(2)		
(3)		
(4)		
(5)		
(6)		
	SUM	

19 21 (1)

22 24 (2)

25 27 (3)

28 30 (4)

31 33 (5)

34 36 (6)

*Individual responsible for safety and health program: This is the person assigned or assuming the role of administering or directing safety and health activities. In large organizations this often will be a safety director or safety manager. In organizations with limited safety and health programs, the plant manager, personnel director or other management staff may have this role part-time.

**Specialize in treatment or prevention: Worker and/or administrative staff who devote at least 50% of their work time in activities related to the treatment or prevention of occupational illness, injury or fire. Included in this category are: medical personnel, such as doctors and nurses; safety, health and fire personnel, such as fire chiefs, hygienists, inspectors, health physicists, technicians, etc. Fire fighters may be excluded when their major job activities are not in the area of fire prevention.

Do not write in this space

Skip to cc 78

78

79 80

14. Please fill out one tan form* for each job title listed under question 13.

15. Please fill out one yellow form** for each individual employee listed above. Total number of forms should equal SUM from question 13.

16. At present, do you see a need for any additional OSH personnel not listed above?

( ) Yes ( ) No ( ) Don't Know

17. If yes to question 16, please list prospective job titles.

(1) _____

(2) _____

(3) _____

(4) _____

(5) _____

18. Please complete one tan form for each title listed under question 17.

THANK YOU FOR YOUR TIME AND COOPERATION.

---

*Job Role Questionnaire: The enclosed tan forms are designed to yield data regarding the responsibilities or activities which are assigned to occupational safety and health employees with similar job roles and titles. Only one form should be completed for each job title. For example, if your organization has three individuals with the same job title, only one form should be completed.

**Employee Characteristics Questionnaire: These are the enclosed yellow forms. One form is to be completed for each and every employee specializing in safety and health, and describes educational, experience and age characteristics for those employees. As completion of this form may require research in personnel files, it has been designed to be easily completed by clerical staff. It is not necessary to place the name of the employee on the form.

EXHIBIT 9

JOB ROLE QUESTIONNAIRE

Form Approved
OMB No. 0937-0039

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In this space

JOB ROLE QUESTIONNAIRE

Complete one of these forms for each job title listed in the ORGANIZATION QUESTIONNAIRE.

1. Job title: _____

2. Of the total time spent in safety and health activities, what percentage of effort does an individual in this job role spend in each of the following areas? Total should equal 100%.

Prevention or treatment of occupational injury	_____%
Prevention or treatment of occupational illness due to radiation	_____%
Prevention or treatment of occupational illness due to other causes	_____%
Prevention of fire	_____%
TOTAL	**100%**

Do not write in this space

3. Here is a list of occupational safety and health related activities. Please read through it and choose at most the five that best describe this job. Do not mark minor activities.

( ) 1. Inspects work place to identify existing or potential hazards

( ) 2. Performs tests or measurements

( ) 3. Analyzes results of tests or measurements

( ) 4. Analyzes proposed plans or specifications to identify potential hazards

( ) 5. Investigates to determine cause of illness, injury or fire

( ) 6. Prescribes personal protective equipment

( ) 7. Develops operating procedures to eliminate or control hazards

( ) 8. Designs protective or other equipment

( ) 9. Recommends and/or conducts research related to identification, prevention or control of hazards

( ) 10. Advises top level management

( ) 11. Directs fire fighting

( ) 12. Directs evacuation procedures

( ) 13. Prepares OSH instructional material

( ) 14. Provides education and training to employees by conducting training sessions

( ) 15. Provides education and training to employees through personal contact

( ) 16. Provides education and training to employees by other means (bulletins, posters, memos)

( ) 17. Inspects equipment for compliance with established OSHA regulations and standards

( ) 18. Maintains and repairs equipment

( ) 19. Adapts or modifies existing equipment to meet a specified requirement

( ) 20. Attends professional meetings and reviews pertinent scientific findings and studies to determine significance to organization

( ) 21. Interprets current OSH laws, regulations and standards in terms of the impact on organization and the action necessary to assure compliance

( ) 22. Plans and develops programs in the area of occupational safety and health

( ) 23. Administrates (directs, manages)

( ) 24. Supervises three or more OSH personnel

( ) 25. Practices medicine

( ) 26. Practices nursing

( ) 27. Gives first aid

25

27

29

31

33

Do not write in this space

4. How many additional personnel in this job role does this organization need, if any? _____

(If zero, please go to question 8 of this form.)

5. Are you actively trying to hire someone for this job role?

( ) Yes

( ) No (Please skip to question 7.)

( ) Don't know (Please skip to question 7.)

6. For approximately how many weeks have you been trying to hire someone?

_____ weeks (Please skip to question 8.)

7. Is possible hiring in the discussion stage?

( ) Yes ( ) No ( ) Don't Know

8. What would be or what are the requirements for filling this job if someone were to terminate or if you are actively trying to hire?

A. Would s/he work full or part-time in safety and health?

( ) Full-time ( ) Part-time

B. What is your estimate of the minimum educational requirements?

( ) No requirements ( ) Masters degree

( ) High School graduation ( ) LPN

( ) Some college or technical/ business school ( ) RN

( ) Graduate from technical school ( ) Ph.D., M.D. or D.O.

( ) Bachelors degree ( ) Other, please specify: _____

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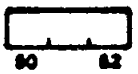

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to 59-60

8. (continued)

C. Would licensing or certification be required?

( ) Yes ( ) No ( ) Don't Know

D. What is your estimate of the minimum number of years experience in a related area that would be required?

_____years ( ) Don't Know

E. How many years of experience would substitute for one year of education?

_____years ( ) Don't Know

F. What would be the minimum yearly salary offered? (Please estimate.)

$_____

G. How would this job be advertised? Check all that apply.

( ) Internally with company communication channels (bulletins, announcements, etc.)

( ) Newspaper or other periodical

( ) State employment agencies

( ) Private employment agencies

( ) Contact professional or other societies and associations

( ) Contact university or technical school sources

Total number of (ten) JOB ROLE QUESTIONNAIRES should equal the number of job titles entered in ORGANIZATION QUESTIONNAIRE.

EXHIBIT 4

EMPLOYEE CHARACTERISTICS QUESTIONNAIRE

Form Approved
OMB No. 68S76039

EMPLOYEE CHARACTERISTICS QUESTIONNAIRE

Complete one of these forms for each employee in an occupational safety and health related job.

1. Job Title: _____

2. Employee I.D., initials or first name: _____

   This item is only for your aid in completing these forms. If necessary, it may be left blank or obliterated upon completion of the form.

3. Please describe the employee in terms of the following characteristics.

   A. Age _____

   B. Years in this job _____

   C. Was this employee's prior job related to occupational safety and health activities?

   ( ) Yes ( ) No ( ) Don't Know

   D. How many years of formal education does this employee have?

   ( ) 7 years or less ( ) 13

   ( ) 8 ( ) 14

   ( ) 9 ( ) 15

   ( ) 10 ( ) 16

   ( ) 11 ( ) 17

   ( ) 12 ( ) 18 years or over

Do not write
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501

4

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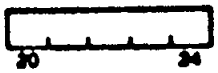

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E. Is this person registered, licensed or certified in the area of occupational safety and health?

( ) Don't Know
( ) No
( ) Certified Safety Engineer
( ) Professional Engineer, Safety
( ) Professional Engineer, Fire
( ) Certified Safety Professional
( ) Fire Protection Engineer
( ) Certified Industrial Hygienist
( ) Certified Health Physicist
( ) Other, specify: _____

F. Does this individual have a physical or biological science, engineering or medical degree directly related to occupational safety and health?

( ) Don't Know
( ) No related degree
( ) Associate Arts
( ) LPN
( ) RN
( ) Bachelors
( ) Masters
( ) Ph.D.
( ) M.D. or D.O.
( ) Other, specify: _____

Total number of (yellow) EMPLOYEE CHARACTERISTICS QUESTIONNAIRES should equal sum of employees specializing in occupational safety and health.

EXHIBIT 5

OSH JOB TITLES GENERATED BY FEASIBILITY STUDY

OSH JOB TITLES GENERATED BY FEASIBILITY STUDY

Administrative Assistant
Administrative Officer
Admin. Supv. of Safety Department
Area Manager
Area Security Officer
Assistant Chief
Assistant Manager
Assistant Plant Supv. Safety
Assistant Safety Engineer
Assistant to Safety Director
Associate Counsel

Building and Grounds Supt.
Building and Maintenance Supv.

Carpenter Safety Manager
Chief Accident & Fire Prevention
Chief Department Fire Marshall
College Nurse
Construction Manager
Contract Administrative Officer
Coordin. Environ. Health & Toxicology
Coordinator Safety Security
Corp. Director Safety & Security
Customer Service Supv.

Delivery & Dispatch Supt.
Department Physician
Director of Environmental Control
Director of Ground Safety
Director of Personnal and Safety
Director of Physical Plant
Director of Safety
Division Plant Engineer
Doctor

Employee Benefits, Safety Manager
Employee Health Nurse
Employee Supv.
Engineering Manager
Environmental Control Director
Environmental Control Manager
Environmental Health Safety Technician
Environmental Health Standards
Environmental Toxicology
Experimental Toxicology

Facilities Engineer
Facilities Manager
Facilities Security Safety Admin.
Fire Chief
Fire Protection Engineer
First Aid Attendant

Ground Safety Engineer
Ground Safety Specialist

Head Nurse
Health Physicist Technician

Industrial Hygienist
Industrial Hygienist Engineer

Laborer
Lead Safety Engineer

Maintenance Supv.
Manager of Safety
Manager Safety & Security
Manager Safety Division
Manager Safety Loss Prevention
Manager Safety Security
Manufacturing Engineering Mgr.

Nurse

Occupational Health Nurse
Operations Manager
OSHA Compliance Coordinator
OSH Coordinator

Personnel and Safety Director
Personnel & Safety Supv.
Personnel Director
Personnel Supv. - Counseling
Plant Engineer, Industrial
Plant Manager
Plant Nurse
Plant Staff Assistant for Safety
Plant Staff Supv., Safety
Port Safety & Environ. Control Officer
Port Steward, Safety Director
Product and Chemical Toxicologist
Production Director, Safety Div.

Safety Admin. Supv.
Safety Consultant
Safety Coordinator
Safety Counselor
Safety Director
Safety Director and Labor Dispatcher
Safety Director EEOC and Asst. Employ. Dir.
Safety Engineer
Safety Engineer Consulting
Safety Inspector
Safety Man
Safety Manager
Safety Officer
Safety Program Specialist
Safety Representative
Safety Supervisor
Senior Safety Engineer
Specialist in Industrial Arts
Staff Engineer
Staff Nurse
Superintendent
Supervising Program Specialist
Supervising Safety Engineer
Supervisor of Personnel
Supv. of Safety
Supv. of Safety & Security

Technical Manager
Technicians, X-Ray and Lab
Trainee Safety Program Specialist

Vice President
Vice President, Managing Director
Vice President, Safety Director