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SUPERVISORY MANAGEMENT SELECTION AND DEVELOPMENT

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16. Abstract (Limit: 200 words) This report presents the results of a study examining the relationship between supervisor characteristics and performance in underground coal mines. The specific objectives of the research include: document tasks performed by first-line supervisors during a normal shift; explain why supervisors carry out their duties as they do; identify salient characteristics of effective first-line supervisors; and formulate criteria for selecting and developing candidate supervisors. To accomplish the study objectives, on-site observation and data collection was carried out at 13 underground mines in Illinois, Ohio, and Pennsylvania. One hundred thirty-eight first-line supervisors were observed during a full work-shift and discussions with the supervisors and the mine superintendent were held during the course of the visit. The observational data from the study provide a detailed description of what supervisors do during their shift. The report begins with an introduction discussing the problem being studied and objectives of the research. The literature related to supervisor selection is then reviewed. The following section describes the research design including data collection procedures and statistical methodology used in the study. The next sections present the analysis of mine, section, crew, and supervisor characteristics. The report concludes with a discussion of the results of the study and recommendations concerning supervisor selection and development.				
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FOREWORD

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SUPERVISORY MANAGEMENT
SELECTION AND DEVELOPMENT¹

by

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***EXECUTIVE SUMMARY

The purpose of this study is to examine the relationship between supervisor characteristics and performance in underground coal mines. The specific objectives of the research include: document tasks performed by first-line supervisors during a normal shift; explain why supervisors carry out their duties as they do; identify salient characteristics of effective first-line supervisors; and formulate criteria for selecting and developing candidate supervisors.

To accomplish the study objectives, on-site observation and data collection was carried out at 13 underground mines in Illinois, Ohio, and Pennsylvania. at each mine, first-line supervisors were observed during a full work-shift and discussions with the supervisors and the mine superintendent were held during the course of the visit. In all, 138 supervisors were included in the study.

The observational data from the study provides a detailed description of what supervisors do during their shift. On average, 34 percent of their time is for system and safety activities or equipment failure observation; 18 percent for interacting with management and workers; and 21 percent for work activities or passive observation. There is considerable variation in how supervisors spend their time; differences exist depending upon the characteristics of the mine and crew.

The results of the study indicate that the proper selection of supervisors can have a positive effect on production. Personality traits of the supervisor also have an impact on production. However, the greatest impact of supervisors is on safety rather than production. The supervisor's experience, feelings about the job, and time spent interacting with workers were found to influence the number of accidents. Supervisor turnover can also result in increased accidents.

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To improve the selection of supervisors, greater reliance should be placed on the use of formal testing procedures and assessment centers. Long term goals should be developed to recruit and select supervisors with personality traits suited for the position. To increase the number of applicants from which to select, the importance of the supervisor position needs to be reinforced and career paths should be developed.

***INTRODUCTION

This report presents the results of a study examining the relationship between supervisor characteristics and performance in underground coal mines. The first-line supervisor (section foreman) plays a critical role in the production process since he/she is responsible for making sure the crew and equipment are producing efficiently. The safety of the crew is also the responsibility of the first-line supervisor. They must be knowledgeable about the safety procedures and ensure that procedures are followed. Therefore, an important question is what are the characteristics of supervisors which contribute to increased production and greater safety? Although much research has been conducted examining factors affecting mine production and safety, many questions remain concerning the characteristics of effective first-line supervisors.

The report is divided into nine sections. The remainder of this section describes some issues related to the selection of supervisors, and presents the specific objectives of this study. The second section reviews the literature relating to coal mine supervision. The literature concerning supervisor selection procedures is also discussed for both mining and non-mining occupations. The following section provides an overview of the research design for the project including the research hypotheses, sampling plan, data collection methodology, and statistical methodology. The following four sections of the report present the research findings from the study. Statistics are presented which describe the sample mines, sections, crews and supervisors. In addition, an assessment of factors which influence mine production and safety is presented. In the next section, the results of the study are summarized. Recommendations concerning the supervisor selection process and training are given in the last section along with suggestions for further study.

UNDERSTANDING THE SUPERVISOR'S DILEMMA

In the underground coal mining industry, every first-line supervisor must be "certified" by the state in which they work. To become certified, each candidate must have a minimum level of underground mine experience, depending on college experience, and pass a detailed test on mining law. This certification can be revoked by the state under certain conditions, e.g., a mine disaster resulting from a supervisor's mistake, a fatal accident, etc. Therefore, the state holds the certified section foremen responsible for the safety of their workers. In addition, the employing company holds the supervisors responsible for their section's production and cost control. In the short term, these safety and production requirements can be in conflict. This is the dilemma that each supervisor faces on a daily basis and is one reason for the resistance by some employees to become supervisors. A second reason for the limited number of applicants for supervisory positions is the disparity in hourly wages

between workers and supervisors. In some cases, the hourly worker, who is paid for overtime, will make as much money as the first-line supervisor. A third reason is the substantial number of work hours per week required of supervisors. Typically, supervisors work more than nine hours per day and one extra day every two weeks. Some mining companies pay for this extra weekend work time, some do not.

Therefore, management's problem is twofold: limited qualified candidates from which to choose and difficulty in selecting the most qualified candidate. While our objective is to assist with the second problem, the results of the study should provide more understanding regarding the first.

Issues of Safety and the First-Line Supervisor

During the years 1981-1984, fifteen percent of all fatal accidents at metal and non-metal operations in the U.S. had supervisors as the victim. Eighteen of these 33 fatalities occurred while the victims were performing non-supervisory work. Table 1 provides a list of these fatalities by accident type.

TABLE 1. - Supervisor fatalities at metal and non-metal mines 1981-1984 (44)

Type of accident ¹	Number of fatalities
Haulage	9
Explosives	5
Electricity	4
Machinery	4
Fall of back	3
Fall of person	3
Falling material	2
Fall of highwall	1
Handling material	1
Inundation	1
Total.....	33

¹ Accident descriptions are for metal and non-metal mines.

These fatalities prompted several comments by key MSHA administrators:

1. MSHA Chief David A. Zegeer - "We at MSHA are very concerned by the number of fatal accidents involving foremen and supervisors. We're also concerned by what these accidents say about the quality of supervision in some mining operations." (44)

2. MSHA's Administrator for Metal and Non-Metal Mine Safety and Health - "Supervisors and foremen are the people who should have the greatest knowledge and skill in working safely. They should set an example for their employees. But fatality reports show that too many supervisors and foremen either don't know or don't follow safe procedures." (44)
3. Dick Judd - MSHA Health and Safety Specialist - "The majority of supervisors come-up through the ranks. They're the ones who put extra effort into their work. They don't ask anyone to do anything they won't do themselves." (44)
4. Dave Moore - MSHA Education Specialist - "In a lot of situations, hands-on-work is part of the supervisor's normal job." (44)

In coal mining during the period 1981 through 1983, 49 supervisors were killed. Table 2 provides a listing of the fatalities by type of accident. Of these 49 fatalities, section foremen were the victims

TABLE 2. - Supervisor/foreman fatalities by accident classification, 1981 through July 1983 (46)

Accident classification	Number of fatalities
Fall of roof or rib	13
Ignition or explosion of gas or dust	12
Powered haulage	7
Electrical	5
Machinery	5
Exploding vessel under pressure	2
Explosives	1
Fall of person	1
Hoisting	1
Inundation	1
Not yet classified	1
Total	49

in 19 cases. It is interesting to note that while section foremen are above the industry average by occupation for fatalities they are below the average for non-fatal injuries. Table 3 provides a comparison for the two periods 1971-1977 and 1978-1980.

Table 4 addresses the issue of experience and supervisor fatalities in coal mining. The results reinforce the importance of experience, but experience by itself is not the solution to reducing fatalities.

TABLE 3. - Comparison of fatalities and non-fatal injuries
for the periods 1971-1977 and 1978-1980 (46)¹

	1971-1977	1978-1980
FATALITIES		
Average all supervisory categories	.13	0.10
Section foremen	.11	0.80
Industry average all classifications ...	.09	0.06
NON-FATAL INJURIES		
Average all supervisory categories	9.54	7.04
Section foremen	12.28	3.38
Industry average all classifications ...	13.98	10.47

¹ Entries in table are fatalities/non-fatal injuries per 200,000 hours

TABLE 4. - Supervisor fatalities in coal mining, by victims' experience Jan. 1981 through July 1983; total of 49 fatalities involving supervisors (47)

Years experience	Total mining experience	In job classification	At mine
More than 20	x6	1	0
20	0	0	0
19	1	0	1
18	1	0	1
17	0	0	0
16	0	1	0
15	1	1	1
14	1	0	0
13	0	1	1
12	9	0	1
11	4	2	1
10	2	1	1
9	1	0	0
8	7	5	4
7	3	2	2
6	1	5	2
5	4	4	2
4	3	6	1
3	2	4	4
2	1	3	5
1	0	4	5
Less than 1	0	7	10
Not given	2	2	8

x = number indicates the number of fatalities for this category of time.

In the coal industry eighteen supervisors have recently been killed while performing non-supervisory work. As reported by Snyder (45), "If you get along good with (the crew), they'll let you operate the equipment, said one former section foreman, we all did it for a couple of reasons. It's done to gain an understanding of the men, a comradeship ... to be one of the boys ... I was fascinated running the equipment -- like a boy with a new car."

Mr. Zegeer responds by saying, "A good foreman has so many responsibilities that ... he doesn't have time to do classified work and he shouldn't short change his responsibilities by doing it."

This project provides insight into how each surveyed supervisor spends their day and how this time allocation has an impact on their safety as well as production performance.

Mine Productivity

In Figure 1, mine productivity and the number of mines operating is shown for the period 1975 to 1984. The productivity of underground mines has gone from 1.19 tons per personhour in 1975, to a low of 1.04 tons per personhour in 1978. Productivity gradually increased to 1.72 tons per personhour during the years 1979 to 1984. This increase is partially a result of the closing of over 750 underground coal mines. As shown in Figure 1, there were over 2,500 mines in 1977 which declined to less than 1,700 mines in 1983. The mines which were closed tended to be the least productive. These closings have increased the availability of supervisors and has generally improved the quality of supervision. On the other hand, these closings have increased the job-future ambiguity, anxiety, and job stress of supervisors.

PROJECT OBJECTIVES

The two initial objectives of this study were to identify salient characteristics of effective supervisors and to formulate criteria for selecting and developing candidate supervisors. In agreement with the USBM, it was decided that a detailed description of tasks a supervisor performed during a shift as well as an understanding of why certain tasks were performed, was needed before the other objectives could be addressed. Therefore, the following four objectives were developed:

1. Document tasks supervisors perform during a normal shift.
2. Explain why supervisors carry out their work as they do.
3. Identify salient characteristics of effective first-line supervisors.
4. Formulate criteria for selecting and developing candidate supervisors.

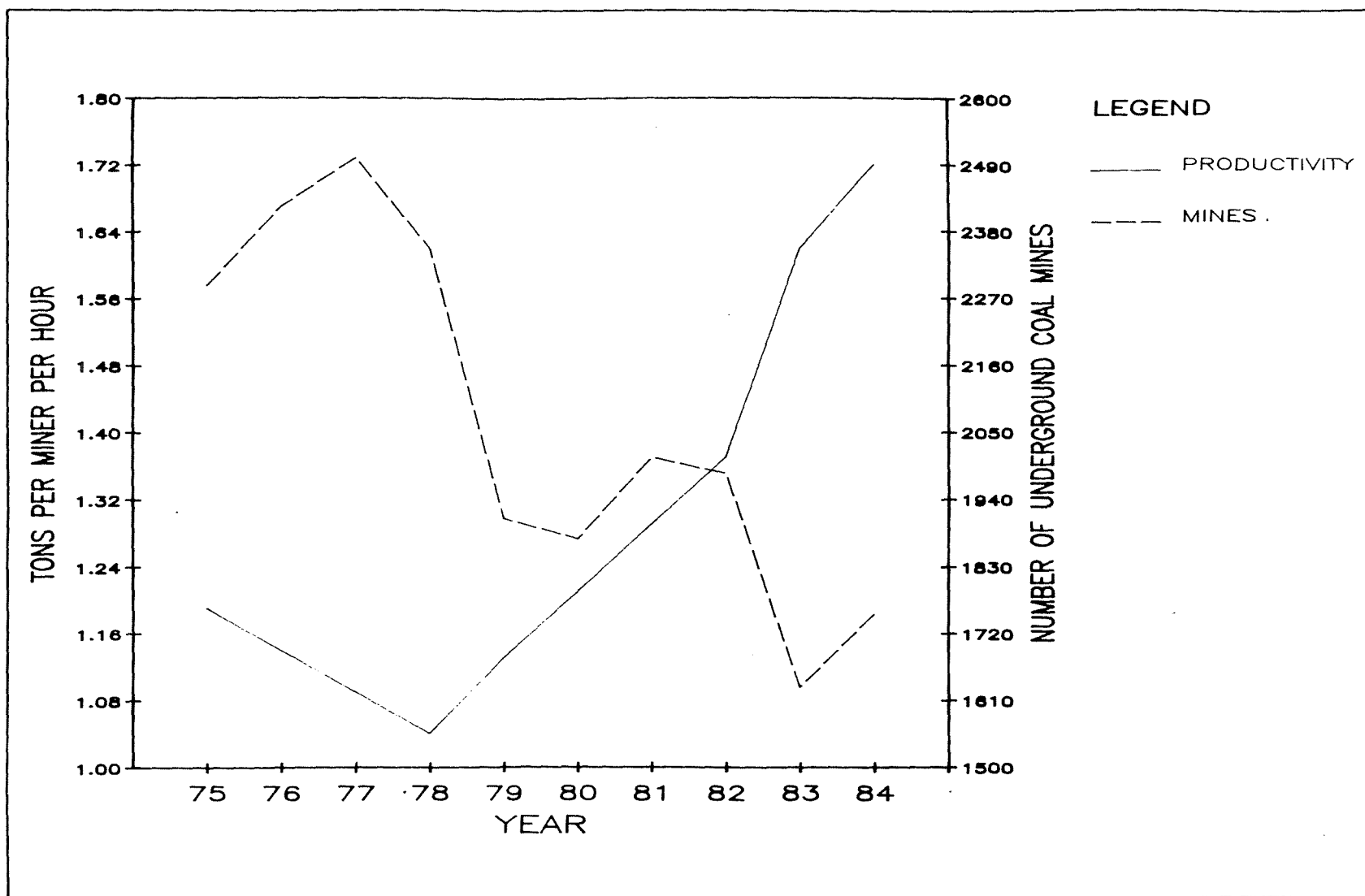


FIGURE 1. - Mines Productivity and Number of Mines: 1975 to 1984

***LITERATURE REVIEW

In this section, a literature review is presented which describes the current state of knowledge concerning the role of supervisors and selection procedures. Three main topics are discussed: (1) coal mine supervision, (2) supervisory selection procedures in the mining industry, and (3) supervisory selection procedures in non-mining industries.

COAL MINE SUPERVISION

Several studies [Baker (4), Brown (11), Hill (23), Walton (52)] have documented the importance of supervision on coal productivity. In addition, the quality of supervision is believed to be directly related to safety performance [Althouse (2), Brown (10), Pfeifer (36), Sanders (39), and Trist (49)].

Smith (42) in analyzing factors which were common to successful safety programs, identified not only the importance of the supervisor's role but also the importance of well developed selection, job placement and advancement procedures for both the workers and supervisors.

Blehl (7), during a needs assessment program for a coal company, identified several problems and stated: "Faulty communications account for more loss of supervisor's effectiveness than any other single problem."

Gavin (20) in a micro-study of one underground mining company explored the dimensions of underground miner's perceptions of the work environment, how these dimensions related to measures of well being, and to what extent such factors as age, seniority and work assignment accounted for perceptions of the environment and one's well being. In the analysis of the results the following issues emerged:

- "Supervisory considerations, for example, taps the human relations skill and safety-mindedness of the shiftboss, suggesting that miners see a clear connection between how open-minded and fair a boss is and how concerned he is with their physical well-being." (20)
- "Within the task measure cluster: describes a shift boss "syndrome" of unfair criticism, under task measures and punitive practices." (20)

The major implication of this study "strongly underscores the significance of promotion policies and the interpersonal behaviors of supervisors regarding the well-being of his miners". Studies of industrial organizations have traditionally examined the constraints

imposed on middle and lower management personnel, the results of which have produced the legendary description of the lower echelon manager and foreman as the "man-in-the-middle". Foremen and supervisors can effectively influence the performance and safety of miners through recognition, reward, and instruction (24). At the same time, foremen frequently report, and often experience, a level of legitimate authority which falls short of the authority needed to make crucial on-site decisions. Among miners themselves it was not at all uncommon to hear them describe the foreman's job as among the most dangerous in the mine not simply because they were involved in production but also because foremen usually were directing workers whenever trouble had occurred during production. Theodore Barry and Associates (5) found that the foreman's job was ranked 4th in accounting for fatal accidents in underground coal mines.

In the analysis of first-line supervisors, the issue of job stress and strain must be discussed. This became clear in a 1977 study by Althouse and Hurrell (2) in which they analyzed the responses of 486 miners and supervisors employed in 29 mines in 9 different states.

Few surprises emerged from a comparison between miners and mine foremen. Foremen reported that they wanted, and in fact had, considerable responsibility for their crew, projects and equipment, while feeling much less ambiguous about their assignments than miners felt about their own jobs. Although miners themselves reported low ambiguity concerning their future careers, the foremen reported even less future ambiguity than miners. Comparatively, the foremen were significantly higher in the amount of participation they experienced in decisions affecting them, as well as in the feedback received from the results of their productive activities and were lower in their feeling of unused skill and ability. There were no other significant differences between stressors for these two groups, except for stronger dissatisfaction with workload and higher somatic complaints among the underground miners.

The results of the study did not support the initial hypothesis that high accident mine employees would express higher stress than miners in lower accident mines. Nor, as a result, was there support for the idea that greater stress would produce greater dissatisfaction with one's job and higher psychological strain.

While the specifics of a supervisor's job varies from mine to mine, four basic functions of supervision remain constant. These functions are planning, leading, organizing and controlling. HumRRO (26) categorized the tasks of first-line supervisors into five main activity groupings corresponding to logical division of the workday. Accordingly, they provide the following observations:

- pre-shift activities are concerned with getting information about the conditions in the mine and the personnel, supplies, and equipment available for the shift. Based on the information received on these conditions and resources, a basic plan for the day is developed and passed on to the crew.

- early shift activities involve assigning tasks to individual crew members, seeing that the work area is safe and cleared for work, having crew members check out equipment and supplies, taking gas and ventilation readings, and resolving any problems that come up.
- mid-shift activities are concerned with ensuring that crew members are doing their job well. These activities involve evaluating safety conditions, identifying training needs, conducting on-the-job training, motivating the crew and exercising leadership, and assisting in contingency and emergency plans.
- late shift activities are concerned with creating good working conditions for the oncoming section crew. Activities during this period involve having the crew clean up the area and service the equipment as required, determining the general condition of the mine, the equipment and supplies and communicating the information to the oncoming supervisor and maintenance and mine personnel.
- post-shift activities are concerned with preparing production and delay reports, reports on condition of machinery and other equipment at start and end of shift, and reports on changes in conditions in the mine.

Thus, when a candidate is being considered for a supervisory position, mine management must assess the candidate's ability to perform these activities in a manner that will maximize production, while reducing the chance of an accident.

For the purposes of the current study, it was important that more specific information regarding what a supervisor does during the course of his/her day be developed. A time study of each supervisor provided this information. It was assumed that the tasks and allocated time per task would vary by supervisor, by mine, by company, and by state.

This study also provides an opportunity to expand the work started by Althouse and Hurrell (2) in examining the key elements of how each supervisor perceives their job and how this relates to their effectiveness. The results from this examination will identify which elements are evident in effective supervisors and which elements need to be analyzed to improve supervision.

SUPERVISORY SELECTION PROCEDURES IN THE MINING INDUSTRY

Psychological Testing

A review of the literature indicated that both psychological testing and assessment centers have been used for selecting supervisors in the underground coal industry. Psychological testing was introduced into the West Virginia coal industry following World War II. Since that time only sporadic experimentation with its use has been conducted.

According to a 1970 study, four Pennsylvania companies were using psychological testing in their employment procedure (30):

- Island Creek Group - Employment and non-exempt clerical, wage and hourly employees only;
- U.S. Steel Corporation (Frick Division) - Initial hiring of all mine personnel and supervisors;
- Consolidation Coal Group - Initial hiring of all mining personnel and supervisors; and
- North American Coal Corporation - Initial hiring of all mine personnel and supervisors, clerical workers, and all office personnel. Also, tests are a consideration in promotion to higher and supervisory positions.

Of these, North American Coal Corporation (NACCO) has the longest and, perhaps, most extensive experience with psychological testing. NACCO instituted a testing program for hiring and promotion in 1954. During the applicant evaluation stage, seven tests were administered with classification scores as shown in Table 5.

TABLE 5. - Classification scores in NACCO testing program (30)

	Test scores		
	Unsatisfactory	Satisfactory but watch	Favorable
General intelligence:			
1. ¹ PRI Classification	40-Below	41-62	63-Higher
2. Army General Classification	70-Below	71-90	91-Higher
Handling detail:			
3. PRI Name Comparison	94-Below	95-97	98-Higher
4. PRI Number Comparison	34-Below	35-47	48-Higher
Mechanical aptitude:			
5. Purdue Mechanical	87-Below	88-97	98-Higher
6. Minnesota Paper	39-Below	40-46	47-Higher
Supervision:			
7. How Supervise?	55-Below	56-70	71-Higher

1 PRI refers to the Personnel Research Institute

The test-battery has since been narrowed down to only three tests, and NACCO finds the reduced test-battery to be equally as good as "predictors of success". The test-battery now consists of:

- Personnel Research Institute Classification;
- Personnel Research Institute Number Comparison; and
- Minnesota Paper Form Board (MPFB).

In Pennsylvania and Ohio, all new employees take all three tests. In Utah and North Dakota, applicants for a UMWA job take only the Minnesota Paper Form Board test. Salaried personnel take the same three tests everywhere, and their scores must be indicated on their application form before they are approved for employment.

A study of some of the test results obtained by NACCO at various mining properties shows a substantial variation in scores in different geographical areas. The results of only the MPFB and the Personnel Research Institute (PRI) Classification Tests were used for comparison by Lang (30) (see Table 6 below).

TABLE 6. - Examples of test scores from different North American Coal Corporation divisions (30)

Mine location	Personnel type	Number tested	MPFB average	PRI average
Eastern Ohio:				
Mine A.....	Supervisory	22	35	54
Mine B.....	Mine worker	69	32	40
Mine C.....	..do.....	70	33	40
West Virginia:				
Mine D.....	..do.....	13	21	36
Mine E.....	Supervisory	14	37.5	50
Mine F.....	Mine worker	3	37.6	43.5

NACCO drew the following conclusions after seventeen years of testing (30).

1. Employment norms must be varied in certain geographic locations.
2. The Minnesota Paper Form Board Test has more reliability than any other test because it is not related to education.
3. The Personnel Research Institute Number Comparison Test indicates only if a person can think under pressure and can handle details. If candidates score poorly, they will likely fail in any test involving detail work.
4. The Personnel Research Institute Classification Test is simply a measure of the effectiveness of the education to which a person has been exposed. One must have a good

vocabulary in order to score high. This test is correlated with the applicant's school grades, therefore they cannot be misrepresented. The minimum acceptable score for a job should be related to the amount of reading the job involves; a score of 50 is the minimum acceptable score for supervisors.

Assessment Centers

The assessment center method is a standardized procedure in which candidates, gathered at a center, are evaluated for their potential for promotion or training. Multiple observational techniques are used, and each person is evaluated along a number of defined supervisory abilities or "dimensions". A team of trained observers, drawn from the organization, carries out the task of evaluating the candidates on these dimensions, and then makes an overall judgment of each person's potential for advancement, placement or training. During the 1970's, U.S. Steel (50) at their Cumberland Coal operations initiated a formal "Section Foreman" Assessment Center. While details of its operation and results to date are not available, the dimensions analyzed have been presented in several papers. The twelve dimensions which were assessed are contained in Table 7.

The assessment center generally has the following features.

1. Multiple techniques are used, such as group exercises, interviews, peer ratings, and other performance measures. These techniques are designed to bring out performance by the candidates relative to the dimensions which are critical to success on the job.
2. Trained line-supervisors staff the center. They are the "observers" and are drawn from a stratum of supervisors, either two or three levels above the candidates. Thus, a candidate's immediate supervisor is usually involved in the assessment center process.
3. Six or twelve candidates are assessed at the same time.
4. Observers interpret their observations, and then they integrate them judgmentally for each candidate. The strengths and limitations of each candidate are evaluated and followed by a global rating of potential.
5. The assessment center is conducted off the job, generally during a one- to three-day period.

TABLE 7. - Assessment center dimensions for supervisors

Oral communication skill.....	Effectiveness of expression in individual or group situations.
Stress tolerance.....	Stability of performance under pressure and opposition.
Management/work standards.....	Identification with the responsibilities of management; cooperation with other section foremen; and desire to do a good job for the job's own sake.
Leadership.....	Initiation of interpersonal contact and cooperation; effectiveness in getting ideas accepted and in guiding toward task accomplishment.
Sensitivity.....	Skill in perceiving and reacting to the needs of others.
Listening skill.....	Ability to extract important information in oral communications.
Behavioral flexibility.....	Ability to modify behavioral style and management approach to reach a goal.
Planning and organization.....	Ability to efficiently establish an appropriate course of action and to make proper assignments of personnel and appropriate use of resources.
Problem analysis.....	Skill in identifying problems and possible causes.
Judgment.....	Ability to make logical and rational decisions which minimize risk.
Decisiveness.....	Readiness to make decisions, render judgments, and take action.
Sensitivity to employee safety needs.....	Awareness of conditions that affect employees' safety and a willingness to take appropriate action.

SUPERVISORY SELECTION PROCEDURES IN NON-MINING INDUSTRIES

Although few jobs have received as much attention as has the job of first-line supervisor, the literature until recently has been relatively sparse. The literature primarily addresses three areas: the role of supervisors, their qualifications or their training.

Northrup's study (34) of eight plants from eight industries illustrates how informal the procedures tend to be. Table 8 summarizes the selection systems used in the eight sample plants. In interviewing sample first-line supervisors, complaints were often voiced concerning the informality and unreliability of the selection systems. Northrup found that "lists or any other objective criteria for rating potential supervisors were not generally used in the plants studied". Most plants rely on a general consensus of the foreman and top management for selecting the best candidates to fill a position.

A more formalized selection procedure could encompass several distinct steps. Figure 2 provides one possible sequence. This possible sequence is appropriate for use with the use of any predictor.

For step one -- the job analysis, all characteristics and required behavior for the specific position should be studied. This study is normally conducted either by observing some one perform within the position or having a current position occupant describe what he/she does. Both techniques have problems which can be summarized as follows (28):

1. The "halo" error: This is the tendency to allow one characteristic of a rating object to dominate ratings along other dimensions of the object being rated. An example of this is when we are more likely to attribute intellectual qualities to a person who wears glasses than a person who does not.
2. The "central tendency" error: This is the tendency to rate all rating objects around the "middle" or mean of a rating continuum and not to use the extremes.
3. The "leniency" error: This is the tendency to rate all social objects in a relatively favorable manner and not to attribute negative aspects to them.

In step 2 -- hypothesis development determines the kinds of individuals who would be most likely to fit the behavioral demands of the job. A listing of potential dimensions has been listed in the previous section of this literature review.

Step 3 -- predictor development focuses on how one is to measure individual differences in job applicants on the relevant variables.

Step 4 -- administration of predictors to sample is often ignored in the process and thus creates problems with examining the validity of the measures. It is important that during the development stages that personnel being selected for a position be selected using the prior procedure. After people have been selected, the predictors are administered, scored and filed for use in step 5.

TABLE 8. - First-line supervisor selection strategies (34)

Plant	Formality	Group vs. independent decision	Involvement of top management	Involvement of lower management	Sources of replacement
Nonferrous smelter	Very informal; general foreman makes major decision.	Group consultation.	Plant superintendent reviews decisions of supervisor and has choice approved by at least one higher level.	General foreman consults with foremen and recommends candidates to his superintendent.	Most "come up through the ranks."
Paper manufacturer	Very informal; new system is being respective.	Group decision.	General superintendent and mill manager review the recommendation.	Handled almost exclusively by line managers; superintendent asks assistants and foremen for opinions and recommendations and refers to upper management.	People from the top of their respective progression lines.
Electrical products manufacturer	Informal procedures due to small size of the plant.	Tends to be made by top management; group interview.	Personnel office may recommend; superintendents, general foreman, and personnel interview candidates; superintendent has final say.	General foreman and superintendent decide; most supervisors and foremen are not consulted.	Current employees get first consideration, generally the next level below; plant must frequently recruit from the outside.
Chemical manufacturer	No formal procedures, but general practices followed.	Group decision among top management.	Plant manager, operations manager, personnel manager, superintendent, and supervisor meet and review candidates; if there is a disagreement, the plant manager makes the final decision.	Superintendents consult supervisors; supervisors do not consult foremen, but recommend candidates after checking files.	Most selected from group-one employees who have some experience due to supervisory responsibilities of a group-one job; only a little departmental line crossing.

TABLE 8. - First-line supervisor selection strategies (34) -- Continued

Plant	Formality	Group vs. independent decision	Involvement of top management	Involvement of lower management	Sources of replacement
Aircraft manufacturer	Very informal; reflects recent layoffs and downgrading of supervisors.	Manufacturing management and personnel decide together; general foreman has most impact.	Personnel office recommends and confers with line management.	Line management, from assistant foreman to director of manufacturing, recommends; general foreman decides on list.	In the past, leadmen were used, now supervisors are usually grade ones unless previously laid off or downgraded supervisors are available.
Petroleum refinery	Informal procedures; guidelines not always practiced.	Personnel and line management review decisions; when 2 candidates are equal, seniority is important.	Department head develops list, submits to director, who submits to personnel office; candidates tested, used on a temporary basis; joint committee for permanent opening reviews and recommends; decision depends primarily on top management which reviews all decisions.	Occasionally consulted, but rarely is anyone lower than general foreman involved; first-line supervisors evaluate temporaries; 70% of the selection decision is based on their evaluation.	Try to maintain equal ratio of college to hourly sources in operations maintenance; promote from within; come from top of progression line on probation; if they perform well, they are retained.
Food processing plant	Somewhat formal; general procedures followed.	All potentials are identified in yearly reviews; when a position opens, several management levels are involved.	If a college graduate is to be chosen, division manager selects; personnel dept. reviews recommendations for possible problems.	If an hourly is upgraded, lower levels are involved; degree of involvement of first-line supervisors varies between departments.	For production, a utility service operator position is the training ground; maintenance supervisors come from top classification or from inspectors (if department lines are crossed).

TABLE 8. - First-line supervisor selection strategies (34) -- Continued

Plant	Formality	Group vs. independent decision	Involvement of top management	Involvement of lower management	Sources of replacement
Automobile assembly	Very formal; extensive application form, training program after selection.	Committee of comptroller, EEO coordinator, production manager, production director, personnel supervisor, material directors, and top officials interview applicants.	Plant manager's assistant confers with personnel.	Consultation with foremen and superintendents.	Selected mostly from assemblers--not those with key positions because those are usually the ones with most seniority and not necessarily the best.

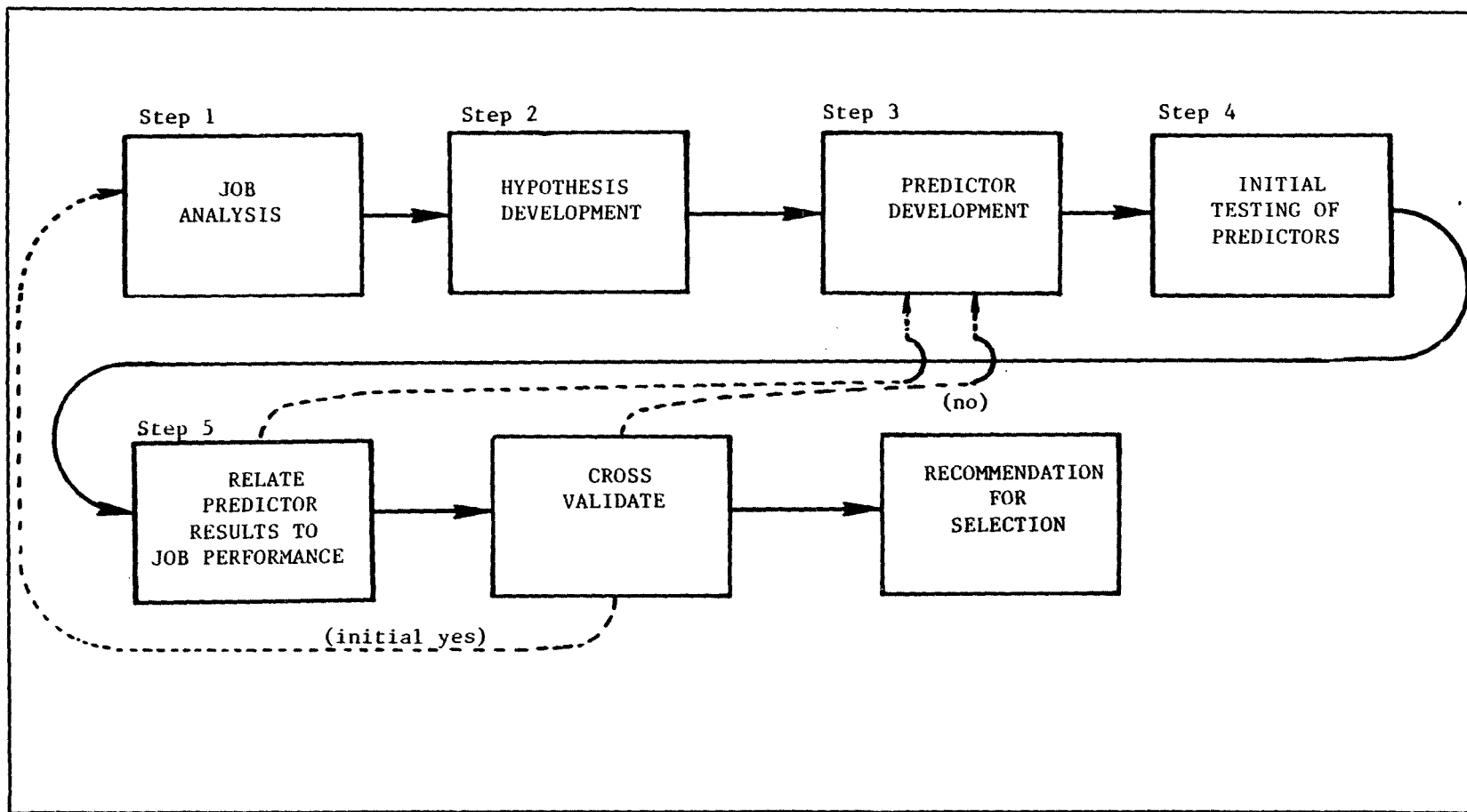


FIGURE 2. - Potential selection procedure sequence (30)

Step 5 -- relate predictor results to job performance is performed after the previously selected personnel have been on the job long enough to get meaningful measures of job performance. Using the predictor's scores from step 4 and the performance measures from step 5, various statistical techniques can measure the relationships between the two. Table 9 provides a list of principles based on the two factors, the base rate of success (difficulty level) and the selection ratio in a given situation. These two factors determine the practical usefulness of a given selection instrument.

Step 6 -- cross validation provides the first check point. If the results of step 5 show promise then the entire process should be repeated to eliminate potential "chance errors". If the results are not promising the process should either be re-started at step 1 or step 3 depending on the results of step 5.

The final step in the procedure is step 7 -- recommendation for selection. Based on the results of the cross validation, a set of guidelines should be developed for the administration of the recommendation. The results of step 6 could result in a table or series of tables which define acceptable scores (e.g. Figure 3.)

The remainder of this section will address the two most common formal methodologies for personnel selection: (1) assessment centers and (2) selection testing. Both the selection testing and assessment center programs are founded on the same principle: objective, job-related information can be gathered about a position and position applicant and related through the use of a measurement instrument. Furthermore, the information collected by the measurement instrument can be used to predict the applicant's potential success in a specific position.

The similarities of both programs are:

- The need for professional expert counsel and assistance to implement and maintain the selection system.
- The requirement for an active, relevant role for line managers to play in the development and administration of the selection tools and procedure.
- Both are costly in comparison with traditional, non-validated solution practices.
- The need for a periodic comprehensive audit and evaluation of the program.

TABLE 9. - Usefulness of selection devices when related to validity, selection ratio, and job difficulty (21)

The higher the validity of the selection device, the larger will be the proportion of selected persons who turn out to be satisfactory (e.g., with a selection ratio and job difficulty of 50%, a validity of .75 will yield 77% satisfactory workers. Under these same conditions a validity of .25 will yield only 58% satisfactory workers).

The smaller the proportion of candidates selected, the larger will be the proportion of selected persons who turn out to be satisfactory (e.g., with a validity of .50 and a job difficulty of 50%, a selection ratio of 20% will yield 78% satisfactory workers, whereas a selection ratio of 80% will yield only 57% satisfactory workers).

The easier the job, the larger will be the proportion of selected persons who turn out to be satisfactory (e.g., with a validity of .50 and a selection ratio of 50%, a job with a base success level of 80% will yield 91% satisfactory workers, but one with a base success level of 20% will yield only 31% satisfactory workers).

A selection device of lower validity when coupled with a lower selection ratio may be as effective as, or more effective than, a device of higher validity which is coupled with a higher selection ratio (e.g., for a job of 50% difficulty, with a validity of .25 and a selection ratio of 20%, the yield of successful workers will be 64%. In a job of equal difficulty, but with a validity of .75 and a selection ratio of 80%, the yield of successful workers will be 61%).

A selection device of lower validity when applied to an easier job may be as effective as, or more effective than, one of higher validity which is applied to a harder job (e.g., with a selection ratio of 50%, a validity of .25, and a job difficulty of 80%, the yield of successful workers will be 86%. With a selection ratio of 50%, a validity of .75, and a job difficulty of 20%, the yield of successful workers will only be 37%).

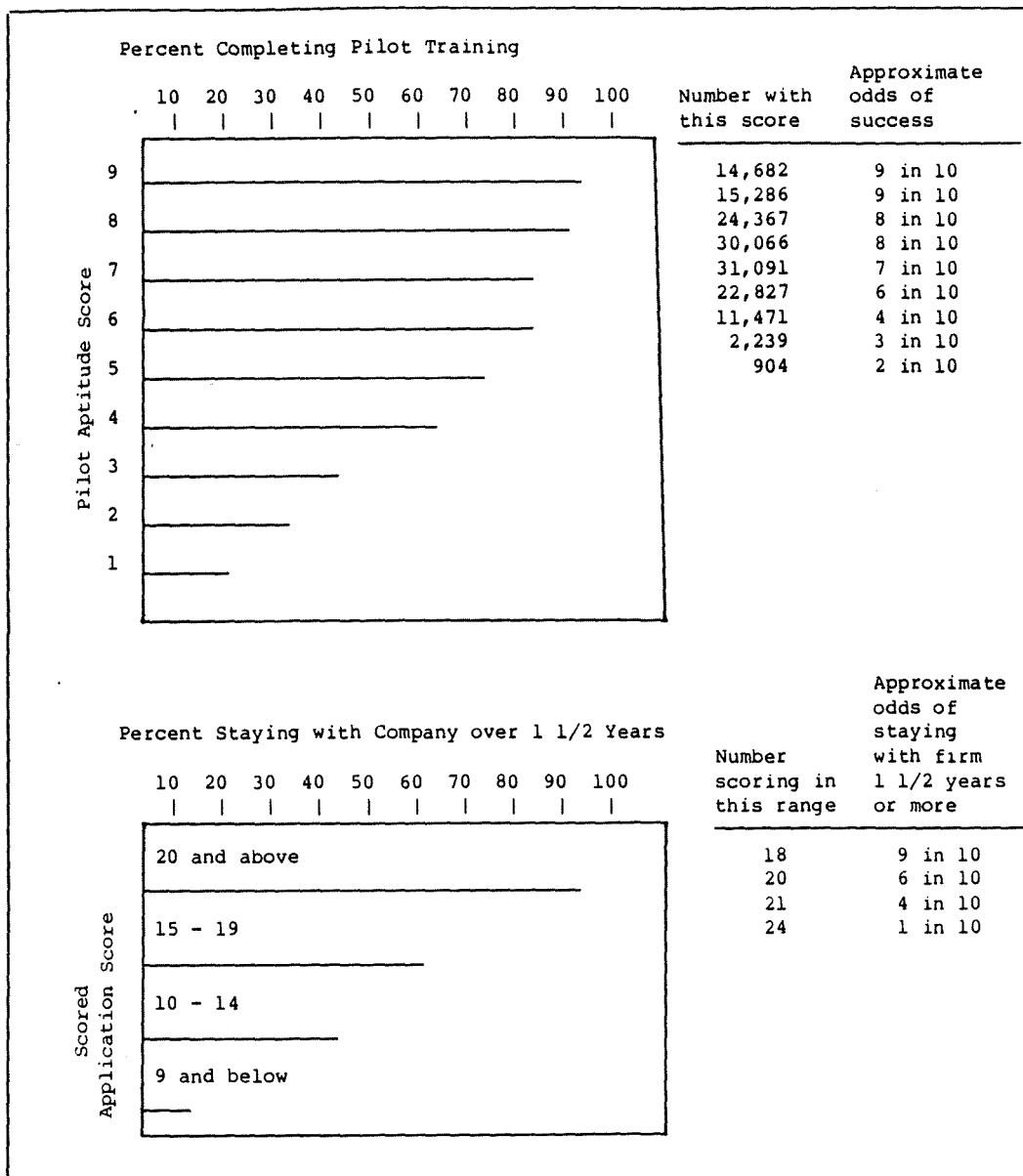


FIGURE 3. - Examples of simple cut-off systems relating test scores to job behavior (34)

The differences in the programs include:

- The assessment center approach encompasses a number of selection devices to evaluate behavioral traits and is viewed as a "broad band" approach. The selection testing systems lend to be a "narrowband" approach.
- The assessment center focus on job behavior and selection testing focuses on performance standards. The difference is that assessment variables encompass traits, abilities, qualities, and performance considered characteristic of being a good manager. Performance standards, in contrast, are specific measurements of job execution or achievement in a particular job.

Assessment Centers

The combination of management's desire to select managers of high quality and the federal government's policy of demanding objective proof of nondiscriminatory selection has generated substantial interest in the assessment center method. In 1969, only twelve American organizations employed this method; by 1977, over one thousand organizations worldwide were using it (14).

The assessment center method is holistic; it engages almost totally the personalities of candidates for upgrading and provides an analytical and evaluative structure whereby a number of assessors can observe the candidates and can combine several predictors to form an overall rating of potential for each candidate. Based on the well-established principle that early behavior tends to persist, the method consists of a variety of standardized tests and a system of simulations of actual work-related problems and complex situations that elicit behavior clearly related to success in a supervisory position.

Figure 4 provides a detailed flow diagram for ALCAN'S foreman selection program using the assessment center methodology. Any definition of the assessment center method must allow for the adaptability that is one of the method's major strengths. The individual characteristics of the many assessment center programs in operation vary greatly; time required, cost, content, staffing, administration, and selection of candidates differ because they depend upon the company's objective in assessment, the dimensions to be assessed, and the employee population. But in order to maintain the integrity and validity of the technique, certain requirements must be met. Table 10 provides a listing of these requirements (32).

AT&T is one of the best examples of an effective assessment center. The federal government tacitly approved the assessment center method as a nondiscriminatory selection device when the January 1973 Consent Decree was issued to AT&T. The "affected class" included women hired into management positions between July 1965 and December

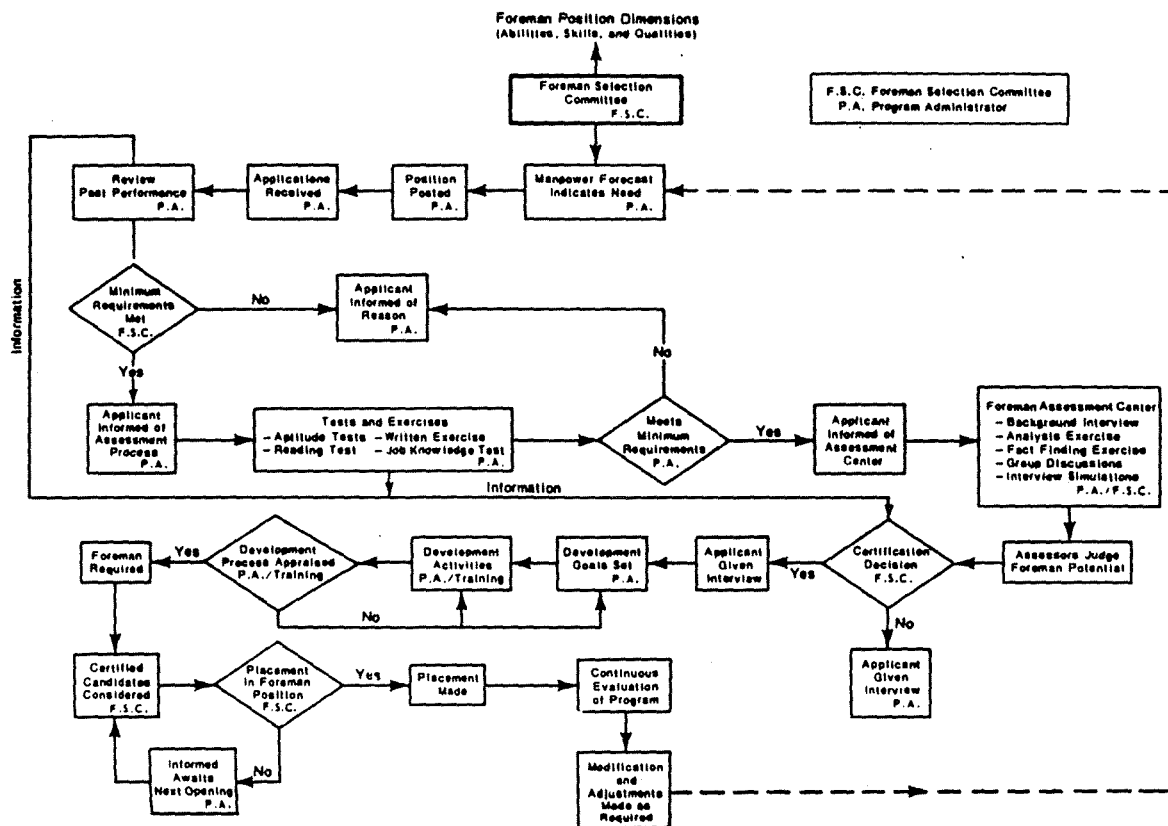


FIGURE 4. - Flow diagram of foreman selection program

1971 and not placed in the company's "fast track" development program. An assessment center program was used to determine the third-level management potential of those women in the affected class who elected to attend. Ninety-two percent (1,701) of the eligible women chose to attend the center; 42 percent of those assessed were designated as having high third-level potential and received immediate salary increases, and their names were placed on a third-level promotion list (25).

An examination of the Personnel Assessment Program (PAP) at Michigan Bell provides more detail into the workings of an assessment work program. The PAP examines eighteen variables (Table 11) drawn from the Management Progress Study. For the study, twenty-five variables had been selected from three sources: management and psychological literature outlining qualities important to managerial success, variables "proposed by several behavioral scientists outside the Bell System," and recommendations from senior personnel executives within the company (9).

There is nothing mysterious about the assessment process. Managers observe and evaluate the behavior of their subordinates every day. By manipulating circumstances and situations, the assessment center method intensifies this information procedure and helps managers who act as assessors by giving them a structured method of observation and a rigorous analytical technique.

The assessment techniques used in the PAP include the following:

Personal Interview. A one-and-one-half hour interview is conducted by an assessor with each assessee. It is directed toward obtaining insights into the individual's personal development up to that time, their work objectives, attitudes toward company policies, range of interest, and motivation. (In other companies, interviews vary in terms of structure, standardization of interpretation, and the general climate in which they are conducted.)

In-Basket. The candidate is presented with a set of materials that Bell System managers might expect to find in their In-Baskets. The twenty-five items encompass many things, from production reports to letters from customers. The subject is provided with the necessary material to complete the exercise, such as a copy of the union contract, management guide, organization chart, and stationery. Three hours are allotted to take appropriate action on the items by writing letters and memos, delegating, and so on. Following completion, all candidates undergo an interview with an assessor to determine their approach to the task, reasons for taking actions, and opinions of peers and supervisors.

No prior experience is necessary, but an individual's ability to establish priorities, make decisions, anticipate the

TABLE 10. - Necessary requirements for an effective
assessment center program (32)

-
1. Multiple assessment techniques must be used. At least one of these techniques must be a simulation.

A simulation is an exercise or technique designed to elicit behaviors related to dimensions of performance on the job by requiring the participant to respond behaviorally to situational stimuli. The stimuli present in a simulation parallel or resemble stimuli in the work situation. Examples of simulations include group exercises, in-basket exercises, and fact-finding exercises.
 2. Multiple assessors must be used. These assessors must receive training prior to participating in an assessment center program.
 3. Judgments resulting in an outcome (i.e., recommendation for promotion, specific training or development) must be based on pooling information from assessors and techniques.
 4. An overall evaluation of behavior must be made by the assessors at a separate time from the observation of the behavior.
 5. Simulation exercises are used. These exercises are developed to tap a variety of predetermined behaviors and have been pretested prior to use to insure that the techniques provide reliable, objective, and relevant behavioral information for the organization in question.
 6. The dimensions, attributes, characteristics, or qualities evaluated by the assessment center are determined by an analysis of relevant job behaviors.
 7. The techniques used in the assessment center are designed to provide information which is used in evaluating the dimensions, attributes, or qualities previously determined.
-

TABLE 11. - The PAP variables (9)

1. Energy - To what extent can this individual maintain a continuous high level of work activity?
2. Resistance to stress - To what extent will this individual's work performance stand up in the face of unusual pressures?
3. Inner work standards - To what extent will this individual want to do a good job, even if he could get by with doing a less acceptable job?
4. Self-objectivity - To what extent does this individual realize his own assets and liabilities?
5. Managerial identification - To what extent has this individual incorporated (or is likely to incorporate) values such as service, friendliness, justice of company position one earnings, rates, wages, etc.?
6. Forcefulness - To what extent does this individual make an early impact on others?
7. Likeability - To what extent does this individual make a likeable impact on the staff?
8. Range of interest - To what extent is this individual interested in a variety of fields of activity such as science, politics, sports, music, art, etc.?
9. Scholastic aptitude - To what extent does this individual compare to other individuals in his ability to learn new things?
10. Awareness of social environment - To what extent can this individual perceive subtle cues in the behavior of others toward him?
11. Behavior flexibility - To what extent can this individual, when motivated, modify his behavior to reach a goal?
12. Leadership - How effectively can this individual lead a group to accomplish a task without arousing hostility?
13. Need for superior approval - To what extent does this individual have a need to have his behavior approved of by those he views as his superiors?
14. Need for peer approval - To what extent does this individual have a need to have his behavior approved of by those he views as his peers?
15. Organizing and planning - To what extent can this individual effectively organize and plan his work?
16. Decision making - To what extent can this individual make decisions of high quality, and how likely is he to make decisions when required?
17. Oral communications skill - To what extent can this individual effectively present an oral report to a small conference group?
18. Written communications skill - To what extent can this individual effectively express his ideas in writing?

consequences of those decisions, organize the workload through proper delegation, and communicate both within and without the organization are assessed. The assessor observes whether the assessee is systematic, spot connections between related problems, and make use of the staff or whether they get bogged down in detail and ignore important matters. (The In-Basket materials are tailored to meet the needs of an individual company and position, but the basic structure is consistent.)

Small Business Problem. This is a manufacturing game wherein the participants assume the roles of partners in an enterprise manufacturing toys for handicapped children. This cooperative venture in an unstructured environment requires participants to buy parts and sell finished products under changing market conditions, to maintain inventories, and to manufacture toys.

Management games, as used at Michigan Bell and other companies, usually require participants to solve problems, either cooperatively or competitively. Topics include the problem described above, stock market tasks, or merger negotiations. The games should be geared to the level of the job concerned. They elicit leadership, organizational abilities, interpersonal skills, and sometimes reactions under stress.

Promotion Problem. This is an assigned-role leaderless group discussion centering on a management personnel function. The participants assume the roles of managers, each having a supervisor capable of promotion reporting to them. During the oral presentations phase of the problem each assessee has five minutes to present a description of their supervisor. The group then discusses the assets and liabilities of each hypothetical supervisor, and it tries to reach a group decision on the relative promotability of each. Compared to the Small Business Problem, this exercise is more structured and involves more competition.

The purpose of the leaderless group discussion is to examine the interpersonal skills of the assessee. No formal organizational roles are involved, nor is the authority which usually accompanies the title. Some individuals take control of the situation and lead the group, while others just sit, fearful of entering the discussion. A definite advantage of this exercise is that it provides an opportunity to view directly how well an individual interacts with others. As the assessee interacts, the assessors (usually three present) describe and evaluate their group influence, verbal skills, flexibility, and interpersonal relations.

Q-Sort. Here the candidates are presented with seventy personal statements and asked to sort the statements into several categories ranging from those which best describe themselves to those which least describe themselves. The Q-Sort provides more data regarding self-objectivity.

Paper-and-Pencil Test. This includes three separate tests. The School and College Ability Test (SCAT) is designed to measure general mental ability or learning ability. The General Information Test (GIT) provides a measure of the assessee's range of interest. The third item is a short autobiographical letter written by the candidates; it describes their job and how it relates to the overall company operation. This essay is scored on its unity and thesis, coherence, idea development, sentence structure, diction, style and general effectiveness.

Personal History Questionnaire. The questionnaire requests biographical information, e.g., educational background, previous work experience.

Table 12 provides an overview of the variables that some of the techniques are designed to tap.

The most extensive empirical validation of an assessment center program in industry was done by Douglas W. Bray and Donald L. Grant on AT&T's Management Progress Study (9). The focus was aptly chosen. Because none of the information collected about the subjects was ever given to company officials connected with the subjects, there was no criterion contamination; that is, the subjects' careers were not affected by their overall assessment rating. Table 13 shows the relationship between the overall assessment ratings and management levels that the college-educated and noncollege-educated subjects had attained by mid-1965. Of the former subjects, 49.6 percent had been judged to have management potential; of the latter, 28.4 percent. An additional study found that the predictive validities of this uncontaminated data were high; 82 percent of the college-educated who had reached middle management had been correctly judged; 75 percent of the noncollege-educated who had reached middle management had been likewise judged.

The first validity study of Michigan Bell's PAP compared the subjects assessed with the first forty employees promoted before the program began. Of the assessed group, 62.5 percent had received "better than satisfactory" ratings on the job; of the nonassessed group, only 35 percent had received that rating. Further, 67 percent of the assessed had been found capable of moving higher in management, while only 35 percent of the nonassessed had been found that capable.

The following is a list of the beneficial effects that a well-designed, validated assessment center program can have on an organization (41).

1. Identification of the criteria most important to management success.
2. Provision of standardized data to be used in placement. (When a manager is faced with considerable

TABLE 12. - Sources of evidence for assessment variables by assessment technique (9)

Variable	Personal interview	Promotion problem	In-basket	Small business	Tests
Energy	X	X	X	X	
Resistance to stress.....	X	X	X	X	
Inner work standards	X	X	X	X	
Self-objectivity		X	X	X	X
Managerial identification	X				
Forcefulness	X	X	X	X	
Likeability	X	X	X	X	
Range of interest	X				X
Scholastic aptitude					X
Awareness of social environment		X	X	X	
Behavior flexibility		X		X	
Leadership		X		X	
Need for supervisor approval	X		X		
Need for peer approval ..		X		X	
Organizing and planning			X		
Decision making			X		
Oral communication skills		X			
Written communication ... skills				X	

TABLE 13. - Relationship between assessment staff prediction
and management level achieved by 1965 (8)

Sample	Staff prediction	No. pre- dicted	No. at first-level management	No. at second-level management	No. at middle manage- ment or above
College	Will make middle management in ten years	62	1	31	30
	Will not make middle management in ten years	63	7	49	7
Noncollege	Will make middle management in ten years	41	3	25	13
	Will not make middle management in ten years	103	62	36	5

differences between the requirements of a candidate's present job and those of the position for which they are being considered or with differences between the kinds of jobs which the candidates hold, the usefulness of standardized data cannot be underestimated.)

3. Early identification of managerial potential in the manpower pool. (Although criticized for recommending personnel who actually do not have managerial skills; that is, its validity appears strong.)
4. Improvement of the candidates through the method's inherent ability to train and develop and through the simulation of their self-awareness.
5. Facilitation of selecting minorities and women for supervisory positions.
6. Through accurate placement, a reduction of management turnover.
7. Improvement of the assessors' managerial skills.
8. Enlightenment of management to a flexible, multi-level aid to making decisions about human resources.
9. Formulation of the organization's development plan.

Selection Testing

Personnel Testing refers to the practice of administering psychological tests to personnel in order to secure information useful in their selection, placement, and career guidance. Users of psychological tests believe that a carefully and professionally developed program of personnel testing can and does substantially reduce costly methods of trial and error in personnel administration and reduces the relative incidence of faulty decisions concerning personnel moves. Ideally, then, the end objective of personnel testing is to help in insuring a flow of the right people into the right jobs at the right times.

Broadly defined, personnel testing extends back at least as far as the early Greeks. References to the need for applying tests to determine latent capacities occur frequently in Plato's "Republic". However, modern testing grew out of the work of Sir Francis Galton in England, Alfred Binet in France, and James McKeen Cattell in the USA. In 1894, Cattell administered early "mental tests" (tests of strength of grip, reaction time, memory for letters, etc.) to students at Columbia University. Working with school children in France, Alfred Binet was the first to demonstrate the usefulness of more complex tests (e.g. following directions, unscrambling words to make

sentences, etc.) for the identification of mental retardation and the assessment of general mental ability. His series of tests, published in 1908, constituted the first intelligence test. By far the most successful translation and revision of Binet's tests for use in the USA was completed under the direction of Lewis Terman of Stanford University. First published in 1916, the Stanford Binet Test of Intelligence has undergone two major revisions (1937 and 1960) and remains today the most widely used individually administered measure of intelligence in the world.

Personnel testing on a broad scale came of age during World War I when psychologists, under the direction of R. M. Yerkes, developed tests of intelligence which could be administered to groups rather than requiring individual administration. In the process of screening and assigning recruits during World War I, the Army tests were taken by over one and one-half million men. After the war, personnel testing expanded rapidly along many fronts. Scores of new tests were developed; test usage extended into a wide variety of educational and industrial settings; and, during the 1930s and 1940s, heavy emphasis was placed on developing vocational interest and personality tests. The 1950s and early 1960s were years of consolidation and further expansion and also witnessed the proliferation of large scale nationwide testing "programs." (27).

Most testing programs are based on the convictions that (1) discrete performance for a particular job can be defined and, with some degree of accuracy, measured; (2) information related to performance in a specific job can be obtained from a job applicant; and (3) information collected from a job applicant through interests tests, patterned interviews, etc., can be used to judge objectively the applicant's relative suitability for the job.

This concept has a number of implications for upgrading and selection. First, the method can indicate what information about candidates is job related (valid). Second, it provides a structure for a more complete description of the job and a better matching of the candidates to a specific job. Third, because minorities and women may be at a disadvantage in that they have not had the opportunity for certain previous jobs or experiences (factors often used to evaluate candidates for first-level supervision), the method provides a means to evaluate the validity of past jobs and experiences, as well as to evaluate the validity of alternatives. Fourth, besides providing guidance to the candidates about what will be expected on the job, the performance standards provide essential input for training programs. (34)

The process is, as developed by Honeywell, conducted in two or three phases: (1) Phase 1 - Development of performance standards, (2) Phase 2 - Predictor validation and (3) Optional phase 3 - Development of interest profiles. The steps in phase 1 are shown in Figure 5. The objective of phase 1 is to develop a set of performance standards that apply to a specific position as defined by the expectation of a sample of managers. Table 14 provides a listing of performance categories

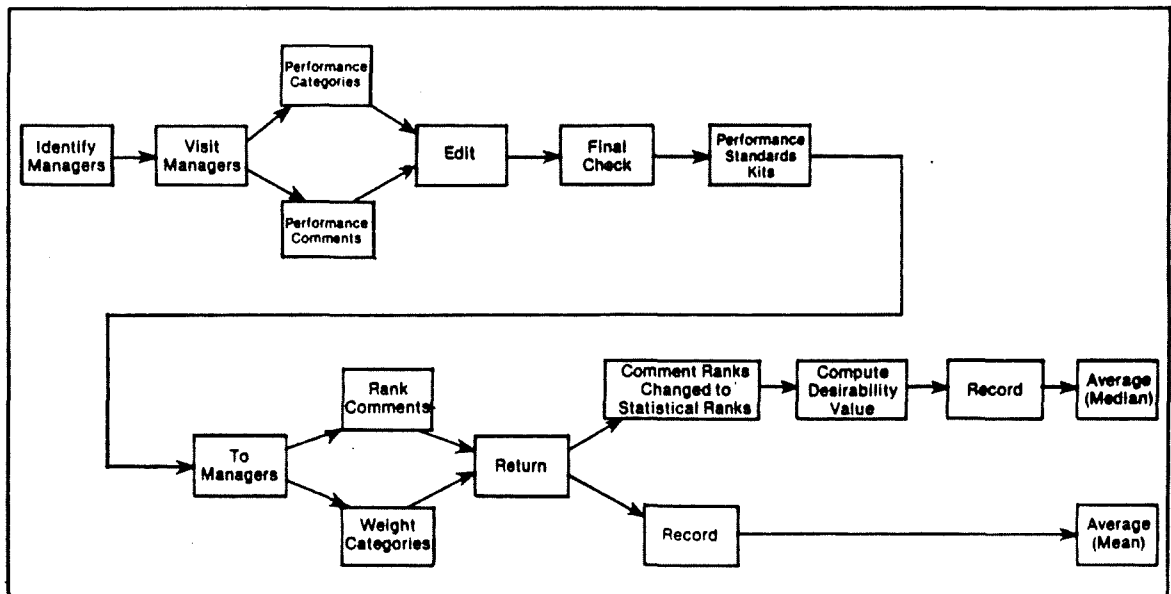


FIGURE 5. - Development of performance standards (34)

TABLE 14. - Performance categories for factory supervisors (34)

-
1. Ability to plan for the accomplishment of goals (8%)
 2. Ability to administer rules and policies fairly and consistently (8%)
 3. Interdepartmental relations (6%)
 4. Ability to train and develop subordinates (8%)
 5. Initiative (9%)
 6. Member of management (7%)
 7. Technical competence (6%)
 8. Human relations skills (10%)
 9. Safety and housekeeping (5%)
 10. Communications (8%)
 11. Willingness to accept responsibility (8%)
 12. Integrity, trustworthiness, and honesty (10%)
 13. Department administration (7%)
-

for factory supervisors. Table 15 provides an example of computed weights and desirability values for one example performance category. Computing the weightings requires calculating a mean value for each category with the total point value for the entire job equal to 100.

Honeywell's phase 2 (predictor validation procedure) is shown in Figure 6. Once the performance standards are defined, selection tools can be developed and validated. In addition companies are also concerned about the retention of position applicants and incumbents. Therefore, Honeywell also has developed a phase 3 development of interest profile to measure occupational interest. This procedure is shown in Figure 7.

If psychological selection tests are used, the importance of validating the tests cannot be understated. In an article supporting the use of assessment centers rather than traditional methods alone, Norton (35) makes the following statements concerning psychological tests based upon reviewing the literature.

1. "Paper and pencil tests of mental ability are inexpensive and moderately valid predictors of managerial success. However, ability tests containing items related to supervision do not seem to offer any advantages over general mental ability tests." (35)
2. "The literature... reveals many failures to predict managerial success by these measures [paper and pencil personality and interest tests] and few successes.... A reasonable generalization would be that if an organization invests a substantial amount of time and money in predictive validity studies, it will find personality and interest tests to be of some value in predicting managerial success." (35)
3. "Although projective tests seem to have more potential for predicting managerial success than paper and pencil personality tests, they are much more expensive and would be easier to defend in an EEO lawsuit." (35)

Norton therefore advocates the use of assessment centers involving multiple techniques and multiple trained observers because of the stability of its validity.

TABLE 15. - Performance category weighting and
performance comment desirability values (34)

Category:

Ability to plan for the accomplishment of goals. (8¹)

Description of Category:

Includes determination of subgoals to support company goals,
anticipating possible problems, gathering relevant
information, setting priorities, and implementing plans.

Comments:

Adjusts to changing conditions and reacts accordingly;
accomplishes his planned results. (96²)

Is able to determine and set priorities despite
interruptions from a variety of departments. (96)

Foresees possible problems and has contingency plans ready.
(91)

Plans ahead, but remains flexible. (89)

Can differentiate a short-term situation from a long-term
situation. (87)

Requisitions more personnel when the workload changes. (77)

Good on short-range planning, but makes no long-range
plans. (74)

Tends to overcommit himself. (54)

Makes plans before weighing all the facts. (54)

Is reluctant to delegate work which could be done by someone
else. (46)

Is not adequately aware of company goals - both short- and
long-range - when he makes his plans. (43)

Gets involved doing the work, rather than supervising it.
(39)

Makes plans, but they are unrelated to company goals. (39)

Has difficulty meeting deadlines and hates to commit
himself. (37)

Occasionally spends a day or more on small problems (e.g.,
tracking down a \$1.80 change on his budget printout).
(35)

Considers planning alone sufficient without action to
implement it. (35)

Makes sure he always has enough work on hand, even if it
means missing a schedule date. (31)

Plans come apart under pressure. (30)

Plans are usually grandiose and unjustifiable. (26)

Makes no plans, but reacts to the latest or loudest
demands. (22)

Planning is incomplete and half-baked, many changes of
direction. (20)

Every change is a crisis or disaster. (10)

1 Category weighting

2 Desirability values

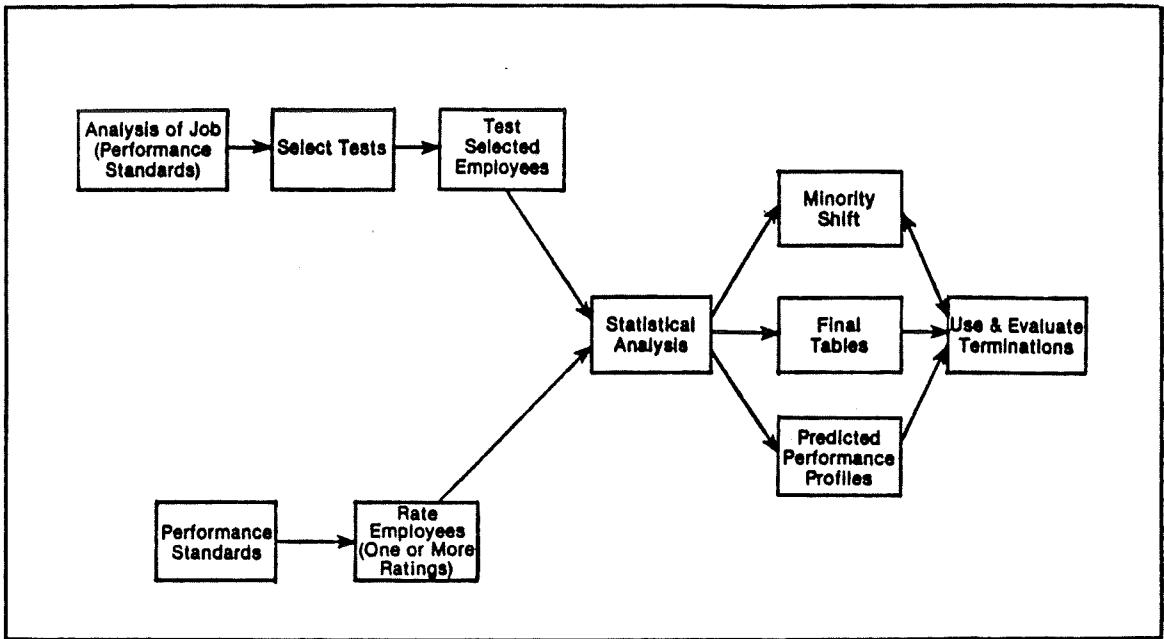


FIGURE 6. - Predictor validation (34)

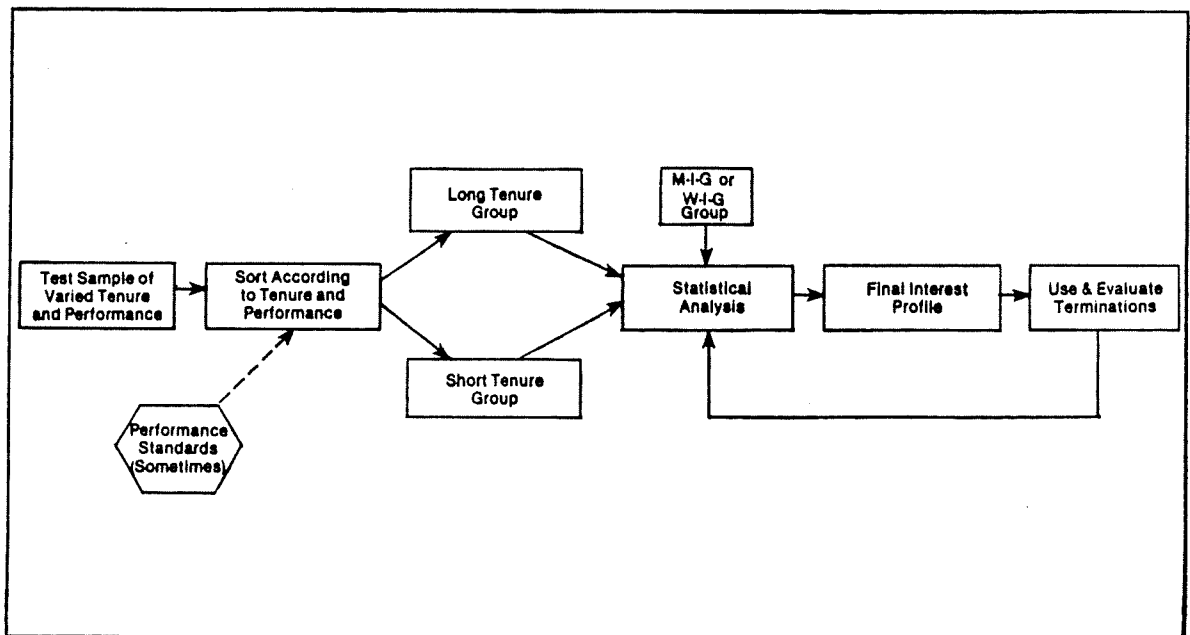


FIGURE 7. - Development of interest profile (34)

CONCLUSIONS

The review of the literature has shown the need for:

1. A detailed documentation of the supervisor's job. This documentation should include not only what supervisors do but how often and for what period of time;
2. A determination of what activities have an impact on supervisory effectiveness;
3. How these factors are affected by company policies and state mining laws;
4. More documentation on procedures currently used by companies for selecting supervisors;
5. A closer examination of different leadership styles and its potential impact on effectiveness;
6. A better understanding of what supervisors think about their job;
7. Better answers regarding how geotechnical variables affect a supervisor's attitude and effectiveness; and
8. Developing better measures of supervisory effectiveness.

***RESEARCH DESIGN

This section of the report describes the research design for the study. This includes three major parts: (1) the research hypotheses and specific questions to be addressed by the study, (2) the sampling plan, site visits and data collection instrument, and (3) the statistical methodology used in the study.

RESEARCH HYPOTHESES

The primary objective of this project is to identify the salient characteristics of effective first-line supervisors in underground coal mines. The measures of effective supervision must include both production and safety. Therefore, our first research hypothesis is that the effectiveness of a first-line supervisor (performance) is a function of the characteristics of the mine (M), section (S), supervisor (F), and crew (C):

$$\text{Performance} = f(M, S, F, C) \quad (1)$$

While the focus of the study is on the characteristics of the supervisor (F), the potential impact of the variables, M, S, and C, must also be considered and analyzed.

In investigating this hypothesis, several questions were developed and examined.

1. Is there a relationship between supervisory safety and production performance?
2. It has been determined from other studies (48) that differences in geotechnical variables account for 50% of the variance in production. Of the remaining variance, how much can be explained by characteristics of the supervisors and crew?
3. What are the more important characteristics of a section supervisor that influence safety and production?
4. How does the variation in crew characteristics affect supervisory performance?
5. Which crew characteristics have the greatest impact on safety and production?
6. How does the state law affect the performance of supervisors?
7. Does the union status of the mine affect supervisor activity?

The second major objective is to formulate criteria for selecting candidate supervisors. Several dimensions of supervisory behavior, as well as general characteristics, were documented and analyzed. The performance of a mine section (relative to safety and production) is a function of: (1) the section supervisor's behavior (FB), e.g., leadership style, planning and communication skills; (2) supervisor's characteristics (FC), e.g., age, work experience, and education; (3) mine controllable factors (MC), e.g., equipment maintenance, downtime utilization; and (4) mine uncontrollable factors (MU), e.g., physical conditions and mining laws. Thus, the performance equation can be rewritten:

$$\text{Performance} = g (\text{FB}, \text{FC}, \text{MC}, \text{MU}) \quad (2)$$

This formulation of the performance function leads quite naturally to the following additional research questions.

1. How does mine management currently select section supervisors?
2. Are these techniques effective?
3. What characteristics of supervisors does management feel are important?
4. What behaviors by supervisors have an impact on performance?
5. How does the behavior of an effective supervisor differ from an ineffective supervisor?
6. How do supervisors feel about their job and how does this affect their performance?
7. How do incentive plans affect a supervisor's behavior and performance?

The totality of information collected in the study has been used to define four categories of explanatory variables for equations 1 and 2. The relationship among the variables is displayed in Table 16.

TABLE 16. - Relationship¹ among explanatory variables of equations 1 and 2

	Supervisor		Mine factors	
	Behav- ior (FB)	Character- istics (FC)	Control- lable (MC)	Uncontrol- lable (MU)
Mine (M).....			X	X
Section (S).....			X	X
Supervisor (F).....	X	X		
Crew (C)			X	X

¹ An X denotes that the variable categories are derived from the same set of basic information.

SAMPLING PLAN

Based on the research hypotheses and project objectives, specific data requirements can be specified. The sampling plan identifies considerations which were also taken into account in the selection of the sample. For the results of the study to be useful, it is important that the sample is representative of the mining industry and of first-line supervisors. The following sections discuss factors taken into account in the selection mines and supervisors.

Mine Sample

Based on Health and Safety Analysis Center (HSAC) data, charts comparing production and accident rates for various mines were prepared. After eliminating very small mines (those with an average production of 10,000 tons or less per year over the last 4 years) and mines with no production record in the HSAC files for 1980-1983, approximately 2,300 mines remained for the sample design. The design was based on assigning mines to one of three categories corresponding to level of production and accident rate. The definitions for the high, medium and low categories for production and accident rate are given in Table 17.

TABLE 17. - Definition of high, medium, and low categories

	High	Medium	Low
Production....10 ³ tons/yr.....	500	100-500	100
Accidents:			
Per 10 ³ employee-hours.....	1.0	0.3-1.0	0.3
Per 10 ⁶ short tons.....	60	30-60	30

As an example of the mine selection criteria, Table 18 categorizes eleven representative Illinois mines in terms of production and accidents per million tons and accidents per thousand employee-hours.

Table 19 provides a comparison of various key factors, e.g., selection procedure, mining method, seam height, union status, and size for a majority of the larger underground coal producers in Pennsylvania, Illinois, and Ohio. The intention was to select mines that were representative of the distribution of mines considering production and accident rate, subject to their willingness to participate in the study.

Supervisor Sample

The superintendent of the selected mines was requested to make a list of twelve supervisors to be studied. Based on the superintendent's judgment, these twelve supervisors were to include six of the most effective and six of the least effective supervisors.

Within a sealed envelope, which would not be opened until the mine data collection was completed, the superintendent noted which supervisors were rated most effective and which were rated least

TABLE 18. - Categorization of representative Illinois mines¹

Accident rate.....	High	Medium	Low
PRODUCTION VERSUS ACCIDENTS PER 10 ⁶ SHORT TONS			
High production....	Orient #3.....	Crown #2, Inland #2, Wabash, Orient #4.	Inland #1, Monterey #1.
Medium production..	Turris.....	None.....	Crown #3.
Low production....	None.....	None.....	Sahara #7.
PRODUCTION VERSUS ACCIDENTS PER 10 ³ EMPLOYEE HOURS			
High production....	Crown #2, Orient #3-#4, Inland #1-#2, Wabash, Monterey #1.	None.....	None.
Medium production..	Turris.....	None.....	Crown #3.
Low production....	None.....	None.....	Sahara #7.

¹ See Table 17 for definition of categories.

TABLE 19. - Company sampling information (underground mines)

	Selection		State			Mining			Seam inches		Union		Company		Sections	
	F	IF	PA	IL	OH	CT	CV	LW	54	54	Yes	No	Large	Small	2	2
U.S. Steel.....	X		X			X		X	X		X		X		X	
North American Coal Corp.....	X				X	X		X	X	X	X		X		X	
PMC.....		X	X			X				X	X		X		X	
Bethlehem Steel.		X	X			X		X	X	X	X		X		X	X
Republic.....	X		X			X		X	X		X		X		X	
Consol.....	X		X			X			X		X		X		X	
Y & O Coal.....		X			X	X			X		X			X	X	
MAPCO.....		X		X		X	X		X			X	X		X	
Monterey.....	X			X		X	X		X		X		X		X	
Freeman United..		X		X		X			X		X		X		X	
Shell Oil.....	X			X		X			X			X	X		X	
Inland Steel....	X			X		X		X	X		X		X		X	
R & P Coal.....		X	X			X		X		X	X		X		X	
AMAX.....	X			X		X			X		X		X		X	
Kerr-McGee.....	X			X		X			X			X	X		X	
Reitz Coal.....		X	X			X				X	X			X		X
SOHIO.....	X		X	X		X	X	X	X		X		X		X	

F Formal procedure.

IF Informal procedure.

CT Continuous.

CV Conventional.

LW Longwall.

PA Pennsylvania.

IL Illinois.

OH Ohio.

effective in rank order. This procedure was followed so that the observation of the supervisor by the field staff was not biased by a prejudgment. This categorization was subsequently used in the analysis.

Sample Size

KETRON has found that representative industry behavior is generally achieved with a sample of between 10 and 20 mines, depending on the nature of the issues being addressed by the research. With this number of mines, the results tend to span a reasonable range of conditions and therefore are useful to the industry, a principal concern of the project. On this basis, a sample of 13 mines was selected for the research project. The number of supervisors to be included in the study is additionally important. Information was originally collected for 138 supervisors. However, due to data collection problems, 3 observations could not be used. This left 135 observations which were used throughout the analysis.

SITE VISITS

Visit Organization

An important phase of the study was the site visits for collecting the observational data. Based on the considerations discussed earlier, mines were selected for participation in the study. Companies were then contacted to determine if they would be willing to participate in the study. The person contacted was generally the President of the company or Vice-President in charge of operations. Additional information or meetings to discuss the project were sometimes required to encourage companies to participate.

If the company agreed to participate in the study, the mine manager was then contacted. A time period for the site visit was selected when most supervisors would be working and which did not have any planned interruptions in production. Visits to the mines were for periods of 1 to 2 weeks and involved 2 or 3 observers for collecting the data. During the first day of each visit, historical and geotechnical information was collected on the mine, section and supervisors. A schedule was also developed for observing each supervisor during their normal shift.

The remaining days of the site visit were spent observing the supervisors. Each supervisor was observed for an entire day, from the time they were required to be at the mine until the time they left the mine. The average total observation time for each supervisor is over 9 hours.

Post-Visit Debriefing

On the last day of each site visit, a post visit debriefing was conducted. The mine manager, superintendent, and personnel director were invited to the meeting. The agenda for each debriefing included: thanking the mine personnel for their participation in the study; identifying any problems encountered in the data collection; providing an overview of the observations; giving recommendations for improvement; and, answering any questions. Following the site visits, mine personnel were contacted to fill any gaps in the mine data.

DATA COLLECTION INSTRUMENTS

In this section, the data collection instruments used in the study are described. Two data collection instruments were developed by using sections from instruments tested in earlier research projects. This approach was taken to minimize the time and costs associated with developing, testing and validating a data collection instrument.

The first data collection instrument consists of three sections corresponding to the computer file that would be constructed for each section. These are: (1) the mine file; (2) the mine section file; and (3) the supervisor's file. The second data collection tool is the time study instrument. In the data base development phase, data from the time study is matched with data from the appropriate supervisor, mine, and mine section file to form an observation for each of the 135 supervisors in the sample. A general description of the data collection instruments is provided in the remainder of this section. The first data collection instrument is contained in Appendix B while Appendix C provides a detailed description of activities observed during the time study of the face supervisor. A list and brief description of all the variables in the data base is given in Appendix D. Variables used in the analysis are described in greater detail in the section presenting the descriptive statistics.

Mine File

The mine file consists of seven records of data which were collected for each of the 13 mines. The data collected includes general mine information such as location, total coal production, number of employees for various categories of employees (e.g., managers, first-line supervisors, and underground hourly workers), and some mine effectiveness numbers (e.g., accidents, violations, grievances, turnover, strikes). Information on characteristics of the mine which may affect production include mine type (union vs. non-union), the coal market (captive vs. non-captive), the coal type, the number of wildcat strikes, the number of shifts per day, and the shift rotation system. Information about supervisors includes whether formal or informal selection procedures are used, supervisor turnover rate, whether there is a mine incentive plan, and the supervisor rotation system (rotates with the crew or not).

One personality test used in the study was the Leadership Opinion Questionnaire (LOQ) which was developed by Fleishman (19). This test measures two personality characteristics of the person: structure and consideration. The structure score provides a measure of how 'task' oriented the person is. The consideration score measures how 'person' oriented the person is. This test was given to the mine superintendent and the consideration and structure scores for the superintendent are included in the mine file.

Section File

The mine section file consists of two records of information which were recorded for the 61 sections that were visited. The questions in this part of the data collection instrument are similar to those used by Suboleski (48). Suboleski found that much of the variation in mine production is explained by the mine and mine section variables.

This part of the data collection instrument includes questions on geotechnical data for the section such as seam depth, seam height, entry widths, floor conditions, and other factors. There is also information about the equipment used in the section such as the shuttle car payload, manpower access and coal haulage mode, the number and type of roof bolters used, and the age of the continuous miner. Some performance data for the mine section is included such as shuttle car loading time, man-trip time, and average tons of coal production for the section.

Supervisor File

The third file is the supervisor file which consists of 12 records of data. The file contains background data on the supervisor, descriptive data on the crew, ranking of activities, information collected in discussions regarding the supervisor's job and regarding leadership. The background data on the supervisor includes information on age, education, race, sex, and various experience measures, whether the supervisor has mine manager's papers, union background, hours of training and supervisor status (regular vs. fill-in).

Data describing the supervisor's crew includes crew size, average age and experience of crew members, crew turnover, and number of minority workers in the crew. Performance measures for the supervisor include average coal production and number of accidents to the supervisor's crew. The mine superintendent was asked to rank effectiveness of the first-line supervisors. This ranking is included in the supervisor file and provides an additional performance measure for the supervisor. Since the focus of the study is to identify characteristics of effective first-line supervisors, several psychological tests were used to identify personality traits of supervisors in the sample. Although many tests were available, constraints on the supervisor's time limit the number of tests which

could be used. Two tests were selected for use with the supervisor: the LOQ instrument and NIOSH Occupational Environment Questionnaire. The LOQ instrument (discussed earlier) measures the supervisor's leadership characteristics along two dimensions, structure and consideration. The Occupational Environment Questionnaire measures factors related to job stress. This questionnaire compares characteristics of the person and the job to identify how well suited the person is for the environment they work in.

The second data collection instrument used in the project was the time study instrument. A flow chart for typical supervisor activity was developed along with a listing of potential interruptions which interfere with normal supervisory activity. The list of supervisor activities was obtained from HumRRO (26). The flow chart of activities is shown in Figure 8. A list of interruptions is presented in Table 20. Detailed descriptions of the activities and interruptions observed during the time study is given in Appendix C.

TABLE 20. - Supervisor time study interruption codes

Interruption code	Interruption description
50	Personal preparation
53	Power failure
54	Water delay
55	Equipment failure
57	Belt failure
61	Count and/or order supplies, locate, place
62	Work stoppage
63	Instruct workers (operator delay)
64	Management interaction peer, upper
65	Questionnaires
66	Mine reports
67	Marking and measuring face
68	Check on crew
71	Measure ventilation/install or correct curtains
72	Inspect section belt
73	Safety talk with crew
74	State/federal inspector/union safety committeemen
75	Accident investigation
76	Roof fall inspect/clean up/torque roofbolts
78	Gas check
79	Lunch/break

Collecting the time study data involved using a cassette tape recorder and digital wristwatch to record the start and end of each activity throughout the shift. For example, the following information

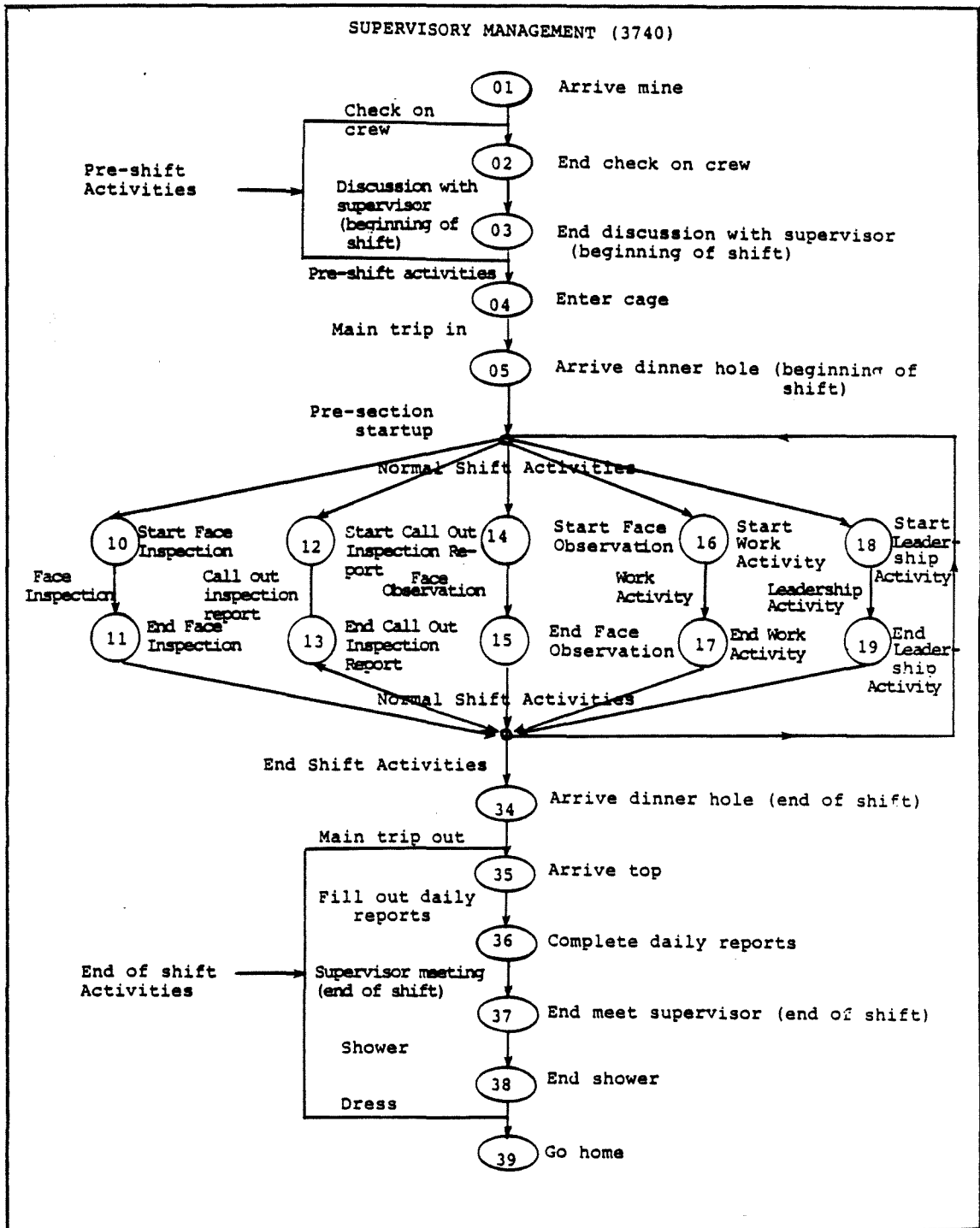


FIGURE 8. - Flowchart of supervisor activities

might be recorded on the tape:

- Start pre-shift planning in map room; 6:45:20
- Meet with departing crew supervisor at shaft bottom; 7:05:30
- End meeting; 7:10:40
- Begin face inspection; 7:25:10
- Etc.

This information was then transcribed, coded, and entered into a computer data base. A computer program processed the data to obtain the total time and frequency for each activity for each supervisor. Activities were aggregated into eight categories for the analysis. These categories are:

1. Equipment failure observation,
2. Safety activities,
3. System activities,
4. Interaction with management,
5. Interaction with workers,
6. Work activities,
7. Passive observation, and
8. All other activities.

The activities included in each category are defined in Appendix C.

STATISTICAL METHODOLOGY

The statistical methodology used in the project consists of four parts: (1) data base development, (2) descriptive statistics, (3) correlation analysis, and (4) regression analysis. The first step, data base development, involved defining variables and correcting any problems in the data. Descriptive statistics were used to obtain an understanding of the data and relationships between variables. The correlation and regression analysis identifies characteristics of supervisors which are related to the performance measures. Much of the initial data base development was done using programs written for the project on IBM PCs. The descriptive statistics, correlation analysis, and regression analysis were conducted using the Statistical Analysis System (SAS). This software is widely used and accepted.

Data Base Development

A data base containing all of the information which was collected at the mine site visits was created. A description of the data entry, validation and editing procedures utilized will be discussed in this section. Also included will be a discussion of the files created and the programs which operate on and manipulate these files.

The data collected is divided into four categories corresponding to the source of the data: (1) mine characteristics and identifying information; (2) section physical attributes; (3) supervisor

characteristics and attitudes; and (4) observation (time study) information. The information contained in each category was initially saved as a separate file. One mine file was entered per mine; one section file was entered per section observed; and one supervisor and one supervisor observation file were entered per supervisor observed. A total of 13 mine files, 61 section files, 138 foreman files and 135 foreman observation files were entered.

The data collection instrument used in this study (see Appendix B) also contained file layout and data entry information which were used by data entry personnel as keying instructions. The data entry personnel first reviewed the data collection instrument to insure that all data had been properly entered. In some instances fields were left uncoded and in other cases data values were found that were obviously out of the range of expected values for that particular field. When either of these situations occurred, questions were referred to the field researcher who collected the data. In some cases the researcher could assign a correct value to the field while in other cases a proper value could not be determined, in which case a special code was assigned to represent a missing value.

Using an IBM PC, the data was then keyed to floppy disk using the layout found on the appropriate portion of the data collection instrument. The supervisor observation file (time study data) was then run through a series of three programs. The first program validates the time study input file against a network file which contains all valid event and interruption codes and the sequence in which they may appear. All improper event and interruption codes, codes which appear out of proper order, and time values which were not in ascending time order are identified as errors which were then corrected. The second program separates interruptions from activities, categorizes and aggregates the time spent in the various types of activities and interruptions. The third program prints out statistics on the activities and interruptions for the supervisor being analyzed. An output file is written which contains total time engaged in and frequencies for 20 activities, 30 interruptions and 8 aggregate activities and interruptions.

When a complete set of data for a particular mine was entered and verified, the four files were merged into a single file containing one observation per supervisor. A number of index variables were also calculated from the raw data. These variables include the average coal production for shift index, accidents to the crew index, mine superintendent's ranking of foreman percentile, the safety committee ranking of foreman percentile, and the supervisor's Leadership Opinion Questionnaire scores and percentiles. The two index variables and two ranking variables are defined as the percentage of all supervisors who rank below this particular supervisor. The definition of 'below' is those supervisors who have a higher value for accidents and the two ranking variables (lower is better for these variables) and those supervisors who have a lower value for production (higher is better for production). The two LOQ scores were computed by summing the component questions' responses. The two LOQ percentiles were obtained

by looking the respective score up in a table and extracting the corresponding percentile.

This file was then uploaded to an IBM mainframe where SAS procedures were executed to produce both a frequency and a mean report. The resulting reports were examined for unexpected results as a final check on the validity of the data collected for that particular mine. The above procedure was repeated for all thirteen mines in the data base.

Many of the variables in the data base at this point contained missing values for some of the observations. Since this would greatly complicate the statistical analysis, it was decided that estimated values would be computed for the missing observations. To impute missing values, variables were categorized into one of four variable types. These are:

1. Categorical or Discrete Variables - variables that can assume only a countable number of values, and include the coded variables.
2. Continuous Variables - variables that can assume an infinitely large number of values in a line interval.
3. Index or Percentile Variables - variables which are always associated with another continuous or categorical variable. These variables represent the percent of responses in a particular group that ranked below the current response.
4. Composite or Aggregate Variables - variables which are the result of some arithmetic operation on two or more discrete, continuous or other composite or aggregate variables found on the file.

Missing values were only imputed for those discrete and continuous variables which are not index, percentile, composite or aggregate variables. Index and composite variables were not imputed since these variables are dependent on another variable. Composite and aggregate variables do not need to be imputed because they are the result of some arithmetic operation on two or more variables, and therefore can be calculated regardless of whether the values of the component variables are actual or imputed. A value obtained from a calculation involving imputed values was flagged as such. In the regression analysis, imputed values were only used for independent variables; if the observation for the dependent variable was imputed, the observation was dropped from the regression.

Another condition was also added before a missing value was imputed. It is felt that a missing value of a particular variable could not reasonably be imputed unless at least two thirds of the values for that variable are known. Therefore, no

attempt was made to impute values for a variable that had more than one third of its values missing.

A computer program was written to perform the imputation procedure, as well as calculate most of the final index and composite variables. The program first builds an empirical distribution for continuous variables. The minimum and maximum values for each continuous variable are found. Next, using the minimum and maximum values, five class intervals with equal width or size are created. The simple frequency of the values that fall into each interval is tabulated, along with the interval's relative frequency (simple frequency for the interval divided by total frequency) and cumulative relative frequency (sum of all relative frequencies up to and including this interval).

A similar procedure is performed for discrete variables. The values encountered for a variable are compared against the valid values for that variable. If all match, a frequency distribution is created including simple frequencies, relative frequencies and cumulative relative frequencies.

Once the empirical distribution is created, a uniform random number between 0 and 1 is generated. When the variable whose value is to be imputed is a continuous variable, the random number is compared with the cumulative relative frequencies until the first cumulative relative frequency is found that is greater than or equal to the random number. Linear interpolation is then used to estimate a value that falls somewhere within the bounds of the interval. The formula used to interpolate the value is:

$$\text{VALUE} = \text{XBND1} + [(\text{RANDNUM} - \text{Y1}) / (\text{CUMFREQ} - \text{Y1})] * (\text{XBND2} - \text{XBND1})$$

where:

VALUE	= the interpolated value,
XBND1	= lower bound of interval,
XBND2	= upper bound of interval,
CUMFREQ	= 1st cumulative relative frequency that is greater than or equal to the random number,
RANDNUM	= uniform random number, and
Y1	= largest cumulative relative frequency that is less than the random number.

This value, which becomes the imputed value, is added to the data base and is identified as imputed.

For a discrete variable the process is similar. The cumulative relative frequencies for every acceptable value of the variable are searched until the first value is found that is greater than or equal to the random number. The value associated with this cumulative

relative frequency value, preceded by a minus sign, then becomes the imputed value.

Composite or aggregate variables were also calculated at this stage: the supervisor's total training time (hours), the supervisor's LOQ consideration and structure scores and percentiles, and the accidents to crew variable. Three index variables, average coal production for shift index, the mine superintendent's ranking of supervisor percentile and the personnel ranking of supervisor percentile, were also calculated. Since a number of the variables on the supervisor file are answers to questions found on psychological testing instruments, a number of new variables which represent scores on these testing instruments were needed.

All the constructed variables were appended to the original file to create a data base containing over 500 variables. The complete list of variables is given in Appendix D. At the time of the regression analysis, there were some additional transformation to the variables which are also defined in Appendix D.

DESCRIPTIVE STATISTICS

The first step in analyzing the data involves the use of descriptive statistics. For all variables used in the analysis the mean, standard deviation, minimum and maximum values were computed. This is useful in order to obtain an overall perspective of the sample. For example, how does this sample compare to the rest of the mining industry. The basic descriptive statistics are also important in summarizing the time study information. Using the descriptive statistics we can describe what supervisors do during the shift which is one of the primary objectives of the study.

A second purpose of the descriptive statistics is to provide insight into relationships between the variables. Means can be compared between subgroups in the sample to determine if there are differences between the groups. For example, one question that can be addressed in this way is whether supervisors spend their time differently at union versus non-union mines. Comparing means of the aggregate observational data for each subgroup can help answer this question. In the following sections, comparisons like this are made to describe the data.

In comparing means, it is also important to know whether the difference between two groups is statistically significant (different) from zero. The "t-score", which is presented in tables describing the research findings, is a measure of the statistical significance of the difference between two averages. As the t-score increases in absolute value, the probability that there is no difference between the two

groups decreases. Generally, if this probability is less than 5 or 10 percent, we can reasonably reject the hypothesis that there is no difference between the two groups. Finally, it is also important to consider the magnitude of the difference. The difference between two means may be statistically significant, however, the magnitude of the difference may be very small.

Correlation Analysis

A second statistical technique used to examine the data is correlation analysis. This technique identified the degree of linear relationship between two variables. That is, if we plotted the sample observations for two variables on a graph, how closely would the observations lie to a straight line through the data. The 'correlation coefficient' is a measure of this linear relationship and ranges from -1 to +1. The magnitude of the correlation coefficient in absolute value indicates how strong the linear relationship is. For the sample size in this study, coefficients with an absolute value greater than .25 to .30 indicate a strong linear relationship. The sign of the coefficient indicates the direction of the relationship, positive or negative.

Correlation analysis is applied in two ways in this project. Given the large number of variables in the data base, correlation analysis is useful to identify variables strongly correlated to the dependent variables of production and accidents. Tables were prepared ranking the correlation coefficient of each variable with the performance measure. Variables which had a large correlation coefficient were included in the subsequent regression analysis.

A second purpose of the correlation analysis is to identify highly correlated independent variables in the regression equation. When this occurs, the precision of the regression estimates is reduced. The regression model cannot estimate the separate effect of two variables which are highly correlated. Correlation analysis was used to identify variables in the regression equations which were highly correlated. Some of these variables would then be excluded from the regression equation. Thus, the variables remaining in the equation partially capture the effect of the excluded variables.

Regression Analysis

The third statistical technique used in the project is regression analysis. This involves estimating the performance measures as a linear function of independent variables. The functions defined in equation (1) and (2) are now approximated by a linear functions. That is:

$$\text{Performance} = a + \sum_{i=1}^k b_i x_i + e \quad (3)$$

In this equation, the x_i variables include all the characteristics of the mine, section, supervisor and crew which influence production. Corresponding to each variable is a coefficient, b_i , which is the contribution of that variable on performance. The term, a and e in equation (3) represent the constant and random error term.

The purpose of the regression analysis is to estimate the coefficient and statistical significance of each variable. The regression output reports the significance level for each estimated coefficient. For a coefficient that is significant at a 5 percent level, there is less than a 5 percent chance that there is no effect of the variable on performance. The lower the significance level, the less likely it is that the true effect of the variable is zero. In the tables describing the regression results, we report whether the coefficient is statistically significant from zero at conventional levels (1, 5, and 10 percent).

The regression output also reports how well the regression model explains the variation in the dependent variable. This is measured by the "R-squared" for the equations. The R-squared is defined as the percent of variation in the dependent variable which is explained by the model. Previous research by Suboleski (48) found that over 50 percent of the variation in production is explained by physical conditions and the location of the mine.

To assist in the selection of variables for inclusion in the model, a variation of stepwise regression was used. This procedure is one of several statistical methods available which can be used to decide which regressor or predictor variables should be in the model. In choosing this statistical method we considered two conflicting constraints. First, our understanding of mining operations led us to believe that there are many factors which influence mine productivity and safety. Thus, the model chosen should include as many of the predictor variables as possible if reliable predictions were to be obtained from the fitted equation. Second, because of the time and expense involved in obtaining information on mine supervisors, the number of supervisors included in the sample was limited. The data base for analysis includes approximately 560 information items on 138 supervisors.

The number of potential predictor variables exceeds the number of observations from which to estimate the model; therefore, only a subset of variables could be used. While theory suggests that all potential predictor variables could be important, the number of supervisor observations constrains us to an empirically derived correlational model based on stepwise regression. In addition, many of the independent variables are highly correlated and cannot all be entered in the regression equation. The stepwise regression procedure identified which independent variable contributes the most to the explanatory power of the equation.

The stepwise procedure adds variables based on their contribution to the R-squared. At each step, the variable is added which results in the greatest increase in the R-squared. This process continues until the significance level of any additional variables exceeds some cutoff point (generally .30 to .50). As noted previously, the correlation coefficients of the independent variables were also examined to identify highly correlated variables. If a group of variables was found to be correlated, one of the variables would be included in the model and the remaining variables were dropped from the equation. The variables which appear in the final regression equations are the outcome of this selection process.

In the regression analysis, regression equations were estimated for five dependent variables. Descriptive statistics for these five variables are presented in Table 21. The production variable used is the average tons of coal production per shift for the supervisor's crew during the previous twelve months. The production index is a percentile ranking for the supervisor based on their average production. The production index for a supervisor is the percent of supervisors at the mine with average production less than that supervisor. A high production index corresponds to high production. The accidents variable is the number of accidents occurring to the supervisor's crew in the last year, while the supervisor was with the crew. The accident index for a supervisor is the percent of supervisors at the mine with more accidents than that supervisor. A high accidents index value corresponds to a low number of accidents. The supervisors were also ranked by the mine superintendent based on their effectiveness as a supervisor. The supervisor's rank index is the percent of supervisors at that mine ranked as less effective than that supervisor. A high rank index corresponds to effective supervisors.

The production and accident index variables have an advantage over the corresponding raw number in that mine differences are controlled for. That is, while mine characteristics influence production and accidents, ranking supervisors within a mine and using this rank as the dependent variable, controls for the difference across mines. Therefore, in the index variable regression equation, mine characteristics are not used as explanatory variables.

TABLE 21. - Descriptive statistics for the dependent variables

Characteristic	Mean	Standard deviation	Minimum value	Maximum value
Average coal production per shift tons..	385.2	142.2	158	801
Production index	42.4	29.5	0	92
Accidents	5.7	4.3	0	21
Accident index	39.9	29.5	0	92
Supervisor's rank index ...	44.6	28.5	0	92

***ANALYSIS OF MINE CHARACTERISTICS

In this section, the variables related to mine characteristics are described. The descriptive statistics for each variable are presented and the definition of the variable is clarified. The correlation and regression analyses of the mine characteristics are then discussed. The effect of mine characteristics are also examined in later sections which look at the observational data.

DESCRIPTIVE STATISTICS

The following discussion describes the mine characteristics for the 135 supervisors in the sample. One hundred twenty-one supervisors worked in union mines (all UMWA) and 14 worked in non-union mines. Twenty-four supervisors worked in captive mines (owned by the consumer of the coal) and the remaining 111 were with non-captive mines. Twenty-nine supervisors worked at mines using a formal process (psychological testing) to select supervisors. The remaining supervisors were employed at mines which used informal procedures to select supervisors. The sampled mines used either a 1-week (23 supervisors) or a 4-week rotation schedule (112 supervisors). Thirty-five supervisors were from mines which operated 2 shifts per day while 100 supervisors were from mines operating 3 shifts per day. Four mines (38 supervisors) used a production incentive plan, while 9 mines (97 supervisor) did not. Seventy-two supervisors were from mines located in Illinois, 39 supervisors were from mines in Ohio, and 24 supervisors were from mines in Pennsylvania.

Descriptive statistics for five other mine characteristics are presented in Table 22. The number of management employees at the mine ranged from 46 to 146 with an average of 74. Thus, there is considerable variation in the size of the mines in the sample. This is also reflected in the number of underground hourly employees which ranged from 151 to 364 with an average of 283 employees. Section supervisor turnover is the number of supervisors replaced in the past year. This variable was very skewed with one mine (12 supervisors) having a very high turnover in the past year of 15 supervisors that were replaced. The remaining 123 supervisors were from mines with 4 or fewer supervisors replaced in the past year. The average for this variable is only 2.8 supervisors replaced in the past year.

The mine superintendent LOQ scores provide a measurement of the leadership characteristics of the superintendent. The LOQ consideration and structure scores are two indices which are each based on 20 questions each. For each LOQ question, the respondent is

TABLE 22. - Descriptive statistics for mine characteristics

Characteristic	Mean	Standard deviation	Minimum value	Maximum value
Number of management employees	74.2	32.7	46	146
Number of underground hourly workers	283.0	73.3	151	364
Section supervisor turnover	2.8	4.3	0	15
Mine supt.'s LOQ consideration score ...	50.5	8.8	42	72
Mine supt.'s LOQ structure score	51.6	3.3	47	58

asked to indicate how frequently an item describes how they would like to act. Examples of a structure and consideration question are:

Structure - Insist that persons under you follow to the letter those standards handed down to you?
 1) never 2) seldom 3) occasionally
 4) often 5) always.

Consideration - Help persons under you with their personal problems?
 1) very seldom 2) once in a while
 3) occasionally 4) fairly often 5) often

The complete set of questions is shown in the data collection instrument in Appendix B. The average consideration and structure scores for mine superintendents were 50.5 and 51.6 respectively.

CORRELATION ANALYSIS

The correlation analysis indicated that a number of the mine characteristics were highly correlated with the dependent variables of production and accidents. Both the number of management employees and the number of underground hourly workers have a correlation coefficient greater than .45. Since the correlation coefficient between these two variables is also high (.41), only the number of

underground hourly workers variable is included in the production equation. For the superintendent LOQ scores, it is interesting to note that the correlation coefficient between the structure and consideration score is less than .20. Both scores are included in the production and accidents regression equations.

REGRESSION ANALYSIS

The regression analysis found that mine characteristics have a significant effect on both production and accidents. The estimated coefficients for the mine characteristics variables are presented in Table 23. The results for the complete regression equation are given in Appendix F. In addition to the discussion of the coefficients in this section, Appendix G summarizes the results for all significant coefficients and presents hypotheses for why the variables have the effect estimated in the regression equations.

TABLE 23. - Estimated regression coefficients for mine characteristics

Variable description	Estimated coefficient
PRODUCTION EQUATION	
Number of underground hourly workers.....	¹ .48
Non-union mine.....	² 148.81
Selection procedure.....	² 92.16
Shifts per day.....	² -63.49
Mine supt.'s LOQ consideration score.....	-3.16
Mine supt.'s LOQ structure score.....	³ 6.39
ACCIDENT EQUATION	
Illinois.....	¹ 3.101
Supervisor turnover in past year.....	¹ .433
Selection procedure.....	² 1.595
Mine supt.'s LOQ consideration score.....	³ -.089
Mine supt.'s LOQ structure score.....	.104

- ¹ Statistically significant from zero at the 1 percent level.
- ² Statistically significant from zero at the 5 percent level.
- ³ Statistically significant from zero at the 10 percent level.

For the mine characteristics, the number of underground hourly workers at the mine had a positive effect on production. This may be due to the availability of additional support to compensate for absenteeism, or for face tasks, for example, belt work, brattices, etc. Unionization has an important effect on production with non-union mines producing 148 tons more per shift than union mines. This result is in line with the conclusion reached by many previous studies, that is, union mines are less productive than non-union mines [for example, see Walton (51)].

The number of shifts per day also has a significant effect on production. Production per shift is 63 tons higher at mines operating 2 shifts per day compared to mines operating 3 shifts per day. The results of the regression analysis indicate that production is higher at mines where the superintendent is very task oriented. Although there is a negative relationship between the superintendent's LOQ consideration score and production, the estimate is not statistically significant.

Of particular interest for this study is the coefficient for the selection procedure variable. The estimate suggests that for mines which have a formal selection procedure, production is 92.2 tons higher than for mines which have only informal selection procedures. Formal selection procedures are defined as either an assessment center or a psychological testing program. These results suggest that such selection procedures can have a major impact on production.

Consider now the regression results for the accidents equation. In contrast to the production model, mine and section characteristics are relatively less important in the accidents model, while supervisor characteristics are very important. Many of the mine and section characteristics, highly correlated with accidents, were too highly correlated with each other to include in the model. The variables which were highly correlated included: supervisor turnover, shift rotation system, entry width, dinner time, rib condition, incentive plan, number of hourly workers, and seam depth. Since only supervisor turnover is included in the model, its coefficient of .433 may be partly due to the effect of these other factors on accidents.

The coefficient on the selection procedure indicates that at mines which use a formal selection procedure, the number of accidents is increased by 1.595 compared to mines with any informal selection procedures. Thus, formal selection procedures correspond to both higher production and greater accidents. Other mine characteristics influencing accidents include the location of the mine. The estimates indicate that for mines located in Illinois, 3.1 more accidents occur than for mines located in the other states in the sample.

The mine superintendent's LOQ consideration score is negatively related to accidents. This seems intuitively plausible; as the superintendent is more "person" oriented, accidents decrease. It is interesting to note how the coefficient for the LOQ scores compares in the production and accidents equation. In the accidents equation, the

coefficient for the LOQ consideration score is significant and negative while the coefficient for the LOQ structure score is positive but not significant. In the production equation, the LOQ structure coefficient is positive and significant. Thus higher LOQ consideration scores are associated with fewer accidents while higher LOQ structure scores are associated with greater production.

***ANALYSIS OF SECTION CHARACTERISTICS
DESCRIPTIVE STATISTICS

The data base contains 36 section characteristics. Many of the continuous variables are described in Table 24 and are for the most part self-explanatory (a glossary describing the mining terms is given in Appendix E). Age of the continuous mines is the number of years since it was last rebuilt. The man-trip time is defined as the time (in minutes) from when the crew arrives at the bottom of the slope or shaft until they arrive at the dinner hole on the section. The value is the time for a one-way trip. Other section characteristics were defined in categories. The effect of gas liberation is defined by the gas monitor characteristic. The characteristic originally had three values, two of which would impact the mining rate of the continuous miner. In the analysis, this categorical characteristic was redefined to have two values, either it had an impact (28 supervisors) or not (107 supervisors). The mine plan characteristic had five categorical values. For the analysis, a dummy variable was constructed which had two values corresponding to whether the supervisor was working in rooms or pillaring (38 supervisors) or in other areas, e.g., mains (97 supervisors). Dinner time either has the value of zero for the crews that stagger lunch breaks (84 supervisors) or a value of 30 minutes for lunch (51 supervisors). The seam dip code was redefined into two values: none (105 supervisors) and all other categories (30 supervisors).

TABLE 24. - Descriptive statistics for section characteristics

Characteristic	Mean	Standard deviation	Minimum value	Maximum value
Seam depth.....ft..	529.9	230.4	150	900
Entry center.....ft..	72.1	18.5	40	110
Crosscut center....ft..	72.6	16.5	40	100
Entry width.....ft..	17.5	1.6	16	20
Cut depth.....ft..	21.5	5.8	16	35
Seam height.....in..	71.2	13.2	42	96
Coal seam grade...pct..	0.5	1.5	0	10
Bolt length.....ft..	6.0	1.7	3	10
Number of entries.....	4.9	1.7	3	9
Shuttle car	4.9	1.7	3	9
payload.....tons..	6.3	2.0	3	9
Shuttle car loading	4.9	1.7	3	9
time.....min..	1.2	0.5	1	3
Man-trip time....min..	24.0	8.7	10	45
Age of continuous miner.....yrs..	4.4	4.0	1	14

CORRELATION ANALYSIS

The correlation analyses found that many of the section characteristics were highly correlated with production and accidents. Production correlation coefficients for some of these variables are presented in Table 25. Shuttle car payload, seam height and cut depth all have a positive correlation coefficient with production which exceeds .40. Thus, increases in these variables are associated with greater production. On the other hand, the number of roof bolters and man-trip time are negatively correlated with production.

Although these variables are highly correlated with production, they are also correlated between themselves making it difficult to put many of the variables into the regression equation. Examples of the correlation coefficients between seam height and shuttle car payload with other independent variables are shown in Table 26. Estimation problems can occur if independent variables highly correlated with each other are included in the equation. For this reason many of the variables are excluded from the regression equation.

TABLE 25. - Correlation coefficients between section characteristics and production

Variable description	Correlation coefficient
Shuttle car payload.....tons..	.49
Seam height.....in..	.46
Cut depth.....ft..	.44
Number of roof bolters.....	-.23
Man-trip time.....min..	-.22

TABLE 26. - Correlation coefficients between independent variables

Variable description	Correlation coefficient
Seam height with:	
Number of underground hourly workers.....	.55
Dinner time.....min..	-.51
Number of roof bolters.....	-.31
Shuttle car payload with:	
Number of underground hourly workers.....	.57
Dinner time.....min..	-.72
Number of roof bolters.....	-.36

REGRESSION ANALYSIS

The regression analysis found that section characteristics have a very significant effect on production and a relatively minor impact on accidents. Consider first the result for the production equations. Section characteristics entered into both the shift production and production index equations. The estimated coefficients for these variables are presented in Table 27. The results for the significant coefficients are also summarized in Appendix G.

TABLE 27. - Estimated regression coefficients for section characteristics: production equations

Variable description	Estimated coefficient	
	Shift production	Production index
Seam depth.....ft..	¹ -.24	-.004
Cut depth.....ft..	² 5.10	-.22
Gas monitor, 1 if stops miner.....	¹ 68.19	¹ 23.99
Number of entries.....	¹ 17.73	2.96
Mine plan, 1 if a "room" or "pillaring".....	¹ 58.18	² 12.32
Man-trip time.....min..	¹ -3.23	² -.65
Dinner time.....min..	¹ -3.53	-.21
Number of roof bolters.....	³ -76.33	10.02
Seam dip, 1 if some dip.....	NAP	² -15.27
Bolt length.....ft..	NAP	¹ -5.43
Continuous miner age.....yr..	NAP	³ -1.33

NAP Not Applicable

- ¹ Statistically significant from zero at the 1 percent level.
- ² Statistically significant from zero at the 5 percent level.
- ³ Statistically significant from zero at the 10 percent level.

The regression results suggest that as seam depth increases (that is, deeper mines), production per shift decreases. Cut depth has a positive effect on production as would be expected. As the miner takes a deeper cut, production increases at the rate of 5.1 tons per foot. In mines where the gas monitor stops production, production is higher. This might be due to a higher rate of production causing the gas monitor to stop production.

The design of the mine also has a significant effect on production. Production increases 17.73 tons for each additional entry. Several of the sections observed in "mains" were "super" sections and therefore had higher tonnage than would normally be expected. "Rooms" or "pillaring" were found to be more productive than mains, submains and panels. Being in "rooms" or "pillaring" increased production 58.18 tons per shift. The time available for production also had a significant effect through two variables: dinner time and man-trip time. As dinner time or man-trip time increases, production decreases. The estimated coefficient for the number of roof bolters suggests that one roof bolter is more productive than two. There is a high correlation however with the number of roof bolters and the type of bolters used (single vs. dual boom). Therefore, one dual boom bolter would be more productive than two single boom bolters.

The results for the production index equation basically confirms the shift production equation. The signs of the coefficient are expected to be the same in the two equations. This is the case for coefficients significant in both equations. Additional variables in the index equation include seam dip which has a negative effect on the production index. Bolt length and the age of the continuous miner also have a negative effect on the production index.

The regression results show that section characteristics have relatively little impact on accidents. No section characteristics entered into the accidents equation, however, five section characteristics entered into the accidents index equation. These results are shown in Table 28. Only one variable, seam depth, was statistically significant; as seam depth increases, accidents increase.

The last equation examined was the superintendent's rank of the first-line supervisor. For the most part, section characteristics should not influence how the superintendent ranks the supervisors. However, one section characteristic, man-trip time is partially under the control of the supervisor. Subject for safety limitations, effective supervisors should minimize man-trip time. Supervisors can organize their crew to enter the cage and man-trip quickly. The time study data reveal that man-trip time is 35 percent shorter leaving the mine than entering the mine. The regression results found that the supervisor's rank is negatively related to man-trip time. The estimated coefficient equalled $-.61$ which is significant at the 5 percent level. Thus, as man-trip time increases, the superintendent's ranking of the supervisor decreases.

TABLE 28. - Estimated regression coefficients for section characteristics: accident index equation

Variable description	Estimated coefficient
Seam depth..... ft..	³ .030
Entry center.....ft..	-.015
Entry width.....ft..	3.126
Cut depth.....ft..	-.526
Seam height.....in..	.093

- 1 Statistically significant from zero at the 1 percent level.
- 2 Statistically significant from zero at the 5 percent level.
- 3 Statistically significant from zero at the 10 percent level.

***ANALYSIS OF CREW CHARACTERISTICS
DESCRIPTIVE STATISTICS

Table 29 lists the descriptive statistics regarding the six crew characteristics which were of significant value in either the production or safety equation. The definition of each characteristic is self-explanatory. The majority of the crew minorities were women (only 12 were black or hispanic). It is interesting to note that the typical crew had been together for almost two years.

TABLE 29. - Descriptive statistics for crew characteristics

Characteristic	Mean	Standard deviation	Minimum value	Maximum value
Avg. experience of the members.....yrs..	10.1	4.0	2.1	22.9
Lgth. of time crew has been together....mos..	22.8	19.5	0	96
Crew turnover (no. replaced in previous 12 months).....	1.7	1.8	0	9
Avg. age of crew members.....yrs..	33.4	6.1	22.4	48.4
Crew size.....	8.8	1.4	7	13
Number of minority workers on crew.....	0.4	0.8	0	4

CORRELATION ANALYSIS

The correlation analysis did find several of the crew characteristics which were highly correlated with the performance measures. Several correlation coefficients for variables related to production include: the number of minority workers in the crew, .37; average experience of crew members, -.21; and, average age of crew members, .16. Correlation coefficients for variables related to accidents include: average age of crew members, .22; and, number of minority workers in the crew, .18.

REGRESSION ANALYSIS

In the production equations, three of the crew characteristic variables entered the equation. The estimated coefficients and significance levels are presented in Table 30. The results for the significant coefficients are also summarized in Appendix G. Crew size has a positive and significant effect on production. The coefficient for crew size in the production index equation is negative but not significant. Time the crew has been together is positive and significant in both equations. The number of minority workers in the

crew is positive in both equations and significant in the production equation.

TABLE 30. - Estimated regression coefficients for crew characteristics: production equations

Variable description	Estimated coefficient	
	Shift production	Production index
Crew size.....	² 19.49	-2.09
Time crew has been together.....mths..	¹ 1.26	² .34
Number of minority workers in crew.....	² 27.60	1.80

- 1 Statistically significant from zero at the 1 percent level.
2 Statistically significant from zero at the 5 percent level.
3 Statistically significant from zero at the 10 percent level.

In the accidents equations (Table 31), if the results from the two dependent variables are consistent, then the estimated coefficients should have opposite signs in the two equations. This is because the two variables, accidents and accident index, move in opposite directions. As accidents for a supervisor's crew increase, the accident index for the supervisor decreases. The results from the two equations were consistent. Average experience of the crew and number of minority workers in the crew are significant in the accident index equation. Average length of time crew together and crew turnover are significant in the accidents equation.

TABLE 31. - Estimated regression coefficients for crew characteristics: accidents equations

Variable description	Estimated coefficient	
	Accidents	Accident index
Average experience of the crew.....yr..	-.100	³ 1.528
Time crew has been together.....mths..	² .031	-.120
Crew turnover.....	¹ .470	-1.949
Number of minority workers in the crew.....	NAP	³ -6.781

NAP Not Applicable

- 1 Statistically significant from zero at the 1 percent level.
2 Statistically significant from zero at the 5 percent level.
3 Statistically significant from zero at the 10 percent level.

***ANALYSIS OF SUPERVISOR CHARACTERISTICS

There are three sets of variables in the data set which describe the supervisor. First, there is basic demographic data relating to the supervisors. Next, there is the supervisor's response to the discussion issues. The last set of variables is the observational data obtained from the time study of the supervisor.

DESCRIPTIVE STATISTICS

Descriptive statistics of supervisory characteristics are contained in Table 32. With the exception of the LOQ scores and percentiles, the variables are self-explanatory. It is important to note that only two of these characteristics, total training time and supervisor's total experience, were found to be significant in the analysis. As expected, the experience variable was found to be negatively related to accidents. That is, more supervisory experience corresponds to fewer accidents.

The LOQ responses are measured on two dimensions of leadership: consideration and structure. Since this is the first known application of the LOQ with underground supervisors, it is difficult to interpret the raw score. In comparing the LOQ consideration percentiles of this sample of supervisors with first-line supervisors from other industries, underground supervisors placed in the lower half. On the LOQ structure dimension, they averaged near the lower quarter (28th percentile). The generally low scores on the structure dimension may indicate a "laissez-faire" attitude toward leadership, which in turn could result in lower productivity and safety.

Supervisors Responses to Discussion Issues

Table 33 provides descriptive statistics for 18 different discussion issues which were included in the performance equations. These issues are aggregate scores based on a series of questions relating to the issue.

Quantitative Workload

This issue consisted of the following six questions dealing with actual aspects of work and the same six questions reflecting on how the supervisor would like the job to be. There is a maximum score of 30 for each set of six questions. Regarding workload issues, between 32 and 44% of the supervisors felt that they have too much work to do.

How much workload would you like to have?

- 1) a lot less 2) a little less 3) about the same
- 4) a little more 5) a lot more

TABLE 32. - Descriptive statistics for supervisor characteristics

Characteristic	Mean	Standard deviation	Minimum value	Maximum value
Age yr..	37.4	6.2	26	59
Education.....yr..	12.8	1.6	8	17
Non-supervisory experience:				
With this company.....yr..	3.7	4.3	0	22
With other companies.....yr..	3.6	4.7	0	30
Total experience with this company.....yr..	9.8	6.3	0	32
Experience with this crew.....mos..	16.9	18.8	0	96
Supervisory experience:				
With this company.....yr..	6.6	4.5	0	23
With other companies.....yr..	2.3	4.0	0	18
Total supervisory experience.....yr..	8.9	4.4	0	23
Total experience.....yr..	16.1	7.4	2	39
Total training time (for last 12 months).....hr..	171.8	192.2	0	1220
LOQ consideration score.....	49.0	6.1	35	66
LOQ consideration percentile.....	44.0	25.4	2	93
LOQ structure score.....	46.8	8.0	25	64
LOQ structure percentile.....	27.8	27.7	0	93
LOQ total score.....	95.8	10.1	73	119

TABLE 33. - Descriptive statistics for responses to discussion items

Discussion issues	Mean	Standard deviation	Minimum value	Maximum value
Quantitative workload (ideal).....	18.2	1.2	14	23
Repetitiveness, expressiveness & feedback.....	20.4	3.9	9	30
Job self-esteem.....	12.4	1.7	7	15
Anxiety.....	9.5	3.2	4	19
Role ambiguity.....	18.8	2.0	12	20
Involved striving.....	12.1	2.0	6	15
Job boredom.....	9.1	2.8	4	16
Workload dissatisfaction.....	7.4	2.1	3	12
Inequity in pay.....	13.8	3.9	4	20
Variance in workload.....	10.1	2.1	5	15
Responsibility for persons (actual).....	15.6	2.6	8	20
Responsibility for things (ideal).....	11.5	2.3	3	15
Social support from spouse.....	13.7	3.3	4	20
Responsibility for persons (ideal).....	14.5	3.4	4	20
Job future ambiguity.....	11.6	3.7	4	20
Participation with management.....	9.3	2.6	3	15
Somatic complaints off the job.....	10.5	1.9	9	17
Depression.....	7.4	2.1	3	12

How much time would you like to have to do all your work?

- 1) a lot less 2) a little less 3) about the same
- 4) a little more 5) a lot more

How much time to think and contemplate would you like to have?

- 1) a lot less 2) a little less 3) about the same
- 4) a little more 5) a lot more

What quantity of work would you prefer others to expect of you?

- 1) a lot less 2) a little less 3) about the same
- 4) a little more 5) a lot more

How many projects, assignments, or tasks would you like to have?

- 1) a lot less 2) a little less 3) about the same
- 4) a little more 5) a lot more

How many lulls (breaks) between heavy workload periods would you like to have?

- 1) a lot less 2) a little less 3) about the same
- 4) a little more 5) a lot more

Job Self-Esteem

The following three questions were asked and a maximum aggregate score of 15 was possible. This aggregate score has a significant contribution to the production equation.

How successful do you see yourself?

- 1) very unsuccessful 2) unsuccessful 3) okay
- 4) successful 5) very successful

How important are you at work?

- 1) very unimportant 2) unimportant 3) okay
- 4) important 5) very important

How often do you do your best at work?

- 1) never do my best 2) seldom do my best
- 3) occasionally do my best 4) normally do my best
- 5) always do my best

Anxiety

The issue of anxiety consisted of the following four questions. The aggregate of this issue was found to be significant in both the production and accident equations. A maximum score is 20.

How much of the time do you feel this way?

nervous

- 1) never 2) seldom 3) sometimes
- 4) often 5) all the time

jittery

- 1) never 2) seldom 3) sometimes
- 4) often 5) all the time

fidgety

- 1) never 2) seldom 3) sometimes
- 4) often 5) all the time

calm (reverse scoring)

- 1) all the time 2) often 3) sometimes
- 4) seldom 5) never

Role Ambiguity

The supervisor's responses to the issue of role ambiguity (ideal situation) were found to be significant in the accident equation. The responses to the issue of role ambiguity in the actual situation were not significant. A composite variable, which was included in the accident equation, is defined as the sum of the absolute value of the differences between the actual and ideal situation for each of the four questions. The following are the four questions discussed to develop the role ambiguity variables.

How much of the time would you like your work objectives to be well defined?

- 1) never 2) seldom 3) half the time
- 4) often 5) all of the time

How often would you like to be clear on what others expect of you?

- 1) never 2) seldom 3) half the time
- 4) often 5) all of the time

How often would you like to be able to predict what others expect of you on the job?

- 1) never 2) seldom 3) half the time
- 4) often 5) all of the time

How often would you like to be clear on what your job responsibilities are?

- 1) never 2) seldom 3) half the time
- 4) often 5) all of the time

Job Boredom

The issue of job boredom was defined by the responses to the following four questions. The aggregate of the responses was found to have a negative relationship with accidents, that is, higher boredom levels of the supervisor corresponded to fewer accidents to the crew.

My work is interesting to do. (reverse scored)

- 1) never 2) seldom 3) sometimes
- 4) often 5) all of the time

I feel bored with the work I have to do.

- 1) never 2) seldom 3) sometimes
- 4) often 5) all of the time

The work on my job feels dull.

- 1) never 2) seldom 3) sometimes
- 4) often 5) all of the time

I find myself "watching the clock", waiting to go home.

- 1) never 2) seldom 3) sometimes
- 4) often 5) all of the time

Social Support - Spouse

The issue of social support consisted of four parts with each part having four questions. The four parts were related to: 1) immediate supervisor, 2) co-workers -- other bosses, 3) spouse, and 4) other relatives or friends. The questions were analyzed by each part and in the aggregate. The only grouping which was found to have significant impact on either performance measure was spousal support. Spousal support was negatively related to accidents. The following four questions were discussed:

1. How much does your wife/husband go out of her/his way to do things to make your work life easier?
2. How much can she/he be relied on when things get tough at work?
3. How much is she/he willing to listen to your personal problems (with the job)?
4. How easy is it to talk to your wife/husband?

Inequity in Pay

Most of the observed supervisors felt that their pay was equitable in comparison with other foremen at their mines or at other mines nearby. In analyzing the aggregate responses to four questions regarding pay, the responses were found to have a positive impact on accidents. The more equitable the supervisors felt their pay was, the more accidents the crew had. The following are the questions discussed:

Indicate how often you experience each of the following changes on your job:

Compared to the other foremen where you work, who do a job similar to yours (for example, other section foremen), how fair is your pay?

- 1) very unfair 2) somewhat unfair 3) so so
- 4) fair 5) very fair

Compared to other people where you work who do a job different from yours (for example, construction foremen), how fair is your pay?

- 1) very unfair 2) somewhat unfair 3) so so
- 4) fair 5) very fair

Compared to other people who do not work where you work (for example, other mines close by) but who have a similar skill to yours, how fair is your pay?

- 1) very unfair 2) somewhat unfair 3) so so
- 4) fair 5) very fair

Compared to others where you work who do a job different from yours, but with education similar to yours (for example, shift foremen), how fair is your pay?

- 1) very unfair 2) somewhat unfair 3) so so
- 4) fair 5) very fair

Variance in Workload

These questions address the issue of variance in workload. The aggregate responses have a positive relationship with accidents. A greater workload variance is related to a higher level of accidents. The three questions are as follows:

Indicate how often you experience each of the following changes on your job:

A marked (or large) increase in the workload?

- 1) never 2) seldom 3) sometimes
- 4) often 5) all the time

A marked increase in the amount of concentration required on your job?

- 1) never 2) seldom 3) sometimes
- 4) often 5) all the time

A marked increase in how fast you have to think.

- 1) never 2) seldom 3) sometimes
- 4) often 5) all the time

Responsibility for Persons

Questions were asked regarding how much responsibility supervisors have for their crew and how much they would like to have. The responses to the following four questions were aggregated and this

aggregate variable was positively related to accidents.

How much responsibility do you have for the future of others?

1) none 2) a little 3) some 4) a lot 5) total

How much responsibility do you have for the job security of others?

1) none 2) a little 3) some 4) a lot 5) total

How much responsibility do you have for the morale of others?

1) none 2) a little 3) some 4) a lot 5) total

How much responsibility do you have for the welfare and lives of others?

1) none 2) a little 3) some 4) a lot 5) total

Responsibility for Things (Ideal)

The supervisors were also asked three questions regarding how much responsibility they would like to have for things rather than persons. The summation (an aggregate variable) of the responses has a significant negative impact on the accident equation. The following are the three questions discussed.

How much responsibility would you like to have for seeing that various projects are carried out properly?

1) none 2) a little 3) some 4) a lot 5) total

How much responsibility would you like to have for the preparation and adherence to a budget in your work?

1) none 2) a little 3) some 4) a lot 5) total

How much responsibility would you like to have for seeing that the equipment you use in your work is safe and well maintained?

1) none 2) a little 3) some 4) a lot 5) total

Summary

In addition to the responses to the above issues, two other important issues should be reviewed. These are: 1) job future ambiguity and 2) job dissatisfaction.

Job Future Ambiguity

For the future, some jobs will be changing while others will be staying the same. Most supervisors have uncertainty regarding their future as reflected in the answers to the following two questions.

How certain are you about what your future career picture looks like?

very uncertain	12%
uncertain	34%
so-so	30%

How certain are you of the opportunities for promotion and advancement which will exist in the next few years?

very uncertain	18%
uncertain	36%
so-so	28%

Job Dissatisfaction

The responses to the following discussions relating to job dissatisfaction give conflicting signals. While 83% of the supervisors are at least somewhat satisfied with their jobs, the majority would have second thoughts about taking this job again or recommending it to their friends.

Knowing what you know now, if you had to decide all over again whether to take the type of job you now have, what would you decide?

- I would 1. Decide without hesitation to take the same type of job. (38%)
- 2. Have some second thoughts. (44%)
- 3. Decide definitely not to take this type of job. (17%)

If you were free right now to go into any type of job you wanted, what would your choice be?

- I would 1. Take the same type of job as I have now. (41%)
- 2. Take a different type of job. (58%)

If a friend of yours told you he was interested in working in a job like yours, what would you tell him?

- I would 1. Strongly recommend it. (29%)
- 2. Have some doubts about recommending it. (56%)
- 3. Advise him against it. (13%)

All in all, how satisfied would you say you are with your job?

1. Very satisfied (26%)
2. Somewhat satisfied (57%)
3. Not too satisfied (13%)
4. Not at all satisfied (4%)

OBSERVATIONAL STUDIES

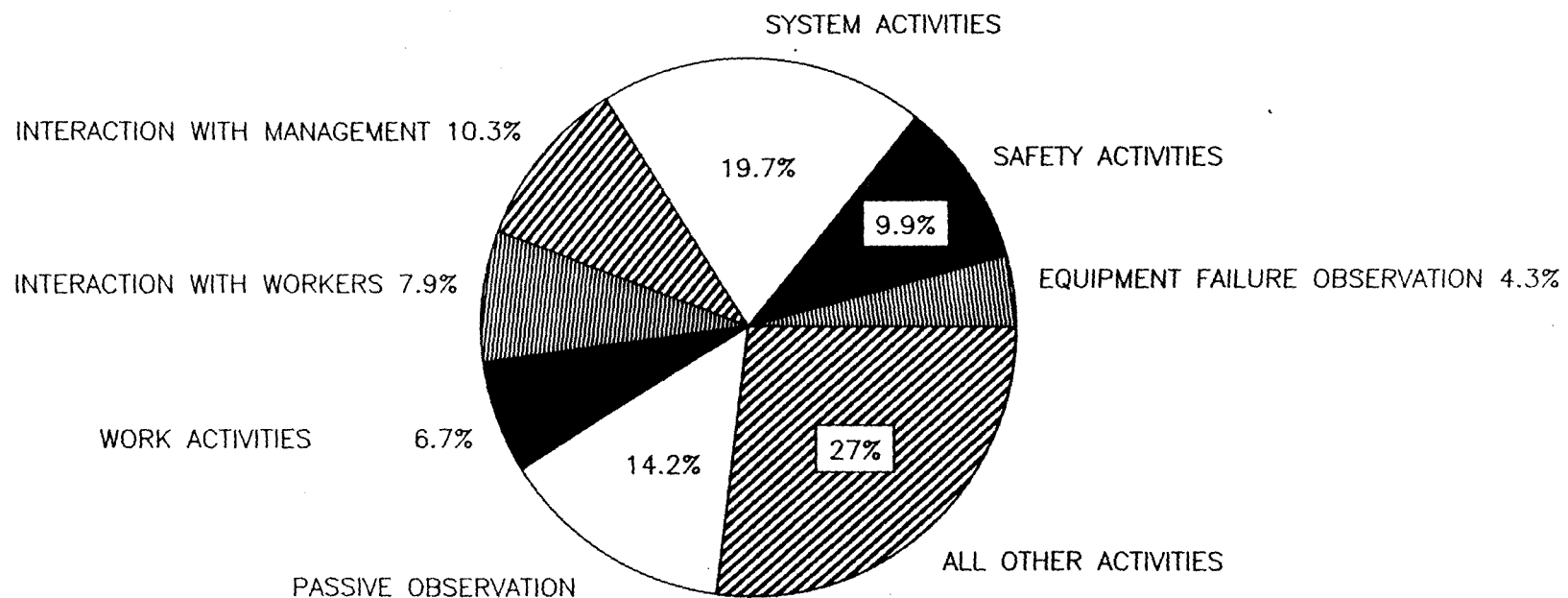
Each of the 138 supervisors was observed for a full work shift. The length of work activities during the shift was measured using a stop watch and was recorded on a tape recorder for subsequent conversion to computer readable form. A typical shift consisted of approximately 549 minutes. Three observations were deleted from further analysis because mechanical problems with the tape recording equipment resulted in unusable information. This resulted in 135 observations which were used throughout the analysis. Work activities were grouped into one of eight categories:

1. Equipment failure observations
e.g., supervisor observations of equipment and belt repairs
2. Safety activities
e.g., face inspections, air measurements, belt inspections, safety talks, roof control investigations, and gas checks
3. System activities
e.g., report and supply order preparation, face measurement, and study participation
4. Interaction with management
e.g., supervisory meetings and call-out's from section
5. Interaction with workers
e.g., worker and other leadership activities supervision
6. Work activities
e.g., equipment operation
7. Passive observation
e.g., crew members observation
8. All other activities
e.g., man-trip time, showering, and personal preparation

Figure 9 provides a statistical summary of supervisor work activities

STATISTICAL SUMMARY OF SUPERVISOR OBSERVATIONS

135 SUPERVISORS



AGGREGATE ACTIVITIES AND INTERRUPTIONS

FIGURE 9. - Statistical summary of supervisor observations

by category. The percentages given in the figure represent the time spent in each activity category. Overall, system activities, safety activities, interaction with management and interaction with workers accounted for 47.8% of the supervisor's time. In general, supervisors spend more time interacting with management (10.3%) than with their crews (7.9%). Only 47.7% of the time is spent on actual management activities (61.9% if passive observation is included). Of the 19.7% involving system activities, 52% was devoted to data collection on the section. Within the safety activities, 63% of the time was spent on air readings, gas checks, or repairing ventilation curtains or fan tubes.

In Table 34 the descriptive statistics for the observational data are presented. From this we can see the actual magnitude of time involved in each activity. It is interesting to note that nearly two hours is spent doing work activities and passive observation combined. The table also shows that there is considerable variation in the time spent doing each activity. The minimum value is 5 minutes or less for each variable except all other activities, while the maximum value is over two hours for each variable.

TABLE 34. - Descriptive statistics for the observational data

Variable description	Mean	Standard deviation	Minimum value	Maximum value
Equipment failure observation...	23.6	26.4	0	145
Safety activities.....	54.1	28.4	5	126
System activities.....	107.9	41.5	3	231
Interaction with management.....	56.4	28.1	1	136
Interaction with workers.....	43.6	42.6	0	206
Work activities.....	36.9	34.6	0	145
Passive observation.....	78.0	46.1	2	210
All other activities.....	148.3	42.4	43	304

With this large variation in the way supervisors spend their time, an important issue is what factors are related to the amount of time spent by supervisors in each activity. To examine this issue, means were calculated and compared for various subgroups of the sample. The first set of comparisons, presented in Table 35, are based on four mine characteristics: union status, selection procedure, mine ownership, and production incentive plan. The mean total time and frequency are calculated for the eight activity categories. The t-score provides a measure of the statistical significance of the difference between the means. As the t-scores increase, it is less likely that the means in the two groups are equal.

Consider first union versus non-union mines. At non-union mines, supervisors spend an average of 13.6 minutes on equipment failure observation compared to 24.7 minutes at union mines. Based on the t-score, the probability that the two means are equal is less than 5 percent. Looking at the other activities, at non-union mines

supervisors spend more time on work activities, and less time on safety activities and all other activities. Also, at non-union mines interaction with management occurs more frequently (probably due to better communication equipment at the union mines visited), as does interaction with workers and passive observation.

Consider the differences between mines that have a formal selection procedure and mines that have informal procedures. At mines using formal selection procedures, supervisors spend more time on worker interaction and less time on passive observation. The supervisors also are more frequently doing safety activities, system activities, interaction with management and worker interaction than supervisors at mines using informal selection procedures.

Supervisors at captive versus non-captive mines spend their time quite differently. At captive mines, supervisors spend more time on safety activities, system activities, and work activities, and less time on interaction with management and passive observation. At captive mines, safety activities occur less frequently as does management and worker interaction and passive observation. At mines with a production incentive plan, supervisors spend less time on equipment failure observation and interaction with management, and more time on system and work activities.

The characteristics of the supervisor's crew can also have an impact on how the supervisor spends their time. Comparisons were made based on four crew characteristics: crew size, average crew experience, average crew age, and time crew has been together. These results are presented in Table 36. Supervisors were grouped together based on the characteristics of their crew. Supervisors with smaller crews spend more time on equipment failure observation and passive observation and less time on interaction with management and workers. Supervisors with more experienced crews spend less time on system activities and less time on management interaction. For older crews, supervisors spent more time on equipment failure observation and less time on system activities, worker interactions and work activities. Supervisors of crews that have been together longer spend more time on equipment failure observation and safety activities and less time interacting with workers.

A final comparison of supervisor activities looked at differences across states (see Table 37). Supervisors in Illinois spend more time on equipment failure observation and passive observation, and less time on safety activities than supervisors in the other two states. The safety time differences are especially interesting since the regression equation results indicate that accidents are more frequent for supervisors in Illinois. Time spent interacting with workers is greater in Ohio than in the other states. Management interaction is greater in Illinois than in Pennsylvania. Supervisors spend more time on work activities at mines located in Pennsylvania.

TABLE 35. - Comparison of supervisor observational data based on mine variables

Variable name	Category	Union status			Selection procedures			Mine ownership			Production incentive plan		
		Non-union mean n = 14	Union mean n = 121	T-Score	Formal mean n = 29	Informal mean n = 106	T-Score	Captive mean n = 24	Non- captive mean n = 111	T-Score	With plan n = 38	Without plan n = 97	T-Score
Equipment failure observation	Time	13.6	24.7	² 2.19	16.7	25.5	-1.59	18.1	24.8	-1.45	16.4	26.4	¹ -2.43
	Freq.	2.1	2.7	-0.97	2.4	2.7	-0.50	2.3	2.7	-0.79	2.2	2.8	-1.53
Safety activities	Time	42.3	55.4	¹ -2.68	60.0	52.4	1.52	64.2	51.9	² 1.95	56.1	53.2	0.57
	Freq.	13.1	15.1	-0.98	22.2	12.9	¹ 3.22	9.5	16.1	¹ -4.55	10.9	16.4	¹ -3.70
System activities	Time	116.0	106.9	1.02	112.4	106.6	0.65	137.2	101.5	¹ 4.02	129.4	99.4	¹ 3.97
	Freq.	15.2	11.8	1.46	15.6	11.2	¹ 3.44	11.4	12.3	-0.68	12.8	11.9	0.74
Management interaction	Time	55.7	56.5	-0.10	55.9	56.6	-0.10	47.5	58.3	³ -1.73	50.5	58.7	³ -1.73
	Freq.	11.1	7.5	¹ 3.13	10.0	7.2	¹ 3.17	6.1	8.2	³ -2.76	7.9	7.8	0.17
Worker interaction	Time	51.6	42.6	1.04	82.2	33.0	¹ 4.08	28.3	46.8	¹ -3.68	36.9	46.2	-1.52
	Freq.	21.6	15.8	³ 1.66	25.9	13.8	¹ 3.90	13.9	16.9	³ -1.70	16.7	16.3	0.22
Work activities	Time	62.9	33.9	² 2.09	29.3	39.0	-1.33	55.0	33.0	² 2.43	57.9	28.7	¹ 3.79
	Freq.	6.5	5.9	0.60	7.3	5.6	1.19	5.9	6.0	-0.16	6.1	5.9	0.21
Passive observations	Time	94.6	76.1	1.43	45.7	86.9	¹ -6.25	63.8	81.1	³ -1.68	75.2	79.2	-0.45
	Freq.	21.0	10.8	¹ 4.18	10.4	12.2	-1.40	7.8	12.7	¹ -4.79	12.7	11.5	0.72
All other activities	Time	131.2	150.3	² -2.20	147.2	148.6	-0.21	144.5	149.1	-0.69	139.6	151.7	³ -1.88
	Freq.	55.9	40.0	¹ 3.82	44.3	40.9	1.06	38.9	42.2	-1.21	45.2	40.2	1.66

¹ Statistically significant from zero at the 1 percent level.² Statistically significant from zero at the 5 percent level.³ Statistically significant from zero at the 10 percent level.

TABLE 36. - Comparison of supervisor observational data based on crew characteristics

Variable name	Category	Crew size			Average crew experience			Average crew age			Time crew has been together		
		Smaller 1/2 mean n = 67	Larger 1/2 mean n = 66	T-Score	Longer 1/3 mean n = 35	Shorter 1/3 mean n = 43	T-Score	Lower 1/3 mean n = 43	Above 1/3 mean n = 42	T-Score	Shorter 1/3 mean n = 33	Longer 1/3 mean n = 35	T-Score
Equipment failure observation	Time	29.5	17.8	¹ 2.58	24.4	23.8	0.09	16.5	28.8	² -2.27	19.8	21.7	¹ -0.33
	Freq.	3.0	2.2	² 2.11	2.4	2.8	0.99	2.4	3.0	-1.04	2.5	2.5	0.06
Safety activities	Time	54.0	54.4	-0.09	54.6	51.3	0.54	54.7	55.5	-0.13	48.6	62.1	³ -1.90
	Freq.	11.2	13.1	³ -1.76	10.5	13.0	³ -1.71	13.6	11.2	³ 1.66	13.1	11.7	¹ 0.90
System activities	Time	107.6	108.5	-0.12	94.0	116.0	² -2.21	118.3	93.7	¹ 2.68	107.3	115.9	-0.85
	Freq.	11.2	13.1	³ -1.76	10.5	13.0	³ -1.71	13.6	11.2	³ 1.66	13.1	11.7	0.90
Management interaction	Time	52.4	60.6	³ -1.70	51.4	66.5	¹ -2.54	53.0	53.2	-0.03	60.0	56.3	0.52
	Freq.	5.8	9.9	¹ -6.38	6.6	8.7	² -2.27	8.0	7.0	0.96	8.6	7.6	1.01
Worker interaction	Time	30.4	57.8	¹ -3.86	41.3	46.8	-0.56	52.5	35.0	² 1.88	58.6	36.4	² 1.99
	Freq.	12.1	21.0	¹ -4.38	14.3	17.8	-1.22	19.6	13.2	¹ 2.43	18.3	15.5	0.97
Work activities	Time	40.6	32.0	1.48	35.8	39.3	-0.43	43.4	31.9	³ 1.70	35.8	32.7	0.35
	Freq.	6.0	6.0	0.20	6.5	4.8	³ 1.85	6.1	6.2	-0.14	5.5	5.2	0.41
Passive observations	Time	87.6	66.3	¹ 2.80	82.3	79.7	0.26	73.4	86.5	-1.27	80.9	70.0	1.05
	Freq.	11.5	12.1	-0.47	11.3	12.4	-0.70	12.2	12.9	¹ -0.41	12.6	9.9	1.52
All other activities	Time	140.6	157.0	² -2.26	153.2	142.5	1.12	145.3	150.5	-0.54	149.2	148.6	0.06
	Freq.	39.2	44.3	² -1.94	38.1	42.1	-1.16	44.5	41.2	0.95	42.8	39.5	0.90

¹ Statistically significant from zero at the 1 percent level.² Statistically significant from zero at the 5 percent level.³ Statistically significant from zero at the 10 percent level.

TABLE 37. - Comparison of supervisor observational data by state

Variable name	Category	IL mean n = 72	OH mean n = 39	PA mean n = 24	IL vs. OH		IL vs. PA		OH vs. PA	
					Difference	T-Score	Difference	T-Score	Difference	T-Score
Equipment failure observation	Time	29.6	15.8	18.1	13.8	¹ 2.84	11.5	² 2.22	-2.3	-0.44
	Freq.	2.9	2.3	2.3	0.6	1.29	0.6	1.17	0.0	0.03
Safety activities	Time	46.8	61.1	64.2	-14.3	¹ -2.86	-17.4	¹ -2.70	-3.1	-0.50
	Freq.	12.7	22.1	9.5	-9.4	¹ -3.90	3.2	² 2.23	12.6	¹ 5.49
System activities	Time	99.3	105.6	137.2	-6.3	0.81	-37.9	¹ -3.99	-31.6	¹ -3.08
	Freq.	10.8	15.1	11.4	-4.4	¹ -3.55	-0.6	0.43	3.7	¹ 2.53
Management interaction	Time	60.9	53.7	47.5	7.2	1.26	13.4	² 2.35	6.2	0.87
	Freq.	7.7	9.2	6.1	-1.5	-1.76	1.6	² 1.92	3.1	¹ 3.07
Worker interaction	Time	31.3	75.6	28.3	-44.3	¹ -4.46	3.0	0.72	47.3	¹ 4.85
	Freq.	12.3	25.4	13.9	-13.1	¹ -4.95	-1.6	-0.91	11.5	¹ 4.28
Work activities	Time	34.4	30.3	54.9	4.1	0.70	-20.5	¹ -2.37	-24.6	¹ -2.61
	Freq.	4.9	8.0	5.9	-3.1	¹ -2.52	-1.0	-1.11	2.1	³ 1.61
Passive observations	Time	97.1	51.5	63.8	45.6	¹ 6.56	33.3	¹ 3.08	-12.3	-1.22
	Freq.	13.4	11.4	7.8	2.0	1.45	5.6	¹ 4.78	¹ 3.6	2.78
All other activities	Time	149.5	148.4	144.5	1.1	0.14	5.0	0.62	3.9	0.59
	Freq.	40.6	45.1	38.9	-4.5	-1.32	1.7	0.59	6.2	³ 1.60

¹ Statistically significant from zero at the 1 percent level.² Statistically significant from zero at the 5 percent level.³ Statistically significant from zero at the 10 percent level.

CORRELATION ANALYSIS

The correlation analysis revealed that many of the supervisor characteristics are correlated with production and accidents. Correlation coefficients for some of the supervisor variables are presented in Table 38. For the production variable, job future ambiguity had the highest correlation at .27. The time study variable, interaction with management, and the discussion issue variable, participation with management, both had positive correlation coefficients. Supervisory experience this company is negatively related to production.

With the accidents variable, variance in workload has the highest correlation coefficient. This variable also enters the accidents regression equation and is significant. Role conflict is positively related to accidents as is total training time. Nonsupervisory experience at other companies is negatively related to accidents.

REGRESSION ANALYSIS

The regression analysis provides some interesting insights into the relationship between supervisor characteristics and performance. The findings suggest that the supervisor has a much greater effect on accidents than on production. Eleven of the supervisor variables are significant in the accident equations compared to six significant supervisor variables in the production equations. Mine, section, and crew characteristics are very important in the production equations and relatively less important in the accident equations. Estimated regression coefficients for the production equations are presented in Table 39. Significant results are also summarized in Appendix G.

TABLE 38. - Correlation coefficients for supervisor characteristics with production and accidents

Variable description	Correlation coefficient
With production:	
Job future ambiguity.....	.27
Frequency of interaction with management.....	.27
Supervisory experience this company.....yr..	-.25
Participation with management.....	.22
With accidents:	
Variance in workload.....	.25
Role conflict.....	.23
Nonsupervisory experience other companies..yr..	-.23
Training time.....hrs..	.22

TABLE 39. - Estimated regression coefficients for supervisor characteristics: production equations

Variable description	Estimated coefficient	
	Shift production	Production index
Total experience this company.....yr..	NAP	-.26
Nonsupervisory experience this company.....yr..	2.29	NAP
Experience with this crew.....mths..	3.64	-.13
Total training time, previous 12 months....hr..	.07	2.02
Time for interaction with workers..... min..	.28	3.13
Quantitative workload.....	-9.19	-2.30
Repetitiveness, expressiveness & feedback.....	3.54	.85
Job self-esteem.....	3.83	2.84
Anxiety.....	3.23	2.84
Somatic complaints off the job.....	NAP	3.01
Depression.....	NAP	1.59

NAP Not Applicable

- 1 Statistically significant from zero at the 1 percent level.
- 2 Statistically significant from zero at the 5 percent level.
- 3 Statistically significant from zero at the 10 percent level.

Total training time for the supervisor is positively related to production while interaction with workers has a positive effect in the production index equation. Four of the supervisor discussion issue variables are significant. As supervisors feel they are overworked, production decreases. Production is positively related to job self-esteem, anxiety and somatic complaints off the job.

In Table 40, the regression results are presented for the two accidents equations. In contrast to the production equations, mine and section characteristics are relatively less important in the accidents equations, while supervisor characteristics are very important.

Ten of the supervisor characteristics have a significant effect on the number of accidents. The supervisor's total experience is negatively related to the number of accidents. For each additional year of experience, accidents to supervisor's crew decrease by .079. As time spent interacting with workers increases, accidents increase. The remaining supervisor characteristics significantly influencing accidents are attitudinal and personality traits identified through the survey instrument. Traits which are positively related to the number of accidents include role ambiguity, responsibility for persons, variance in workload, inequity in pay, and anxiety. Traits which are negatively related to accidents include responsibility for things and social support of the spouse.

TABLE 40. - Estimated regression coefficients for supervisor characteristics: accidents equations

Variable description	Estimated coefficient	
	Accidents	Accident index
Supervisor's total experience.....yr..	³ -.079	-.402
Nonsupervisory exp. other companies.....yr..	NAP	2.014
Total training time.....hr..	NAP	-.030
Time for interaction with workers.....min..	² .020	-.022
Time for work activities.....min..	.012	¹ -.287
Role ambiguity (ideal).....	² .405	² -3.474
Responsibility for persons (actual).....	³ .216	¹ -3.562
Responsibility for persons (ideal).....	.122	.548
Responsibility for things (ideal).....	² -.309	.432
Variance in workload.....	³ .272	.154
Inequity in pay.....	² .193	-.342
Social support - spouse.....	¹ -.348	¹ 3.183
Composite role ambiguity.....	-.180	1.623
Involved striving.....	-.204	1.393
Job boredom.....	² -.241	³ 1.861
Workload dissatisfaction.....	.231	-1.881
Anxiety.....	³ .179	-1.490

NAP Not applicable

- ¹ Statistically significant from zero at the 1 percent level.
- ² Statistically significant from zero at the 5 percent level.
- ³ Statistically significant from zero at the 10 percent level.

In the accidents equations, it should be noted that the accident index variable moves in the opposite direction as accidents; that is, as accidents increase, the supervisor's accident index decreases. Thus the signs of the coefficients in the two equations should be reversed. This occurs for all variables with significant coefficients in both equations.

Five of the supervisor characteristics are significant in the accident index equation. Work activities, role ambiguity, and responsibility for persons (actual), have a negative effect on the accident index. Social support by the spouse and job boredom have a positive effect on the accident index.

The mine superintendent's ranking of the first-line supervisor can also provide insight into characteristics of effective supervisors. This ranking is a percentile index where a high index corresponds to more effective supervisors and a low index corresponds to less effective supervisors. The results for this regression are presented in Table 41. Experience, both with the company and with the crew, have a positive effect on the ranking. Mine face experience is negatively related to the ranking. If the supervisor has mine manager's papers, their ranking is higher. Many of the discussion issue variables are also significant in the equations. Job future ambiguity, role conflict, social support of the spouse, and somatic complaints on the job contribute to lower rankings. Repetitiveness, expressiveness, and feedback, responsibility for persons, and depression are positively related to the ranking.

The production and accident index variables were also included in the equation. Production is highly significant and has a positive effect on the ranking while the accident index is not significant. This is interesting considering the results for the production equations where supervisor characteristics were relatively less important than other mine and section characteristics. Thus although supervisor characteristics are less important in the production equation, the superintendent considers the production performance of the supervisor to be very important in their ranking.

TABLE 41. - Estimated regression coefficients for supervisor characteristics: supervisor's rank equation

Variable description	Estimated coefficient
Nonsupervisory experience this company.....yr..	1.20
Experience with this company.....yr..	³ 1.13
Experience with this crew.....mths..	² .28
Mine manager's papers, 1 if has papers.....	³ 9.43
Mine face experience with this company.....yr..	² -1.88
Responsibility for persons (actual).....	-1.52
Job future ambiguity.....	² -1.55
Underutilization of abilities.....	1.13
Role conflict.....	¹ -2.92
Repetitiveness, expressiveness, & feedback.....	³ 1.34
Social support - spouse.....	² -4.29
Social support - total.....	³ 1.02
Job self-esteem.....	1.54
Somatic complaints on the job.....	³ -2.03
Composite responsibility for persons.....	³ 1.66
Depression.....	² 1.94
Production index.....	¹ .33
Accidents index.....	-.04

- 1 Statistically significant from zero at the 1 percent level.
2 Statistically significant from zero at the 5 percent level.
3 Statistically significant from zero at the 10 percent level.

***RESULTS OF THE STUDY

Earlier in the report we identified four major objectives of the study. These are:

1. Document tasks supervisors perform during a normal shift.
2. Explain why supervisors carry out their work as they do.
3. Identify salient characteristics of effective first-line supervisors.
4. Formulate criteria for selecting and developing candidate supervisors.

At this point, it is useful to summarize the results of the study in relation to these four objectives.

TASKS SUPERVISORS PERFORM

The tasks first-line supervisors perform during a normal shift have been documented by the observational data. From this data it is possible to understand how supervisors are spending their time. Approximately 34 percent of the supervisor's time is spent doing system activities, safety activities or equipment failure observation; 18 percent of their time is spent interacting with management or workers; 21 percent of their time is for work activities or passive observation; and, 27 percent of their time is for all other activities. The observational data also shows that there is considerable variation in the way supervisors spend their time.

EXPLANATION OF TASKS

The analysis has found that mine, section and crew characteristics influence the supervisor's behavior, safety, and production. Crew characteristics included crew size, age of crew members, experience of crew members, and length of time the crew has been together. These crew characteristics were shown to influence how supervisors spend their time. For example, supervisors with larger crews spend more time interacting with management and workers. Supervisors with younger crews spend more time interacting with management and workers.

Supervisors were also found to spend their time differently in different states. In Illinois, less time is spent on safety and system activities and more time is spent on passive observation than in the other states. Worker interaction is greater in Ohio, while in Pennsylvania more time is spent on work activities.

Mine characteristics also have a significant effect on time spent by the supervisor on various activities. At non-union mines, supervisors spend more time on work activities, less time on safety activities and were more frequently interacting with workers than at union mines. Another important characteristic is whether formal or informal selection procedures are used. At mines with formal procedures, supervisors are more frequently involved in safety and system activities, and interaction with workers and management. At mines with a production incentive plan, supervisors spend more time on work and system activities and less time on equipment failure observation and all other activities.

EFFECTIVE SUPERVISORS

The regression analysis provides a number of insights into characteristics of supervisors contributing to effective supervisors. The personality traits of job self-esteem and anxiety are found to be positively related to production. Personality traits play an even greater role in influencing accidents. Anxiety is positively related to the number of accidents, while social support of the spouse and job boredom is negatively related to accidents. Two of the observational variables were found to be significantly related to the performance measures. As the supervisor spends more time interacting with workers, production and accidents increase. Time spent on work activities is also positively related to accidents.

It is also interesting that several variables have opposite effects on accidents and production performance. That is, if the variable is positively related to production, it is also positively related to the number of accidents. Thus a characteristic good for production can be bad for safety. Examples of this include anxiety which increases production and increases accidents.

The results of the study support findings from previous research that mine and section characteristics explain much of the variation in production. Supervisor characteristics have a relatively small effect on the explanatory power of the regression equation. In the accidents equation however, mine and section characteristics are less important, while supervisory characteristics explain much of the variation in accidents.

CRITERIA FOR SELECTING SUPERVISORS

Current Practices

The results of the study provide useful information about selection procedures currently in use, the effectiveness of these techniques, and the impact of supervisor characteristics on production and safety. Selection procedures currently in use include formal and informal procedures.

Formal selection procedures are either assessment centers or testing which applicants must go through. Tests currently used include Minnesota Paper Form Board test, the Personnel Research Institute (PRI) number comparison test and the PRI classification test. The assessment center method is a standardized procedure in which candidates, gathered at a center, are evaluated for their potential for promotion or training. Multiple observational techniques are used, and each person is evaluated along a number of defined supervisory abilities or "dimensions".

Informal procedures include interviews and filling out an application, hiring relatives and friends, and hiring union officers. The study found that most companies use informal selection procedures. With the reduction in the number of operating mines, many of the supervisors hired previously worked for other companies and were laid off. Hiring of relatives is a practice that is either specifically not allowed at a company or is very prevalent within the company. The hiring of union officers into supervisor positions is a practice which companies may use to quiet a vocal union officer. However, very few of the supervisors in the sample were at one time union officers.

Supervisor Characteristics

The characteristics of the supervisors do have an important effect on production, accidents, and the superintendent's ranking of the supervisor. The experience of the supervisor and their training time have a significant effect on increasing production. More experienced supervisors also have fewer accidents to their crew than a less experienced supervisor. The personality traits also have an important effect on performance. Job self-esteem and anxiety contribute to increased production while feelings of being over-worked result in lower production. Personality traits such as role ambiguity, anxiety, and feelings of inequity in pay, contribute to more frequent accidents while social support of the spouse results in fewer accidents. Formal selection procedures were also found to be positively related to production.

***RECOMMENDATIONS

SUPERVISOR SELECTION PROCESS

The results of the study suggest the following three recommendations: (1) focus on long-term rather than short-term objectives in the hiring of supervisors; (2) greater reliance should be placed on testing and assessment centers in the selection process; and, (3) supervisor positions should be made more attractive by developing career paths for supervisors.

The first recommendation of the need to focus on long-term rather than short-term goals is based on the finding that supervisor characteristics have a significant impact on production and safety. Therefore, careful selection of supervisors is quite important. When a supervisor position becomes vacant, management should not fill the position with short-term production goals in mind. Instead, care should be taken in filling the position to ensure that the person hired for the position has the right skills, experience, and personality traits for the position.

Greater use of testing and assessment centers could improve the quality of first-line supervisors hired. These formal procedures can identify the potential candidates for a supervisor position which have the right characteristics for the position. This allows for a more objective decision where trained staff have an influence in the selection of the supervisors.

The objective of the third recommendation, to make the supervisor positions more attractive, is to increase the pool of applicants for supervisor positions. Many well qualified candidates may be deterred from applying for supervisor positions because the job is not sufficiently rewarding. By developing specific career paths for supervisors, the position would become more attractive. Job self-esteem also contributes to effective supervisors. If the supervisor feels their job is important, they will have more of an interest in performing well. The importance of the supervisor's position needs to be reinforced by management, and, good performance by the supervisor needs to be rewarded with career advancement. This will encourage current supervisors to perform better and make the position more attractive to potential applicants.

SUPERVISOR DEVELOPMENT

The study found that supervisor development is needed in four areas: (1) importance of the mining cycle; (2) greater cooperation between supervisors; (3) better management of time; and, (4) improved training in how to supervise employees. The first two recommendations reflect the need for the supervisor to have more training in the mining process. In order for the crew and equipment to produce efficiently, the section must be organized and planned correctly.

Different shifts on the same section can influence production on the other shift. Measures should be taken to prevent one shift from increasing production at the expense of the following shift. One way to minimize this problem might be to rotate supervisors to cross-shift with different supervisors on a regular basis.

The last two recommendations are based on the observations of the supervisor and the importance of personality traits in influencing production and safety. Many of the supervisors observed did not manage their time well. Rather than taking planned actions to supervise their crew, they instead were generally reacting to the situation. Supervisors need to be trained in managing their time and how to give direct orders to their crew. The analysis indicated that traits such as role ambiguity and role conflict do have an impact on production. Therefore, supervisors need to be trained so they are comfortable with their role as a supervisor.

SUGGESTIONS FOR FURTHER STUDY

While the current study extended our understanding of the relationship between the characteristics of supervisors and performance, there are many issues which could be explored further. One possibility would be to have some of the supervisors already in the data base undergo more thorough testing. For example, four mines could be revisited and supervisors at those mines could be given additional psychological tests. This data could be combined with the data already gathered to examine the relationships between the test measurements and performance.

A second improvement would be to add a mine to the data base which uses assessment centers to select supervisors. If similar data were collected at such a mine, the effect of assessment centers on performance could be examined.

A third possible area for study would be to examine the effect of a training program on performance. The current study identified several areas where supervisors need development. Training modules could be developed and given to supervisors. Their performance could then be tracked to determine the effect of the training on performance.

APPENDIX A
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APPENDIX B

DATA COLLECTION INSTRUMENT

DATA COLLECTION INSTRUMENT

Supervisory and Management Selection and Development

U.S.B.M. Project

March 9, 1987

DATE _____

OBSERVER NAME _____

MINE NAME _____

SECTION NAME _____

SUPERVISOR NAME _____

SHIFT _____

MINE FILE LAYOUT

(Name = Mmm.DAT)

Revised 3-9-87

	<u>Var. #</u>	<u>Var. Name</u>	<u>Description</u>	<u>Value</u>	<u>Columns</u>	<u>Data Type</u>
Record 1	1	MSFCOD	Mine code (2 char code = mm)	--	1-2	I2
	2	STATCOD	Location code (1=IL/2=OH/3=PA)	--	3-4	I2
	3	HSACNUM	HSAC Mine ID #	-----	6-12	I7
	---		Mine Name		14-28	A15
	---		Mine Contact		29-48	A20
	---		Mine Contact's Title		49-63	A15
	---		Personnel Officer at Mine		64-80	A17
Record 2	---		Mine Adrs - Line 1		1-25	A25
	---		Mine Adrs - Line 2		26-50	A25
	---		Mine Adrs - Line 3		51-70	A20
	---		Mine Telephone		71-80	I10
Record 3	---		Parent Company Name		1-25	A25
	---		Parent Company Contact		26-50	A25
	---		Parent Company Contact's Title		51-70	A20
Record 4	---		Parent Company Adrs - Line 1		1-25	A25
	---		Parent Company Adrs - Line 2		26-50	A25
	---		Parent Company Adrs - Line 3		51-70	A20
	---		Parent Company Telephone		71-80	A10
Record 5	---		Comments:		1-80	A80

MINE FILE LAYOUT (Cont'd)

Revised 3-9-87

<u>Var.#</u>	<u>Var. Name</u>	<u>Description</u>	<u>Value</u>	<u>Columns</u>	<u>Data Type</u>
Record 6	4	TONSYR	Size (thousands clean tons/yr)	1-5	I5
	5	TOTEMP	Size (total employees)	6-9	I4
	6	MANGEMP	Size (total management personnel)	10-13	I4
	7	NUMSECF	Size (# section foremen)	14-16	I3
	8	NUMHRWKR	Size (# underground hourly workers)	17-21	I5
	9	NUMCREWS	Size (# underground section crews)	22-24	I3
	10	INJINCRT	Injury Incident Rate (#/100,000 man-hours)	25-28	F4.1
	11	ACCRATE	Accident Severity Rate (# lost days/100,000 man-hours)	29-32	I4
	12	NUMVIOL	# Underground Violations (last year)	33-36	I4
	13	NUMSGRV	# Safety Grievances (last year)	37-40	I4
	14	NUMLGRV	# Labor Grievances (last year)	41-44	I4
	15	INCNTPLN	Mine Incentive Plan (2=yes/1=no)	45-48	I4
	16	LTURNOV	Underground Labor Turnover (# workers replaced last yr.)	49-52	I4
	17	STURNOV	Section Supv. Turnover (# supervisors replaced last year)	53-56	I4
	18	SELCPRC	Supervisory Selection Procedures (1 = informal/2 = formal)	57-58	I2
	19	MINETYP	Mine Type (1 = union/2 = non-union)	59-60	I2
	20	COALTYP	Coal type (1 = steam/ 2 = metallurgical/3 = both)	61-62	I2
	21	SHIFTDAY	# shifts per day worked (1 - 3)	63-64	I2
	22	CAPTIVE	Coal Market (1 = captive/ 2 = noncaptive mine)	65-66	I2
	23	NUMSTRIK	# Wildcat Strikes (# days lost last year)	67-69	I3
	24	SHIFTSYS	Shift Rotation System (n = 1 - 4 for every n weeks)	70-71	I2
	25	FORMROTA	Do Foremen Rotate With Crews? (2 = yes/1 = no)	72-73	I2
	26	LOQCSUP	Mine Superintendent's LOQ Consideration Score	74-76	I3
	27	LOQSSUP	Mine Superintendent's LOQ Structure Score	77-79	I3

MINE FILE LAYOUT (Cont'd)

Revised 3-9-87

TASK IMPORTANCE RATINGS OF FIRST-LINE SUPERVISORS (Rank: 1 to 3, 3 being most important; 9 = missing data)

<u>Var.#</u>	<u>Var. Name</u>	<u>Description</u>	<u>Value</u>	<u>Columns</u>
Record 7	---	Check Condition Of Worksite	--	1-2
(Task Importance Rating By Mine Superintendent)	---	Give Orders And Instructions About The Work	--	3-4
	---	Train Crew Members On The Job	--	5-6
	---	Motivate Crew Members	--	7-8
	---	Enforce Policies, Procedures And Safety Rules	--	9-10
	---	Handle Complaints Of Crew Members	--	11-12
	---	Counsel Crew Members About Their Work Performance	--	13-14
	---	Communicate With Crew Members	--	15-16
	---	Discuss Safety Regulations	--	17-18
	---	Receive Directives From Mine Foreman/ Mine Supervisor Regarding Safety, Mine Policy And New Operations	--	19-20
	---	Prepare Reports And Paperwork	--	21-22
	---	Discuss Situation With Off-Going Section Foreman	--	23-24
	---	Discuss Equipment Condition With Maintenance Foreman	--	25-26
	---	Troubleshoot Problems As They Arise	--	27-28
	---	Check Work Of Crew Members	--	29-30
	---	Represent Company To Crew	--	31-32
	---	Build Teamwork Within The Crew	--	33-34
	---	Check Condition And Inventory Of Supplies	--	35-36
	---	Discuss Policy Regulations	--	37-38
	---	Investigate Potential Problems	--	39-40
	---	Instruct Crew Members On How To Handle Problems	--	41-42
	---	Receive Orders For The Day's Work-Shift Foreman	--	43-44
	---	Handle Conflicts Between Crew Members	--	45-46
	---	Discuss Situation With Fire Boss Prior To Start Of Shift	--	47-48
	---	Cite Needs Of The Crew To Higher Management	--	49-50
	---	Plan Work	--	51-52
	---	Check Condition Of Equipment	--	53-54
	---	Estimate Supplies Needed	--	55-56
	---	Estimate Manpower Requirements	--	57-58

SECTION FILE LAYOUT

(Name = Smmss.DAT)

Revised 3-9-87

	<u>Var.#</u>	<u>Var. Name</u>	<u>Description</u>	<u>Value</u>	<u>Columns</u>	<u>Data Type</u>
Record 1	1	MSFCOD	Mine Code (2 char code = mm)	--	1-2	I2
(Geo-technical Data)	1	MSFCOD	Section Code (2 char code = ss)	--	3-4	I2
	28	SEAMDPT	Seam Depth (feet)	---	5-9	I5
	29	ENTCENTR	Entry Centers (feet)	---	10-13	I4
	30	XCUTCENT	Crosscut Centers (feet)	---	14-17	I4
	31	ENTWIDTH	Entry Width (feet)	--	18-21	I4
	32	CUTDEPT	Cut Depth (feet)	--	22-25	I4
	33	SEAMHGT	Seam Height (inches)	---	26-29	I4
	34	FLOORH2O	Floor Water Code: 1) very wet 2) damp 3) dry	--	30-31	I2
	35	FLOORCND	Floor Condition Code: 1) hard 2) firm 3) small ruts 4) badly rutted 5) rutted & slippery	--	32-33	I2
	36	SEAMGRAD	Coal Seam Grade (percent)	--	34-36	I3
	37	SEAMDIP	Coal Seam Dip Code: 1) toward face 2) away from face 3) toward side 4) none 5) rolls	--	37-38	I2
	38	BOLTLGTH	Bolt Length (feet)	--	39-41	I3
	---		Bolting Pattern (specify : _____)		41-51	A10
	39	GASMONIT	Gas Monitor Code: 1) stops miner nearly each car 2) occasionally stops miner 3) never stops miner	--	52-53	I2

SECTION FILE LAYOUT (Cont'd)

Revised 3-9-87

<u>Var.#</u>	<u>Var. Name</u>	<u>Description</u>	<u>Value</u>	<u>Columns</u>	<u>Data Type</u>
Record 1 40 (Continued)	SEAMHARD	Seam Hardness Code: 1) hard 2) medium 3) soft	--	54-55	I2
(Geo- 41 technical Data) 42	TOTTHICK	Parting (total thickness) (inches)	--	56-58	I3
	GRINDCOD	Hardgrove Grindability Index	--	59-62	I4
	43	MINPLAN Mine Plan Code: 1) mains 2) submains 3) panels 4) rooms 5) pillaring	--	63-64	I2
	44	NUMENTRY Number Entries Code:	--	65-67	I3
	45	MINERTYP Miner Type Code: 1) ripper 2) miller	--	68-69	I2
	46	IGNITFRQ Face Ignition Frequency Code: 1) never 2) 1-2x/year 3) 1-2x/month 4) 1-2x/week	--	70-71	I2
	47	RIBCOND Rib Condition Code: 1) stops miner nearly every car 2) occasionally stops miner 3) never stops miner	--	72-73	I2
	48	MANACCES Manpower Access Mode: 1) slope 2) drift 3) shaft	--	74-75	I2
	49	HAULACC Coal Haulage Access Mode: 1) slope belt 2) shaft	--	76-77	I2

SECTION FILE LAYOUT (Cont'd)

Revised 3-9-87

<u>Var.#</u>	<u>Var. Name</u>	<u>Description</u>	<u>Value</u>	<u>Columns</u>	<u>Data Type</u>
Record 2 (Equip- ment and Perfor- mance Data)	50	SCARMOD Shuttle Car Model Code: 1) Joy 10SC - 22 2) Joy 10SC - 26 3) National Mine Service 48-H 4) Jeffrey Ramcar battery 5) Jeffrey Ramcar diesel 6) Joy 21SC 7) LN Unihaul	--	1-2	I2
	51	SCARPAY Shuttle Car Payload (tons)	---	3-5	I3
	52	SCARLOAD S.C. Loading Time (minutes)	----	6-9	I4
	53	MANTRIPT Mantrip Time One-Way (minutes)	-----	10-14	I5
	54	AVGTONSH Average Tonnage/Shift (tons)	-----	15-19	I5
	55	AVGDELAY Average Total Delay Time/Shift (minutes)	-----	20-23	I4
	56	DINNERT Section Dinner Time/Shift (minutes)	----	24-26	I3
	57	CMINRMOD Continuous Miner Model Code: 1) Joy 12CM5 2) Jeffrey 120H 3) Jeffrey 120M 4) Lee Norse 800 5) Jeffrey 3610 6) Joy 14CM 7) Jeffrey 1028 8) Jeffrey 1038 9) LN 265 10) LN 650HH	--	27-28	I2
	58	CMINRAGE Age of Continuous Miner (years)	---	29-31	I3
	59	NUMBOLTR Number Bolters used in section (1 or 2)	--	32-33	I2
	60	BOLTR1T Bolter 1 Model Code: 1) Lee Norse TD43 2) Lee Norse TD2 3) Fletcher Single Boom 4) Fletcher Dual Boom 5) Galis Single Boom 6) other	--	34-35	I2
	61	BOLTR2T Bolter 2 Model Code - same codes as Bolter 1 above	--	36-37	I2
	62	BELTCARC Belt (1) or Mine Cars (2) Code	--	38-39	I2
	63	MCARSIZE Mine Car Size (tons) (if applicable)	---	40-42	I3
		Comments On Equipment/ Performance:		43-80	A38
		(			)

FOREMAN FILE LAYOUT

Revised 3-9-87

(Name = Fmmssf.DAT)

	<u>Var.#</u>	<u>Var. Name</u>	<u>Description</u>	<u>Value</u>	<u>Columns</u>	<u>Data Type</u>
Record 1 (Back- ground Data 1)	1	MSFCOD	Mine Code (2 char code=mm)	--	1-2	I2
	1	MSFCOD	Section Code (2 char code=ss)	--	3-4	I2
	1	MSFCOD	Foreman Code (1 char code=f)	-	5	I1
	64	SUPVAGE	Supervisor Age (years)	---	6-8	I3
	65	EMPYEAR	Employment Date (year)	--	10-11	I2
	66	EMPMTH	Employment Date (month)	--	12-13	I2
	67	SUPVSEX	Sex (1=male/2=female)	-	14	I1
	68	MINORITY	Minority (2=yes/1=no)	-	15	I1
	69	SUPVHGT	Supervisor Height (inches)	--	16-17	I2
	70	SUPVWGT	Supervisor Weight (pounds)	----	18-21	I4
	71	SUPVYRED	Education (years)	---	22-24	I3
	72	TOTEXPTC	Total Mining Non-Supervisory Experience (yrs)-This Company	---	25-27	I3
	73	TOTEXPOC	Total Mining Non-Supervisory Experience (yrs)- Other Companies	---	28-30	I3
	74	TIMETC	Total Time With This Company (years)	---	31-33	I3
	75	TIMECREW	Supervisor's Time With Crew (months)	---	34-36	I3
	76	SUPEXPTC	Supervisory Experience (yrs)- This Company	---	37-39	I3
	77	SUPEXPOC	Supervisory Experience (yrs)- Other Companies	---	40-42	I3
	78	MANGPAPR	Mine manager's papers? (2=yes/ 1=no)	--	43-44	I2
	79	YRUNIONO	# Years Union Officer (0-9)	--	45-46	I2
	80	OFFHELD	Office Held When Union Officer: 1) president 2) vice president 3) mine committee 4) health & safety committee	--	47-48	I2

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	<u>Var. #</u>	<u>Var. Name</u>	<u>Description</u>	<u>Value</u>	<u>Columns</u>	<u>Data Type</u>
Record 1	81	NUMCRWVO	Crew Walkouts (# in last year)	--	49-50	I2
(Cont.)						
(Back-	82	FNUMLGRV	Labor Grievances (# in last year)	--	51-52	I2
ground						
Data 1)	83	FINDLGRV	Labor Grievance Index (0-100)	---	53-55	I3
	84	FNUMSGRV	Safety Grievances (# in last year)	--	56-57	I2
	85	FINDSGRV	Safety Grievance Index (0-100)	---	58-60	I3
	86	FNUMVIOL	Violations (# in last year)	---	61-63	I2
	87	FINDVIOL	Violation Index (0-100)	---	64-66	I3
	88	FNUMACC	Reported Accidents To Crew Members (# in last year)	--	67-68	I2
	89	FINDACC	Accidents To Crew Members Index (0-100)	---	69-71	I3
	90	FSUPVACC	Accidents To Supervisor (# in last year)	--	72-73	I2
	91	SFTPROD	Shift Production (average tons)	----	74-77	I4
	92	SFTPRODI	Shift Production Index (0-100)	---	78-80	I3

FOREMAN FILE LAYOUT (Cont'd)

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	<u>Var. #</u>	<u>Var. Name</u>	<u>Description</u>	<u>Value</u>	<u>Columns</u>	<u>Data Type</u>
Record 2 (Back-ground Data 2)	93	ATESTSC	Selection Test A Score	_____	1-4	I4
	94	ATESTPT	Selection Test A Percentile	_____	5-7	I3
	95	BTESTSC	Selection Test B Score	_____	8-11	I4
	96	BTESTPT	Selection Test B Percentile	_____	12-14	I3
	97	CTESTSC	Selection Test C Score	_____	15-18	I4
	98	CTESTPT	Selection Test C Percentile	_____	19-21	I3
	99	OTHTESTS	Other Selection Procedure Score	_____	22-25	I4
	100	OTHTESTP	Other Selection Procedure Percentile	_____	26-28	I3
	101	SUPRANKF	Mine Supt. Ranking Of Foreman	_____	29-31	I3
	102	SUPRANKP	Mine Supt. Ranking Percentile	_____	32-34	I3
	103	PERRANKF	Personnel Ranking Of Foreman	_____	35-37	I3
	104	PERRANKP	Personnel Ranking Percentile	_____	38-40	I3
	105	SCRANKF	Safety Committee Ranking Of Foreman	_____	41-43	I3
	106	SCRANKP	Safety Committee Percentile	_____	44-46	I3
	107	FLOQCSC	Foreman's LOQ Consideration Score	____	47-49	I3
	108	FLOQSSC	Foreman's LOQ Structure Score	____	50-52	I3
	109	FLOQCPT	Foreman's LOQ Consideration Percentile	____	53-54	I2
	110	FLOQSPT	Foreman's LOQ Structure Percentile	____	55-56	I2
			Non-Supervisory Experience:			
	111	FACPOSTC	Face Position - This Company (years)	_____	57-59	I3
	112	FACPOSOC	Face Position - Other Companies (years)	_____	60-62	I3
	113	MTNPOSTC	Maintenance Position - This Company (years)	_____	63-65	I3
	114	MTNPOSOC	Maintenance Position - Other Companies (years)	_____	66-68	I3
	115	GINPOSTC	Gen. Inside Position - This Company (years)	_____	69-71	I3
	116	GINPOSOC	Gen. Inside Position - Other Companies (years)	_____	72-74	I3
	117	GOTPOSTC	Gen. Outside Position - This Company (years)	_____	75-77	I3
	118	GOTPOSOC	Gen. Outside Position - Other	_____	78-80	I3

FOREMAN FILE LAYOUT (Cont'd)

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<u>Var.#</u>	<u>Var. Name</u>	<u>Description</u>	<u>Value</u>	<u>Columns</u>	<u>Data Type</u>
Record 3 (Back-ground Data 3)		Training (hours) In Following Subjects (within 1 year):			
119	TRNHRTC	Human Relations - This Company	---	1-3	I3
120	TRNHROC	Human Relations - Other Companies	---	4-6	I3
121	TRNLDTCT	Leadership - This Company	---	7-9	I3
122	TRNLDOC	Leadership - Other Companies	---	10-12	I3
123	TRNSAFTCT	Safety - This Company	---	13-15	I3
124	TRNSAFOC	Safety - Other Companies	---	16-18	I3
125	TRNLRTCT	Labor Relations - This Company	---	19-21	I3
126	TRNLROC	Labor Relations - Other Companies	---	22-24	I3
127	TRNIETCT	Industrial Engineering - This Company	---	25-27	I3
128	TRNIEOC	Industrial Engineering - Other Companies	---	28-30	I3
129	TRNPLNTCT	Mine/Section Planning - This Company	---	31-33	I3
130	TRNPLNOC	Mine/Section Planning - Other Companies	---	34-36	I3
131	TRNMSCTCT	Miscellaneous - This Company	---	37-39	I3
132	TRNMSCOC	Miscellaneous - Other Companies	---	40-42	I3
133	STATUS	Status (1 = regular/2 = fill-in)	--	43-44	I2
---		Comments:		45-62	A18
134	EDLEVEL	Education Level Code: 1) less than 12 years 2) 12 years 3) greater than 12 years but less than 16 years 4) 16 years or greater	--	63-64	I2
135	TOTTRAIN	Total Training Time (hours)	-----	65-68	I4
136	SECPROD	Clean Coal Production During Observation Shift (tons)	-----	69-72	I4
137	AVAILTIM	Available Minutes Minus Delays During Observation Shift	-----	73-76	I4
138	PRODRATE	Tons Per Minute During Observation Shift	-----	77-80	F4, 1

FOREMAN FILE LAYOUT (Cont'd)

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<u>Var.#</u>	<u>Var. Name</u>	<u>Description</u>	<u>Value</u>	<u>Columns</u>	<u>Data Type</u>
Record 4 139 (Crew Data 1)	CREWSIZE	Crew Size (# people=1-10)	--	1-3	I3
		Ages Of Crew Members (years):		4-33	10I3

140	AVGAGECR	Average Age Of Crew Members (yrs)			
		Years Of Experience Of Crew Members:		34-63	10I3

141	AVGEXPCR	Average Experience Of Crew Members (yrs)			
		<u>Description</u>	<u>Value</u>	<u>Columns</u>	<u>Data Type</u>
Record 5 142 (Crew Data 2)	CREWABS	Crew Absenteeism (days lost last year)	-----	1-4	I4
143	TIMTOGHR	Average Length Of Time Together (months)	----	5-7	I3
144	CRACOSUP	# Crew Accidents With Other Supervisors (last year)	----	8-10	I3
145	CRACTSUP	# Crew Accidents With This Supervisor (last year)	----	11-13	I3
146	NUMUNOFF	# Union Officers (# who are or have been in last 4 years)	----	14-16	I3
147	CRTURNOV	Crew Turnover (# replaced last year)	----	17-19	I3
148	CRMINORT	# Minority Workers In Crew	----	20-22	I3
---		Comments on Crew:		23-80	A58

FOREMAN FILE LAYOUT (Cont'd)

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Supervisor Activities - Supervisor Rate Significance of Activity, Observer Note Occurrence of Activity During Shift

<u>Var. #</u>	<u>Var. Name</u>	<u>Job *</u> <u>Significance</u> (1-4,9)		<u>Observed ?</u> (1=No/2=Yes)	
		<u>Value</u>	<u>Column</u>	<u>Value</u>	<u>Column</u>
Record 6 (Super- visor Activity Signifi- cance Rating By Foreman)		I. <u>Pre-Shift Activity</u>			
		<u>Communicate with peers and higher management</u>			
149	JOBSIG01	Receive orders for days work (from shift foreman)	2	4	
150	JOBSIG02	Discuss situation with off- going section foreman	6	8	
151	JOBSIG03	Discuss situation with fire boss	10	12	
152	JOBSIG04	Receive directives from mine foreman/mine superintendent regarding safety, mine policy, new operations	14	16	
153	JOBSIG05	Discuss equipment condition with maintenance foreman	18	20	
		<u>Represent crew to higher management</u>			
154	JOBSIG06	Cite needs of the crew	22	24	
		<u>Plan daily work activities</u>			
155	JOBSIG07	Estimate supplies needed	26	28	
156	JOBSIG08	Estimate manpower require- ments	30	32	
157	JOBSIG09	Investigate potential problems	34	36	
158	JOBSIG10	Plan work	38	40	

* Job Significance or Importance Scale

- 4 very important
- 3 moderately important
- 2 least important
- 1 not part of job
- 9 missing data

FOREMAN FILE LAYOUT (Cont'd)

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<u>Var.#</u>	<u>Var. Name</u>		<u>Job *</u> <u>Significance</u> (1-4,9)	<u>Observed ?</u> (1=No/2=Yes)
II. <u>Shift Activity</u>				
Record 7 (Super- visor Activity Signifi- cance Rating By Foreman, Continued)		<u>Organize crew and equipment for work</u>	<u>Value</u> <u>Column</u>	<u>Value</u> <u>Column</u>
159	JOB SIG11	Check condition and inventory of supplies	___ 2	___ 4
160	JOB SIG12	Communicate with crew members	___ 6	___ 8
161	JOB SIG13	Represent company to crew	___ 10	___ 12
162	JOB SIG14	Discuss safety regulations	___ 14	___ 16
163	JOB SIG15	Discuss policy regulations	___ 18	___ 20
164	JOB SIG16	Motivate crew members	___ 22	___ 24
165	JOB SIG17	Build teamwork within the crew	___ 26	___ 28
166	JOB SIG18	Check condition of worksite (housekeeping, gas checks, ventilation curtain, water)	___ 30	___ 32
167	JOB SIG19	Check condition of equipment	___ 34	___ 36
168	JOB SIG20	Give orders and instructions about the work	___ 38	___ 40
169	JOB SIG21	Instruct crew members on how to handle problems	___ 42	___ 44
170	JOB SIG22	Troubleshoot problems as they arise	___ 46	___ 48
171	JOB SIG23	Check work of crew members	___ 50	___ 52
172	JOB SIG24	Train crew members on the job	___ 54	___ 56
173	JOB SIG25	Enforce policies, procedures, safety rules	___ 58	___ 60
174	JOB SIG26	Handle complaints of crew members	___ 62	___ 64
175	JOB SIG27	Counsel crew members about their work performance	___ 66	___ 68
176	JOB SIG28	Handle conflicts between crew members	___ 70	___ 72
III. <u>End of Shift Activities</u>				
177	JOB SIG29	Counsel crew members who have problems	___ 74	___ 76
178	JOB SIG30	Prepare reports and paperwork	___ 78	___ 80

FOREMAN FILE LAYOUT (Cont'd)

Record 8 Columns

Revised 3-9-87

1. Role Ambiguity (E) (Actual) (ROLAMBE_) [RA-E (1-4)]

Introduction: How often do these aspects appear in your job? (9 = missing data)

Var.#	Value	Item	Col.	Content
179	___	8:1	2	How often are you clear on what your job responsibilities are? 1) never 2) seldom 3) half the time 4) often 5) all the time
180	___	8:2	4	How often can you predict what others will expect of you on the job? 1) never 2) seldom 3) half the time 4) often 5) all the time
181	___	8:3	6	How much of the time are your work objectives well defined? 1) never 2) seldom 3) half the time 4) often 5) all the time
182	___	8:4	8	How often are you clear about what others expect of you on the job? 1) never 2) seldom 3) half the time 4) often 5) all the time

2. Role Ambiguity (P) (Ideal) (ROLAMP_) [RA-P (1-4)]

Introduction: If you could have your own way about designing a job for yourself, how would you like each of the following to be?

Var.#	Value	Item	Col.	Content
183	___	4:1	10	How much of the time would you like your work objectives to be well defined? 1) never 2) seldom 3) half the time 4) often 5) all the time
184	___	4:2	12	How often would you like to be clear on what others expect of you? 1) never 2) seldom 3) half the time 4) often 5) all the time
185	___	4:3	14	How often would you like to be able to predict what others expect of you on the job? 1) never 2) seldom 3) half the time 4) often 5) all the time
186	___	4:4	16	How often would you like to be clear on what your job responsibilities are? 1) never 2) seldom 3) half the time 4) often 5) all the time

3. Responsibility For Persons (E) (Actual) (RSPPERE_) [RFP-E (1-4)]

Introduction: How much of each of the following types of responsibility do you have?

Var.#	Value	Item	Col.	Content
187	___	8:5	18	How much responsibility do you have for the future of others? 1) none 2) a little 3) some 4) a lot 5) total
188	___	8:6	20	How much responsibility do you have for the job security of others? 1) none 2) a little 3) some 4) a lot 5) total
189	___	8:7	22	How much responsibility do you have for the morale of others? 1) none 2) a little 3) some 4) a lot 5) total
190	___	8:8	24	How much responsibility do you have for the welfare and lives of others?

FOREMAN FILE LAYOUT (Cont'd)

Record 8 Columns (Cont'd)

Revised 3-9-87

4. Responsibility For Persons (P) (Ideal) (RSPPERP_) [RFP-P (1-4)]

Introduction: If you could have your own way about designing a job for yourself, how would you like each of the following to be?

Var.#	Value	Item	Col.	Content
191	___	4:5	26	How much responsibility would you like to have for the future of others? 1) none 2) a little 3) some 4) a lot 5) total
192	___	4:6	28	How much responsibility would you like to have for the job security of others? 1) none 2) a little 3) some 4) a lot 5) total
193	___	4:7	30	How much responsibility would you like for the morale of others? 1) none 2) a little 3) some 4) a lot 5) total
194	___	4:8	32	How much responsibility would you like for the welfare and lives of others? 1) none 2) a little 3) some 4) a lot 5) total

5. Responsibility For Things (E) (Actual) (RSPTNGE_) [RFT-E (1-3)]

Introduction: These questions deal with different aspects of work. Please indicate how often these aspects appear in your job.

Var.#	Value	Item	Col.	Content
195	___	9:15	34	How much responsibility do you have for seeing that the equipment you use in your work is safe and well maintained? 1) none 2) a little 3) some 4) a lot 5) total
196	___	9:16	36	How much responsibility do you have for the preparation and adherence to a budget in your work? 1) none 2) a little 3) some 4) a lot 5) total
197	___	9:17	38	How much responsibility do you have for seeing that various projects are carried out properly? 1) none 2) a little 3) some 4) a lot 5) total

6. Responsibility For Things (P) (Ideal) (RSPTNGP_) [RFT-P (1-3)]

Introduction: Again, if you were designing a job for yourself, how much of each of the following would you like to have in such a job?

Var.#	Value	Item	Col.	Content
198	___	5:15	40	How much responsibility would you like to have for seeing that various projects are carried out properly? 1) none 2) a little 3) some 4) a lot 5) total
199	___	5:16	42	How much responsibility would you like to have for the preparation and adherence to a budget in your work?

FOREMAN FILE LAYOUT (Cont'd)

Record 8 Columns (Cont'd)

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7. Quantitative Workload (E) (Actual) (QTYWLDE_) [QWL-E (1-6)]

Introduction: These questions deal with different aspects of work. Indicate how often these aspects appear in your job.

Var.#	Value	Item	Col.	Content
201	___	9:9	46	How much time do you have to think and contemplate? 1) way too little 2) too little 3) okay 4) too much 5) way too much
202	___	9:10	48	How much workload do you have? 1) way too little 2) too little 3) okay 4) too much 5) way too much
203	___	9:11	50	What quantity of work do others expect of you? 1) way too little 2) too little 3) okay 4) too much 5) way too much
204	___	9:12	52	How much time do you have to do all your work? 1) way too little 2) too little 3) okay 4) too much 5) way too much
205	___	9:13	54	How many projects, assignments, or tasks do you have? 1) way too little 2) too little 3) okay 4) too much 5) way too much
206	___	9:14	56	How many lulls (breaks) between heavy workload periods do you have? 1) way too little 2) too little 3) okay 4) too much 5) way too much

8. Quantitative Workload (P) (Ideal) (QTYWLDP_) [QWL-P (1-6)]

Introduction: Again, if you were designing a job for yourself, how much of each of the following would you like to have in such a job? (Scale 1 to 5).

Var.#	Value	Item	Col.	Content
207	___	5:9	58	How much workload would you like to have? 1) a lot less 2) a little less 3) about the same 4) a little more 5) a lot more
208	___	5:10	60	How much time would you like to have to do all your work? 1) a lot less 2) a little less 3) about the same 4) a little more 5) a lot more
209	___	5:11	62	How much time to think and contemplate would you like to have? 1) a lot less 2) a little less 3) about the same 4) a little more 5) a lot more
210	___	5:12	64	What quantity of work would you prefer others to expect of you? 1) a lot less 2) a little less 3) about the same 4) a little more 5) a lot more
211	___	5:13	66	How many projects, assignments, or tasks would you like to have? 1) a lot less 2) a little less 3) about the same 4) a little more 5) a lot more
212	___	5:14	68	How many lulls (breaks) between heavy workload periods would you like to have? 1) a lot less 2) a little less 3) about the same 4) a little more 5) a lot more

FOREMAN FILE LAYOUT (Cont'd)

Record 9 Columns

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9. Job Future Ambiguity (JOBFAMB_) [JFA (1-4)]

Introduction: In the future some jobs will be changing while others will be staying the same. Here are some questions which deal with this topic.

<u>Var.#</u>	<u>Value</u>	<u>Item</u>	<u>Col.</u>	<u>Content</u>
213	___	7:1	2	How certain are you about what your future career picture looks like? 1) very uncertain 2) uncertain 3) so so 4) certain 5) very certain
214	___	7:2	4	How certain are you of the opportunities for promotion and advancement which will exist in the next few years? 1) very uncertain 2) uncertain 3) so so 4) certain 5) very certain
215	___	7:3	6	How certain are you about whether your job skills will be of use and value five years from now? 1) very uncertain 2) uncertain 3) so so 4) certain 5) very certain
216	___	7:4	8	How certain are you about what your responsibilities will be six months from now? 1) very uncertain 2) uncertain 3) so so 4) certain 5) very certain

10. Underutilization Of Abilities (UTLABIL_) [UOA (1-3)]

Introduction: This next set of items deals with the use of your skills and abilities. Indicate how often you use each type.

<u>Var.#</u>	<u>Value</u>	<u>Item</u>	<u>Col.</u>	<u>Content</u>
217	___	6:1	10	How often does your job let you use the skills and knowledge you learned in school? 1) never 2) seldom 3) sometimes 4) often 5) all the time
218	___	6:2	12	How often are you given a change to do the things you do best? 1) never 2) seldom 3) sometimes 4) often 5) all the time
219	___	6:3	14	How often can you use skills from your previous experience and training? 1) never 2) seldom 3) sometimes 4) often 5) all the time

11. Variance In Workload (VARWLD_) [VIWL (1-3)]

Introduction: Indicate how often you experience each of the following changes on your job.

<u>Var.#</u>	<u>Value</u>	<u>Item</u>	<u>Col.</u>	<u>Content</u>
220	___	10:1b	16	A marked (or large) increase in the workload. 1) never 2) seldom 3) sometimes 4) often 5) all the time
221	___	10:2b	18	A marked increase in the amount of concentration required on your job. 1) never 2) seldom 3) sometimes 4) often 5) all the time
222	___	10:3b	20	A marked increase in how fast you have to think.

FOREMAN FILE LAYOUT (Cont'd)

Record 9 Columns (Cont'd)

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12. Participation (With upper management and other supervisors) (PARTICP_) [PART (1-3)]

Introduction: Indicate how often you experience each of the following changes on your job.

Var.#	Value	Item	Col.	Content
223	___	6:1b	22	How much do you take part <u>with others</u> in making decisions that affect you? 1) never 2) very seldom 3) sometimes 4) often 5) very often
224	___	6:2b	24	How much do you participate with others in helping set the way things are done on your job? 1) never 2) very seldom 3) sometimes 4) often 5) very often
225	___	6:3b	26	How much do you decide with others what part of a task you will do? 1) never 2) very seldom 3) sometimes 4) often 5) very often

13. Role Conflict (ROLCONF_) [RC (1-4)]

Introduction: Conflicts can occur in any job. For example, someone may ask you to do your work in a way which is different from what you think best or you may find that it is difficult to satisfy everyone. How often do you face problems in your work like the ones listed below?

Var.#	Value	Item	Col.	Content
226	___	10:1	28	People in a good position to see if you do what they ask (e.g. shift foreman) give you things to do which conflict with one another. 1) never 2) very seldom 3) sometimes 4) often 5) very often
227	___	10:2	30	Persons equal in rank and authority to you ask you to do things which conflict (e.g. the other supervisors in your section). 1) never 2) very seldom 3) sometimes 4) often 5) very often
228	___	10:3	32	People whose requests should be met give you things which conflict with other work you have to do (e.g. inspectors). 1) never 2) very seldom 3) sometimes 4) often 5) very often
229	___	10:4	34	You have feelings of pressure from having to please too many bosses. 1) never 2) very seldom 3) sometimes 4) often 5) very often

FOREMAN FILE LAYOUT (Cont'd)

Record 9 Columns (Cont'd)

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14. Inequity In Pay (INEQPAY_) [IIP (1-4)]

Introduction: How fair is your pay?

Var.#	Value	Item	Col.	Content
230	___	11:1	36	Compared to other foremen where you work, who do a job <u>similar</u> to yours (for example, other section foremen), how fair is your pay? 1) very unfair 2) somewhat unfair 3) so so 4) fair 5) very fair
231	___	11:2	38	Compared to other people where you work who do a job <u>different</u> from yours (for example, construction foremen), how fair is your pay? 1) very unfair 2) somewhat unfair 3) so so 4) fair 5) very fair
232	___	11:3	40	Compared to other people who do <u>not</u> work where you work (for example, other mines close by) but who have a <u>similar</u> skill to yours, how fair is your pay? 1) very unfair 2) somewhat unfair 3) so so 4) fair 5) very fair
233	___	11:4	42	Compared to others where you work who do a job different from yours, but with <u>education similar</u> to yours (for example, shift foremen), how fair is your pay? 1) very unfair 2) somewhat unfair 3) so so 4) fair 5) very fair

15. Repetitiveness, Expressiveness & Feedback (REFDB_) [REF (1-6)]

Introduction: a: How often does your job:
b: How often, on your job, do you:
(Scale 1 to 5)

Var.#	Value	Item	Col.	Content
234	___	12:1a	44	Require you to repeat the same activities over and over. 1) never 2) seldom 3) sometimes 4) often 5) all the time
235	___	12:1b	46	Do different things each day. 1) never 2) seldom 3) sometimes 4) often 5) all the time
236	___	12:2a	48	Give you a chance to develop new talents. 1) never 2) seldom 3) sometimes 4) often 5) all the time
237	___	12:3a	50	Provide you an opportunity to be creative. 1) never 2) seldom 3) sometimes 4) often 5) all the time
238	___	12:3b	52	Know how well you did at the end of the day. 1) never 2) seldom 3) sometimes 4) often 5) all the time
239	___	12:4b	54	See the results of your work. 1) never 2) seldom 3) sometimes 4) often 5) all the time

FOREMAN FILE LAYOUT (Cont'd)

Record 10 Columns

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16. Social Support: From supervisor (SOCSUP1_), coworkers (SOCSUP2_), spouse (SOCSUP3_) and relatives (SOCSUP4_) [SS (1-4)(A-D)]

Introduction: This question asks about the help and support you get for your work from several other people. This help may include both physical or material help, and moral support or morale-boosting.

Please circle one number for each question.

Var.# Col.

		1 = never	2 = seldom	3 = sometimes	4 = often	5 = always	
							<u>Your immediate supervisor, the shift foreman</u>
240	2	1	2	3	4	5	How often does your shift foreman go out of his way to do things to make your work life easier?
241	10	1	2	3	4	5	How much can he be relied on when things get tough at work?
242	18	1	2	3	4	5	How much is he willing to listen to your personal problems (with the job)?
243	26	1	2	3	4	5	How easy is it to talk to your shift foreman?
							<u>Your coworkers, other face bosses</u>
244	4	1	2	3	4	5	How often do other face bosses at work go out of their way to do things to make your work life easier?
245	12	1	2	3	4	5	How much can they be relied on when things get tough at work?
246	20	1	2	3	4	5	How much are they willing to listen to your personal problems (with the job)?
247	28	1	2	3	4	5	How easy is it to talk to other face bosses?
							<u>Your wife/husband</u>
248	6	1	2	3	4	5	How much does your wife/husband go out of her/his way to do things to make your work life easier?
249	14	1	2	3	4	5	How much can she/he be relied on when things get tough at work?
250	22	1	2	3	4	5	How much is she/he willing to listen to your personal problems (with the job)?
251	30	1	2	3	4	5	How easy is it to talk to your wife/husband?
							<u>Other relatives and friends</u>
252	8	1	2	3	4	5	How much do your other relatives and friends go out of their way to do things to make your work life easier?
253	16	1	2	3	4	5	How much can they be relied on when things get tough at work?
254	24	1	2	3	4	5	How much are they willing to listen to your personal problems (with the job)?
255	32	1	2	3	4	5	How easy is it to talk to your other relatives and friends?

FOREMAN FILE LAYOUT (Cont'd)

Record 10 Columns (Cont'd)

Revised 3-9-87

17. Personality (PERSLTY_) [PERS (1-9)]

Introduction: Here are 9 self-descriptive questions. Any answer which describes the way you feel or act is the right one to give.

Answer quickly rather than making a long decision on each question. Of course, if you want to think out some answer, feel free to do so. However, it's your first impressions which are the most important.

Var.#	Value	Item	Col.	Content
256	___	24:1	34	I hate giving up before I'm absolutely sure that I'm licked. 1) strongly disagree 2) disagree 3) so so 4) agree 5) strongly agree
257	___	24:2	36	Sometimes I feel that I shouldn't be working so hard, but something drives me on. 1) strongly disagree 2) disagree 3) so so 4) agree 5) strongly agree
258	___	24:3	38	I thrive on challenging situations. The more challenges I have, the better. 1) strongly disagree 2) disagree 3) so so 4) agree 5) strongly agree
259	___	24:4	40	In comparison to most people I know, I'm very involved in my work. 1) strongly disagree 2) disagree 3) so so 4) agree 5) strongly agree
260	___	24:5	42	It seems as if I need thirty hours a day to finish all the things I'm faced with. 1) strongly disagree 2) disagree 3) so so 4) agree 5) strongly agree
261	___	24:6	44	In general, I approach my work more seriously than most people I know. 1) strongly disagree 2) disagree 3) so so 4) agree 5) strongly agree
262	___	24:7	46	I guess there are some people who can be nonchalant (casual) about their work, but I'm not one of them. 1) strongly disagree 2) disagree 3) so so 4) agree 5) strongly agree
263	___	24:8	48	My achievements are considered to be significantly higher than those of most people I know. 1) strongly disagree 2) disagree 3) so so 4) agree 5) strongly agree
264	___	24:9	50	I've often been asked to be an officer of some group or groups. 1) never 2) very seldom 3) occasionally 4) often 5) all the time

FOREMAN FILE LAYOUT (Cont'd)

Record 10 Columns (Cont'd)

Revised 3-9-87

18. Job Self-Esteem (JSLFEST_) [JSE (1-3)]

Introduction: These are some phrases which ask how you see yourself in your work.

Var.#	Value	Item	Col.	Content
265	___	15:1	52	How successful do you see yourself? 1) very unsuccessful 2) unsuccessful 3) okay 4) successful 5) very successful
266	___	15:3	54	How important are you at work? 1) very unimportant 2) unimportant 3) okay 4) important 5) very important
267	___	15:4	56	How often do you do your best at work? 1) never do my best 2) seldom do my best 3) occasionally do my best 4) normally do my best 5) always do my best

FOREMAN FILE LAYOUT (Cont'd)

Record 10 Columns (Cont'd)

Revised 3-9-87

19. Job Dissatisfaction (JDISATF_) [JD (1-4)]

Introduction: Now we would like you to think about the type of work you do on your job.

Var.#	Value	Item	Col.	Content
268	___	16:1	58	Knowing what you know now, if you had to decide all over again whether to take the type of job you now have, what would you decide? I would 1. Decide without hesitation to take the same type of job. 2. Have some second thoughts. 3. Decide definitely not to take this type of job.
269	___	16:2	60	If you were free right now to go into any type of job you wanted, what would your choice be? I would 1. Take the same type of job as I have now. 2. Take a different type of job.
270	___	16:3	62	If a friend of yours told you he was interested in working in a job like yours, what would you tell him? <u>Circle One Number.</u> I would 1. Strongly recommend it. 2. Have doubts about recommending it. 3. Advise him against it.
271	___	16:4	64	All in all, how satisfied would you say you are with your job? 1. Very satisfied 2. Somewhat satisfied 3. Not too satisfied 4. Not at all satisfied.

FOREMAN FILE LAYOUT (Cont'd)

Record 10 Columns (Cont'd)

Revised 3-9-87

20. Boredom, Workload Dissatisfaction (BWLDDIS_) [B-WLD (1-7)]

Introduction: How often do you feel the following things about your job?

<u>Var.#</u>	<u>Value</u>	<u>Item</u>	<u>Col.</u>	<u>Content</u>
272	___	14:1	66	My work is interesting to do. (reverse scored) 1) never 2) seldom 3) sometimes 4) often 5) all the time
273	___	14:3	68	I feel bored with the work I have to do. 1) never 2) seldom 3) sometimes 4) often 5) all the time
274	___	14:5	70	The work on my job feels dull. 1) never 2) seldom 3) sometimes 4) often 5) all the time
275	___	14:7	72	I find myself "watching the clock", waiting to go home. 1) never 2) seldom 3) sometimes 4) often 5) all the time
276	___	14:2	74	I dislike the amount of work I'm expected to do. 1) never 2) seldom 3) sometimes 4) often 5) all the time
277	___	14:4	76	I am dissatisfied with the pace of my work. 1) never 2) seldom 3) sometimes 4) often 5) all the time
278	___	14:6	78	I am unhappy about my current workload. 1) never 2) seldom 3) sometimes 4) often 5) all the time

FOREMAN FILE LAYOUT (Cont'd)

Record 11 Columns

Revised 3-9-87

21. Affective States: Anxiety, Depression and Irritation (AFTVST_) [AS (1-13)]

Introduction: When you think about yourself and your job nowadays, how much of the time do you feel this way?

Var.#	Value	Item	Col.	Content
279	___	18:12	2	nervous 1) never 2) seldom 3) sometimes 4) often 5) all the time
280	___	18:3	4	jittery 1) never 2) seldom 3) sometimes 4) often 5) all the time
281	___	18:15	6	fidgety 1) never 2) seldom 3) sometimes 4) often 5) all the time
282	___	18:5	8	calm 1) all the time 2) often 3) sometimes 4) seldom 5) never
283	___	18:2	10	sad 1) never 2) seldom 3) sometimes 4) often 5) all the time
284	___	18:6	12	unhappy 1) never 2) seldom 3) sometimes 4) often 5) all the time
285	___	18:12	14	depressed 1) never 2) seldom 3) sometimes 4) often 5) all the time
286	___	18:11	16	good 1) all the time 2) often 3) sometimes 4) seldom 5) never
287	___	18:16	18	blue 1) never 2) seldom 3) sometimes 4) often 5) all the time
288	___	18:18	20	cheerful 1) never 2) seldom 3) sometimes 4) often 5) all the time
289	___	18:13	22	angry 1) never 2) seldom 3) sometimes 4) often 5) all the time
290	___	18:17	24	aggravated 1) never 2) seldom 3) sometimes 4) often 5) all the time
291	___	18:19	26	irritated or annoyed 1) never 2) seldom 3) sometimes 4) often 5) all the time

FOREMAN FILE LAYOUT (Cont'd)

Record 11 Columns (Cont'd)

Revised 3-9-87

22. Somatic (Health) Complaints on the Job (SCONJOB_) [SC-ON-J (1-10)]

Introduction: Have you experienced any of the following during the past month on the job? (1=no; 2=yes)

Var.#	Value	Item	Col.	Content
292	___	17:1A	28	Your hands trembled enough to bother you. 1) no 2) yes
293	___	17:2A	30	You were bothered by shortness of breath when you were not working hard. 1) no 2) yes
294	___	17:3A	32	Your hands sweated so that you felt damp and clammy. 1) no 2) yes
295	___	17:4A	34	You had spells of dizziness. 1) no 2) yes
296	___	17:5A	36	You were bothered by having an upset stomach or stomachache. 1) no 2) yes
297	___	17:6A	38	You were bothered by your heart beating faster than usual. 1) no 2) yes
298	___	17:7A	40	You had headaches. 1) no 2) yes
299	___	17:8A	42	You felt fidgety or tense. 1) no 2) yes
300	___	17:9A	44	You felt nervous or shaky inside. 1) no 2) yes
301	___	17:10A	46	You felt nauseous. 1) no 2) yes

FOREMAN FILE LAYOUT (Cont'd)

Record 11 Columns (Cont'd)

Revised 3-9-87

23. Somatic (Health) Complaints off the Job (SCOFJOB_) [SC-OFF-J (1-9)]

Introduction: In addition, have you experienced any of the following off the job during the past month. (1 = no; 2 = yes)

<u>Var.#</u>	<u>Value</u>	<u>Item</u>	<u>Col.</u>	<u>Content</u>
302	___	17:1B	48	You had trouble falling or staying asleep. 1) no 2) yes
303	___	17:2B	50	You had nightmares. 1) no 2) yes
304	___	17:3B	52	You fainted or blacked out. 1) no 2) yes
305	___	17:4B	54	You had headaches. 1) no 2) yes
306	___	17:5B	56	You felt fidgety or tense. 1) no 2) yes
307	___	17:6B	58	You felt you were going to have a nervous breakdown. 1) no 2) yes
308	___	17:7B	60	You had a loss of appetite. 1) no 2) yes
309	___	17:8B	62	You felt nervous or shaky inside. 1) no 2) yes
310	___	17:9B	64	You felt nauseous. 1) no 2) yes

FOREMAN FILE LAYOUT (Cont'd)

Record 12 Columns

Revised 3-9-87

Instructions: For each item, choose the alternative which most nearly expresses your opinion on how frequently you should do what is described by that item, whether or not you actually can or do do that. Always indicate what you, as a supervisor, or manager, sincerely believe to be the desirable way to act. Please remember -- there are no right or wrong answers to these questions. Different supervisors have different experiences and we are interested only in your opinions.

Var.# Value Item Col. Content (LOQQST_)

- | | | | | |
|-----|----------|-----|----|---|
| 311 | 1. ____ | (S) | 2 | (LOQ) Put the welfare of your unit above the welfare of any person in it.
1) never 2) seldom 3) occasionally 4) often 5) always |
| 312 | 2. ____ | (C) | 4 | (LOQ) Give in to your subordinates in discussions with them.
1) very seldom 2) once in a while 3) occasionally
4) fairly often 5) often |
| 313 | 3. ____ | (S) | 6 | (LOQ) Encourage after-duty work by persons of your unit.
1) very seldom 2) once in a while
3) to some degree 4) fairly often 5) a great deal |
| 314 | 4. ____ | (S) | 8 | (LOQ) Try out your own new ideas in the unit.
1) very seldom 2) once in a while 3) occasionally
4) fairly often 5) often |
| 315 | 5. ____ | (C) | 10 | (LOQ) Back up what persons under you do.
1) never 2) seldom 3) occasionally 4) often 5) always |
| 316 | 6. ____ | (S) | 12 | (LOQ) Criticize poor work.
1) never 2) seldom 3) occasionally 4) often 5) always |
| 317 | 7. ____ | (C) | 14 | (LOQ) Ask for more than the persons under you can accomplish.
1) often 2) fairly often 3) occasionally
4) once in a while 5) very seldom |
| 318 | 8. ____ | (C) | 16 | (LOQ) Refuse to compromise a point.
1) always 2) often 3) occasionally 4) seldom 5) never |
| 319 | 9. ____ | (S) | 18 | (LOQ) Insist that persons under you follow to the letter those standard routines handed down to you.
1) never 2) seldom 3) occasionally 4) often 5) always |
| 320 | 10. ____ | (C) | 20 | (LOQ) Help persons under you with their personal problems.
1) very seldom 2) once in a while 3) occasionally
4) fairly often 5) often |
| 321 | 11. ____ | (C) | 22 | (LOQ) Be slow to adopt new ideas.
1) always 2) often 3) occasionally 4) seldom 5) never |

FOREMAN FILE LAYOUT (Cont'd)

Record 12 Columns (Cont'd)

Revised 3-9-87

<u>Var.#</u>	<u>Value</u>	<u>Item</u>	<u>Col.</u>	<u>Content</u>
322	12. ____	(C)	24	(LOQ) Get the approval of persons under you on important matters before going ahead. 1) never 2) seldom 3) occasionally 4) often 5) always
323	13. ____	(C)	26	(LOQ) Resist changes in ways of doing things. 1) a great deal 2) fairly much 3) to some degree 4) comparatively little 5) not at all
324	14. ____	(S)	28	(LOQ) Assign persons under you to particular tasks. 1) never 2) seldom 3) occasionally 4) often 5) always
325	15. ____	(C)	30	(LOQ) Speak in a manner not to be questioned. 1) always 2) often 3) occasionally 4) seldom 5) never
326	16. ____	(S)	32	(LOQ) Stress importance of being ahead of other units (crews). 1) not at all 2) comparatively little 3) to some degree 4) fairly much 5) a great deal
327	17. ____	(C)	34	(LOQ) Criticize a specific act rather than a particular member of your unit. 1) never 2) seldom 3) occasionally 4) often 5) always
328	18. ____	(S)	36	(LOQ) Let the persons under you do their work the way they think is best. 1) always 2) often 3) occasionally 4) seldom 5) never
329	19. ____	(C)	38	(LOQ) Do personal favors for persons under you. 1) very seldom 2) once in a while 3) occasionally 4) fairly often 5) often
330	20. ____	(S)	40	(LOQ) Emphasize meeting of deadlines. 1) not at all 2) comparatively little 3) to some degree 4) fairly much 5) a great deal
331	21. ____	(S)	42	(LOQ) Insist that you be informed on decisions made by persons under you. 1) never 2) seldom 3) occasionally 4) often 5) always
332	22. ____	(S)	44	(LOQ) Offer new approaches to problems. 1) very seldom 2) once in a while 3) occasionally 4) fairly often 5) often
333	23. ____	(C)	46	(LOQ) Treat all persons under you as your equals. 1) never 2) seldom 3) occasionally 4) often 5) always
334	24. ____	(C)	48	(LOQ) Be willing to make changes. 1) never 2) seldom 3) occasionally 4) often 5) always

FOREMAN FILE LAYOUT (Cont'd)

Record 12 Columns (Cont'd)

Revised 3-9-87

<u>Var.#</u>	<u>Value</u>	<u>Item</u>	<u>Col.</u>	<u>Content</u>
335	25. ____	(S)	50	(LOQ) Talk about how much should be done. 1) not at all 2) comparatively little 3) to some degree 4) fairly much 5) a great deal
336	26. ____	(S)	52	(LOQ) Wait for persons in your unit to push new ideas. 1) always 2) often 3) occasionally 4) seldom 5) never
337	27. ____	(S)	54	(LOQ) Rule with an iron hand. 1) never 2) seldom 3) occasionally 4) often 5) always
338	28. ____	(C)	56	(LOQ) Reject suggestions for changes. 1) always 2) often 3) occasionally 4) seldom 5) never
339	29. ____	(C)	58	(LOQ) Change the duties of persons under you without first talking it over with them. 1) often 2) fairly often 3) occasionally 4) once in a while 5) very seldom
340	30. ____	(S)	60	(LOQ) Decide in detail what shall be done and how it shall be done by persons under you. 1) never 2) seldom 3) occasionally 4) often 5) always
341	31. ____	(S)	62	(LOQ) See to it that persons under you are working up to capacity. 1) never 2) seldom 3) occasionally 4) often 5) always
342	32. ____	(C)	64	(LOQ) Stand up for persons under you, even though it makes you unpopular with others. 1) never 2) seldom 3) occasionally 4) often 5) always
343	33. ____	(C)	66	(LOQ) Put suggestions made by persons in the unit into operation. 1) very seldom 2) once in a while 3) occasionally 4) fairly often 5) often
344	34. ____	(C)	68	(LOQ) Refuse to explain your actions. 1) often 2) fairly often 3) occasionally 4) once in a while 5) very seldom
345	35. ____	(S)	70	(LOQ) Ask for sacrifices from persons under you for the good of your entire unit. 1) very seldom 2) once in a while 3) occasionally 4) fairly often 5) often

FOREMAN FILE LAYOUT (Cont'd)

Record 12 Columns (Cont'd)

Revised 3-9-87

<u>Var.#</u>	<u>Value</u>	<u>Item</u>	<u>Col.</u>	<u>Content</u>
346	36. ____	(C)	72	(LOQ) Act without consulting persons under you. 1) often 2) fairly often 3) occasionally 4) once in a while 5) very seldom
347	37. ____	(S)	74	(LOQ) "Needle" persons under you for greater effort. 1) not at all 2) comparatively little 3) to some degree 4) fairly much 5) a great deal
348	38. ____	(C)	76	(LOQ) Insist that everything be done your way. 1) always 2) often 3) occasionally 4) seldom 5) never
349	39. ____	(S)	78	(LOQ) Encourage slow-working persons in your unit to work harder. 1) very seldom 2) once in a while 3) occasionally 4) fairly often 5) often
350	40. ____	(S)	80	(LOQ) Meet with the persons in your unit at certain regularly scheduled times. 1) never 2) seldom 3) occasionally 4) often 5) always

APPENDIX C

**DESCRIPTION OF ACTIVITIES OBSERVED DURING
TIME STUDY OF THE FACE SUPERVISOR**

**Description of Activities Observed During
the Time Study of the Face Supervisor**

- (1) Discussion with supervisor(s) at the bottom before shift (event #20)

Some mines in the study held meetings between the general shift foreman and the section foreman at the bottom of the shaft at a convenient location. This activity normally occurred before the start of the shift and ended after the start of the shift. There were also instances of discussions with other section foremen, maintenance foremen, etc.

- (2) Discussion with supervisor(s) on the top before shift (event #3)

This activity includes any discussions with other foremen and other supervisors including maintenance personnel, etc. Recording any pre-shift information which may be called out to the supervisor would also be included in this activity.

- (3) Pre-shift activity

This activity is defined by the duration of time between the end of the discussion with a supervisor (event #3) and enter cage (event #4).

- (4) Man-trip in (event #5)

The start of this activity is when the supervisor actually arrives at the man-trip and includes the time until he leaves the man-trip at the working section. If during this period of time he has any discussions with the crew regarding section activities rather than discussions about sports and weather, then that specific time is allocated to the proper activity.

- (5) Pre-section start-up

This activity is defined by the duration of time between arriving at the dinner hole (event #5) and the start of any of the normal shift activities (face inspection, call out inspection report, face observation, work activity or leadership activity). This is a non-coded activity.

- (6) Face inspection

This activity is normally performed as soon as the section foreman reaches the section and the time starts when either he leaves the dinner hole and/or the man-trip. The activity includes any gas checks, special reporting requirements which are required for the pre-shift inspection, initialing the different areas which are inspected, and checking the general condition of the section including the location

of equipment. This activity is differentiated from the activity #78 which is entitled "gas check" because of its continuity over several different entries or cross-cuts within the working area of the section. The start of the activity is indicated by event #10 and the finish is indicated by event #11.

(7) Call out inspection, tonnage or delay report

This activity varies from mine to mine but most mines require that the supervisor call out upon completing his face examination and as soon as he is ready to start producing coal. Some mines also require that this "call out" be made anytime a major delay occurs and to report the tonnage at the lunch break and at the end of the shift. Event #12 is the start of the activity and event #13 is the finish.

(8) Face observation

This activity is started with an event #14 and concludes with event #15. This activity is used to document the time the supervisor spends passively observing activities on the section. During this time the observer will ask the supervisor what he is thinking about and if appropriate (e.g., planning his next move) the time will be allocated to that activity (e.g., leadership).

(9) Work activity

This activity is used to record any time which the supervisor spends in physical labor. The criteria used is that the supervisor actually be replacing a member of the crew in performing the work. For example, operating a shuttle car during the spell-out period of the lunch break, or installing a new curtain would be work. If he is assisting crew members (e.g., moving a fan or cable, etc.) the leadership activity codes should be used. If he only repairs a curtain which has been damaged then that would constitute an activity #71. Events #16 and #17 designate the start and finish of this activity.

(10) Leadership activity on the section

This activity normally includes any interaction with the crew members with the exception of when he is giving specific instructions to a worker on how to perform a job which is designated as an activity #63, or when he interrupts an on-going activity to check on another member of the crew which is an activity #68. Events #18 and #19 indicate the start and finish of the activity.

(11) Normal shift activity

This activity defines any time from the finish of any of the normal shift activities and the start of any other activity. This is a non-coded activity.

(12) End of shift activity

This activity is defined by the duration of time between the last normal shift activity (minus any interruptions) and arriving at the dinner hole (event #34) before leaving the section.

(13) Man-trip out (event #22)

This activity includes the time from when the supervisor arrives at the man-trip for the trip out of the mine until he leaves the man-trip when it arrives at the bottom of the shaft or slope.

(14) Fill out various mine reports (event #36)

This activity is defined as when the supervisor is completing his daily reports at the end of the shift. If he works on his reports either before the shift starts or during the shift then an event #66 is used.

(15) Discussion with supervisor on the top at the end of the shift (event #37)

This activity includes any time which is spent in discussion with either upper management, other line management (for example, maintenance personnel) and other face supervisors. It would also include any time spent reporting information which is being "called-out" from the section.

(16) Showering at the end of the shift (event #38)

(17) Dressing at the end of the shift (event #39)

(18) Discussion with supervisor at the bottom at the end of the shift (event #21)

Again, some mines have the on-going and off-going foreman, for a particular section, meet at the bottom of the shaft to discuss various issues regarding the section and this time would be included within this activity.

(19) Cage-trip out (event #35)

This activity begins when the supervisor leaves the man-trip at the end of the shift and is concluded when the supervisor arrives at the top of the shaft or slope. This time would not include any other events (e.g., #21) which would occur.

(50) Personal preparation (event #50)

This activity includes: dressing, preparing his flame safety lamps, checking his methane detector, etc.

(53) Power failure (event #53)

This activity documents the time the supervisor spends observing personnel repairing various electrical power failures. If the supervisor repairs the failure himself, then an activity #9 is used. If he instructs another worker in the repair of the failure, then an activity #63 is used for that portion of the time.

(54) Water delay (event #54)

Same as activity #53 except that it pertains to section water delays.

(55) Equipment failure (event #55)

Same as activity #53 except that it pertains to equipment failures.

(57) Belt failure (event #57)

Same as activity #53 except that it pertains to conveyor belt failures. The time spent walking the belt to find the cause of the failure would also be included.

(61) Count and/or order supplies (event #61)

This activity includes any time the supervisor spends during the pre-shift, during-shift or post-shift in obtaining, counting or ordering any supplies for his section.

(62) Work stoppage (event #62)

This activity includes any planned or unplanned work stoppage which is not the result of either a power, belt, water or equipment failure. The closure of the section because of a safety violation would be an example. A crew walk out would be another example.

(63) Instruct workers (event #63)

This activity documents any time which the supervisor spends in the instruction of workers to perform various tasks. This could include the supervisor actually operating a piece of equipment if it is for training purposes.

(64) Management interaction on the section (event #64)

This activity is used to document the time spent with other supervisory personnel when they visit on the section.

(65) Study participation (event #65)

This activity documents the amount of time the supervisor spends interacting with the interviewer and answering questions regarding the project.

(66) Mine reports (event #66)

Any time the supervisor spends before the shift starts or on the section completing various management reports is included in this activity. It includes report work done in the dinner hole at the end of the shift, during delays and on the man-trip.

(67) Marking and measuring the face area (event #67)

This activity includes any time measuring the depth of "cuts", width of entries, width of intersections, etc. It also includes installing center lines in entries and crosscuts.

(68) Check on crew (event #68)

This activity documents the amount of time the supervisor spends checking on the crew at the start of the shift and if he has to interrupt another activity in order to check on the availability and/or location of other workers on the section. It also includes finding replacements for absent crew members at the start of the shift.

(71) Measure ventilation and repair curtains (event #71)

Included in this activity are measuring the air quantity in the face areas, repairing any torn tubing or curtains, checking regulators, etc.

(72) Inspect section belt (event #72)

Some mines require the section foreman to inspect the section belt for the pre-shift inspection as required by State Law. If this is the case, then this is the activity which would document the required time.

(73) Safety talk with crew (event #73)

This activity would include both organized safety talks which are required by the company on a periodic basis as well as any informal safety talks which the foreman may have during the course of the shift with his crew.

(74) Interaction with safety inspectors (event #74)

This activity would include any time spent in discussions with state, federal, company and union safety inspectors.

(75) Accident investigation (event #75)

This activity would include any time which is required to investigate any accidents on the section including completing any required forms.

(76) Roof control investigation (event #76)

This activity would include the time required to torque roof bolts, inspect roof falls, measure the distance between roof bolts, etc.

(78) Gas check (event #78)

This activity includes any random decision on the part of the supervisor to make a gas check in the face area. If it is part of a conscientious effort on the part of the supervisor to inspect all the faces, then activity #6 would be used.

(79) Lunch (event #79)

(90) Start interruptive delay

A code #90 is used in indicate the start of an interruptive delay.

(95) End of "missed" time

For various reasons, e.g., recorder failure, stop-watch problems, etc., time is lost during observations. A code #95 is used to designate when control of the time measurement is regained. The time from the last noted activity and the code #95 is discarded from the time summary.

Description of Aggregate Description Codes (Activity #)

- 1.0 Equipment failure observations include:
 - 1.1 Power failure (53)
 - 1.2 Water delay (54)
 - 1.3 Equipment failure (55)
 - 1.4 Belt failure (57)
- 2.0 Safety activities include:
 - 2.1 Face inspection (6)
 - 2.2 Measure ventilation and repair curtains (71)
 - 2.3 Inspect section belt (72)
 - 2.4 Safety talk with crew (73)
 - 2.5 Interaction with safety inspectors (74)
 - 2.6 Accident investigation (75)
 - 2.7 Roof control investigation (76)
 - 2.8 Gas check (78)
- 3.0 System activities include:
 - 3.1 Fill out various mine reports (14)
 - 3.2 Count and/or order supplies (61)
 - 3.3 Work stoppage (62)
 - 3.4 Study participation (65)
 - 3.5 Mine reports (66)
 - 3.6 Marking and measuring the face area (67)
 - 3.7 Lunch (79)
- 4.0 Interaction with management includes:
 - 4.1 Discussion with supervisor at the bottom before shift (1)
 - 4.2 Discussion with supervisor on the top before shift (2)
 - 4.3 Call out inspection, tonnage or delay report (7)
 - 4.4 Discussion with supervisor on the top at the end of the shift (15)
 - 4.5 Discussion with supervisor at the bottom at the end of the shift (18)
 - 4.6 Management interaction on the section (64)
- 5.0 Interaction with workers includes:
 - 5.1 Leadership activity on the section (10)
 - 5.2 Instruct workers (63)
 - 5.3 Check on crew (68)
- 6.0 Work activities include:
 - 6.1 Work activity (9)
- 7.0 Passive observation includes:
 - 7.1 Face observation (8)

8.0 All other activities include:

- 8.1 Pre-shift activity (3)
- 8.2 Man-trip in (4)
- 8.3 Pre-section start-up (5)
- 8.4 Normal shift activity (11)
- 8.5 End of shift activity (12)
- 8.6 Man-trip out (13)
- 8.7 Showering at the end of the shift (16)
- 8.8 Dressing at the end of the shift (17)
- 8.9 Cage-trip out (19)
- 8.10 Personal preparation (50)

APPENDIX D
LISTING OF VARIABLES

MINE FILE VARIABLES

Var #	Variable	Format	Begin Posit.	Description
1	MSFCOD	I5	1	Mine, section, foreman code
2	STATCOD	I1	6	State code
3	HSACNUM	I7	7	HSAC mine ID
4	TONSYR	I5	14	coal production (1000 tons/yr)
5	TOTEMP	I4	19	Total underground employees
6	MANGEMP	I4	23	# of management employees
7	NUMSECF	I3	27	# of section foremen
8	NUMHRWKR	I5	30	# of underground hourly workers
9	NUMCREWS	I3	35	# of underground section crews
10	INJINCRT	F4.1	38	Injury incident rate
11	ACCRAE	I4	42	Accident severity rate
12	NUMVIOL	I4	46	# of underground violations
13	NUMSGRV	I4	50	# of safety grievances
14	NUMLGRV	I4	54	# of labor grievances
15	INCNTPLN	I4	58	Mine incentive plan
16	LTURNOV	I4	62	Underground labor turnover
17	STURNOV	I4	66	Section supv turnover
18	SELCPRC	I2	70	Supv selection procedures
19	MINETYP	I2	72	Mine type
20	COALTYP	I2	74	Coal type
21	SHIFTDAY	I2	76	# of shifts per day worked
22	CAPTIVE	I2	78	Coal market
23	NUMSTRIK	I3	80	# of wildcat strikes
24	SHIFTSYS	I2	83	Shift rotation system (number of weeks)
25	FORMROTA	I2	86	Foreman rotation system (1 if with crew)
26	LOQCSUP	I3	88	Mine supt's LOQ consideration score
27	LOQSSUP	I3	91	Mine supt's LOQ structure score
467	MANHOURS	I5	1599	# of manhours (1000's)
468	TONPMAN	I5	1604	Tons/underground person
469	TONPMHR	F5.2	1609	Tons/underground manhour

SECTION FILE VARIABLES

Var #	Variable	Format	Begin Posit.	Description
28	SEAMDPT	I5	94	Seam depth (feet)
29	ENTCENTR	I4	99	Entry center (feet)
30	XCUTCENT	I4	103	Crosscut center (feet)
31	ENTWIDTH	I4	107	Entry width (feet)
32	CUTDEPT	I4	111	Cut depth (feet)
33	SEAMHGT	I4	115	Seam height (inches)
34	FLOORH2O	I2	119	Floor water code
35	FLOORCND	I2	121	Floor condition code
36	SEAMGRAD	I3	123	Coal seam grade code
37	SEAMDIP	I2	126	Coal seam dip code
38	BOLTLGTH	I3	128	Bolt length (feet)
39	GASMONIT	I2	131	Gas monitor code
40	SEAMHARD	I2	133	Seam hardness code
41	TOTTHICK	I3	135	Parting (total thickness)
42	GRINDCOD	I4	138	Hardgrove grindability index
43	MINPLAN	I2	142	Mine plan code
44	NUMENTRY	I3	144	Number of entries
45	MINERTYP	I2	147	Miner type code
46	IGNITFRQ	I2	149	Gas ignition code
47	RIBCOND	I2	151	Rib condition code
48	MANACCES	I2	153	Manpower access mode
49	HAULACC	I2	155	Coal haulage mode (out of mine)
50	SCARMOD	I2	157	Shuttle car model
51	SCARPAY	I3	159	Shuttle car payload
52	SCARLOAD	I4	162	Time to load shuttle car (minutes)
53	MANTRIPT	I5	166	Mantrip time (one way) (minutes)
54	AVGTONSH	I5	171	Avg tons of coal prod for the section
55	AVGDELAY	I4	176	Avg total delay time/shift (minutes)
56	DINNERT	I3	180	Section dinner time/shift (minutes)
57	CMINRMOD	I2	183	Model of continuous miner
58	CMINRAGE	I3	185	Age of continuous miner (years)
59	NUMBOLTR	I2	188	Number of roof bolters
60	BOLTR1T	I2	190	Model/type of roof bolter #1
61	BOLTR2T	I2	192	Model/type of roof bolter #2
62	BELTCARC	I2	194	Method of hauling coal out of section
63	MCARSIZE	I3	196	Size of mine car for hauling coal (tons)

FOREMAN FILE VARIABLES

Var #	Variable	Format	Begin Posit.	Description
64	SUPVAGE	I3	199	Supervisor's age (years)
65	EMPYEAR	I3	202	Employment date - year
66	EMPMTH	I2	205	Employment date - month
67	SUPVSEX	I2	207	Sex
68	MINORITY	I2	209	Minority
69	SUPVHGT	I3	211	Supervisor's height (inches)
70	SUPVWGT	I4	214	Supervisor's weight (pounds)
71	SUPVYRED	I3	218	Education (years)
72	TOTEXPTC	I3	221	Nonsupervisory experience this co (years)
73	TOTEXPOC	I3	224	Nonsupervisory experience other cos (years)
74	TIMETC	I3	227	Experience with this company (years)
75	TIMECREW	I3	230	Experience with this crew (months)
76	SUPEXPTC	I3	233	Supervisory experience this co (years)
77	SUPEXPOC	I3	236	Supervisory experience other cos (years)
78	MANGPAPR	I2	239	Mine manager's papers
79	YRUNIONO	I2	241	# of years union officer
80	OFFHELD	I2	243	Office held when union officer
81	NUMCRWVO	I2	245	Crew walkouts (# last year)
82	FNUMLGRV	I3	247	Labor grievances (# last year)
83	FINDLGRV	I3	250	Labor grievances index
84	FNUMSGRV	I3	253	Safety grievances (# last year)
85	FINDSGRV	I3	256	Safety grievances index
86	FNUMVIOL	I3	259	Violations (# last year)
87	FINDVIOL	I3	262	Violations index
88	FNUMACC	I3	265	Accidents to crew (# last year)
89	FINDACC	I3	268	Accidents to crew index
90	FSUPVACC	I2	271	Accidents to supervisor (# last year)
91	SFTPROD	I4	273	Avg coal production for shift (tons)
92	SFTPRODI	I3	277	Avg coal production for shift (index)
93	ATESTSC	I4	280	Selection test A (score)
94	ATESTPT	I3	284	Selection test A (%)
95	BTESTSC	I4	287	Selection test B (score)
96	BTESTPT	I3	291	Selection test B (%)
97	CTESTSC	I4	294	Selection test C (score)
98	CTESTPT	I3	298	Selection test C (%)
99	OTHTESTS	I4	301	Other selection procedure (score)
100	OTHTESTP	I3	305	Other selection procedure (%)
101	SUPRANKF	I3	308	Mine supt's ranking of foreman (rank)
102	SUPRANKP	I3	311	Mine supt's ranking of foreman (%)
103	PERRANKF	I3	314	Personnel ranking of foreman (rank)
104	PERRANKP	I3	317	Personnel ranking of foreman (%)
105	SCRANKF	I3	320	Safety committee ranking of foreman (rank)
106	SCRANKP	I3	323	Safety committee ranking of foreman (%)
107	FLOQCSC	I3	326	Foreman's LOQ consideration (score)
108	FLOQSSC	I3	329	Foreman's LOQ structure (score)
109	FLOQCPT	I3	332	Foreman's LOQ consideration (%)
110	FLOQSPT	I3	335	Foreman's LOQ structure (%)
111	FACPOSTC	I4	338	Face position - this company (years)

FOREMAN FILE VARIABLES

Var #	Variable	Format	Begin		Description
			Posit.		
112	FACPOSOC	I4	342		Face position - other cos (years)
113	MTNPOSTC	I4	346		Maintenance position - this co (years)
114	MTNPOSOC	I4	350		Maintenance position - other cos (years)
115	GINPOSTC	I4	354		General inside position - this co (years)
116	GINPOSOC	I4	358		General inside position - other cos (years)
117	GOTPOSTC	I4	362		General outside position - this co (years)
118	GOTPOSOC	I4	366		General outside position - other cos (years)
119	TRNHRTC	I4	370		Training hrs - human relatns - this co
120	TRNHROC	I4	374		Training hrs - human relatns - other cos
121	TRNLDTCT	I4	378		Training hrs - leadership - this co
122	TRNLDOCT	I4	382		Training hrs - leadership - other cos
123	TRNSAFTC	I4	386		Training hrs - safety - this co
124	TRNSAFOCT	I4	390		Training hrs - safety - other cos
125	TRNLRTCT	I4	394		Training hrs - labor relations - this co
126	TRNLROCT	I4	398		Training hrs - labor relations - other cos
127	TRNIETCT	I4	402		Training hrs - IE - this co
128	TRNIEOCT	I4	406		Training hrs - IE - other cos
129	TRNPLNTCT	I4	410		Training hrs - planning - this co
130	TRNPLNOCT	I4	414		Training hrs - planning - other cos
131	TRNMSCTCT	I4	418		Training hrs - miscellaneous - this co
132	TRNMSCOCT	I4	422		Training hrs - miscellaneous - other cos
133	STATUS	I2	426		Supervisor's status (regular/fill-in)
134	EDLEVEL	I2	428		Education category
135	TOTTRAIN	I5	430		Total training time (hours)
136	SECPROD	I5	435		Prod during observation shift (tons)
137	AVAILTIM	I5	440		Prod minutes during observation shift
138	PRODRATE	F4.1	445		Tons per minute during observation shift
139	CREWSIZE	I3	449		Crew size
140	AVGAGECR	F5.1	452		Avg age of crew members (years)
141	AVGEXPCR	F5.1	457		Avg experience of crew members (years)
142	CREWABS	I4	462		Crew absenteeism (days lost last year)
143	TIMTOGHR	I3	466		Avg length of time crew together (months)
144	CRACOSUP	I3	469		# of crew accidents with other supv (last year)
145	CRACTSUP	I3	472		# of crew accidents with this supv (last year)
146	NUMUNOFF	I3	475		# of union officers
147	CRTURNOV	I3	478		Crew turnover (# replaced last year)
148	CRMINORT	I3	481		# of minority workers in crew
149	JOBSIG01	I2	484		Job significance of task 22
150	JOBSIG02	I2	486		Job significance of task 12
151	JOBSIG03	I2	488		Job significance of task 24
152	JOBSIG04	I2	490		Job significance of task 10
153	JOBSIG05	I2	492		Job significance of task 13
154	JOBSIG06	I2	494		Job significance of task 25
155	JOBSIG07	I2	496		Job significance of task 28
156	JOBSIG08	I2	498		Job significance of task 29

FOREMAN FILE VARIABLES

Var #	Variable	Format	Begin Posit.	Description
157	JOBSIG09	I2	500	Job significance of task 20
158	JOBSIG10	I2	502	Job significance of task 26
159	JOBSIG11	I2	504	Job significance of task 18
160	JOBSIG12	I2	506	Job significance of task 8
161	JOBSIG13	I2	508	Job significance of task 16
162	JOBSIG14	I2	510	Job significance of task 9
163	JOBSIG15	I2	512	Job significance of task 19
164	JOBSIG16	I2	514	Job significance of task 4
165	JOBSIG17	I2	516	Job significance of task 17
166	JOBSIG18	I2	518	Job significance of task 1
167	JOBSIG19	I2	520	Job significance of task 27
168	JOBSIG20	I2	522	Job significance of task 2
169	JOBSIG21	I2	524	Job significance of task 21
170	JOBSIG22	I2	526	Job significance of task 14
171	JOBSIG23	I2	528	Job significance of task 15
172	JOBSIG24	I2	530	Job significance of task 3
173	JOBSIG25	I2	532	Job significance of task 5
174	JOBSIG26	I2	534	Job significance of task 6
175	JOBSIG27	I2	536	Job significance of task 7
176	JOBSIG28	I2	538	Job significance of task 23
177	JOBSIG29	I2	540	Job significance of task 30
178	JOBSIG30	I2	542	Job significance of task 11
179	ROLAMBE1	I2	544	Role ambiguity (A) - 1
180	ROLAMBE2	I2	546	Role ambiguity (A) - 2
181	ROLAMBE3	I2	548	Role ambiguity (A) - 3
182	ROLAMBE4	I2	550	Role ambiguity (A) - 4
183	ROLAMP1	I2	552	Role ambiguity (I) - 1
184	ROLAMP2	I2	554	Role ambiguity (I) - 2
185	ROLAMP3	I2	556	Role ambiguity (I) - 3
186	ROLAMP4	I2	558	Role ambiguity (I) - 4
187	RSPPER1	I2	560	Responsibility for persons (A) - 1
188	RSPPER2	I2	562	Responsibility for persons (A) - 2
189	RSPPER3	I2	564	Responsibility for persons (A) - 3
190	RSPPER4	I2	566	Responsibility for persons (A) - 4
191	RSPPER1	I2	568	Responsibility for persons (I) - 1
192	RSPPER2	I2	570	Responsibility for persons (I) - 2
193	RSPPER3	I2	572	Responsibility for persons (I) - 3
194	RSPPER4	I2	574	Responsibility for persons (I) - 4
195	RSPTNGE1	I2	576	Responsibility for things (A) - 1
196	RSPTNGE2	I2	578	Responsibility for things (A) - 2
197	RSPTNGE3	I2	580	Responsibility for things (A) - 3
198	RSPTNGP1	I2	582	Responsibility for things (I) - 1
199	RSPTNGP2	I2	584	Responsibility for things (I) - 2
200	RSPTNGP3	I2	586	Responsibility for things (I) - 3
201	QTYWLDEL	I2	588	Quantitative workload (A) - 1

FOREMAN FILE VARIABLES

Var #	Variable	Format	Begin Posit.	Description
202	QTYWLDE2	I2	590	Quantitative workload (A) - 2
203	QTYWLDE3	I2	592	Quantitative workload (A) - 3
204	QTYWLDE4	I2	594	Quantitative workload (A) - 4
205	QTYWLDE5	I2	596	Quantitative workload (A) - 5
206	QTYWLDE6	I2	598	Quantitative workload (A) - 6
207	QTYWLDP1	I2	600	Quantitative workload (I) - 1
208	QTYWLDP2	I2	602	Quantitative workload (I) - 2
209	QTYWLDP3	I2	604	Quantitative workload (I) - 3
210	QTYWLDP4	I2	606	Quantitative workload (I) - 4
211	QTYWLDP5	I2	608	Quantitative workload (I) - 5
212	QTYWLDP6	I2	610	Quantitative workload (I) - 6
213	JOBFAMB1	I2	612	Job future ambiguity - 1
214	JOBFAMB2	I2	614	Job future ambiguity - 2
215	JOBFAMB3	I2	616	Job future ambiguity - 3
216	JOBFAMB4	I2	618	Job future ambiguity - 4
217	UTLABIL1	I2	620	Underutilization of abilities - 1
218	UTLABIL2	I2	622	Underutilization of abilities - 2
219	UTLABIL3	I2	624	Underutilization of abilities - 3
220	VARWLD1	I2	626	Variance in workload - 1
221	VARWLD2	I2	628	Variance in workload - 2
222	VARWLD3	I2	630	Variance in workload - 3
223	PARTICP1	I2	632	Participation with mgmt - 1
224	PARTICP2	I2	634	Participation with mgmt - 2
225	PARTICP3	I2	636	Participation with mgmt - 3
226	ROLCONF1	I2	638	Role conflict - 1
227	ROLCONF2	I2	640	Role conflict - 2
228	ROLCONF3	I2	642	Role conflict - 3
229	ROLCONF4	I2	644	Role conflict - 4
230	INEQPAY1	I2	646	Inequity in pay - 1
231	INEQPAY2	I2	648	Inequity in pay - 2
232	INEQPAY3	I2	650	Inequity in pay - 3
233	INEQPAY4	I2	652	Inequity in pay - 4
234	REFDB1	I2	654	Repetitiveness, exp & fdbk - 1
235	REFDB2	I2	656	Repetitiveness, exp & fdbk - 2
236	REFDB3	I2	658	Repetitiveness, exp & fdbk - 3
237	REFDB4	I2	660	Repetitiveness, exp & fdbk - 4
238	REFDB5	I2	662	Repetitiveness, exp & fdbk - 5
239	REFDB6	I2	664	Repetitiveness, exp & fdbk - 6
240	SOCSUP1A	I2	666	Social support - supv - 1A
241	SOCSUP1B	I2	668	Social support - supv - 1B
242	SOCSUP1C	I2	670	Social support - supv - 1C
243	SOCSUP1D	I2	672	Social support - supv - 1D
244	SOCSUP2A	I2	674	Social support - coworker - 2A
245	SOCSUP2B	I2	676	Social support - coworker - 2B
246	SOCSUP2C	I2	678	Social support - coworker - 2C
247	SOCSUP2D	I2	680	Social support - coworker - 2D

FOREMAN FILE VARIABLES

Var #	Variable	Format	Begin Posit.	Description
248	SOCSUP3A	I2	682	Social support - spouse - 3A
249	SOCSUP3B	I2	684	Social support - spouse - 3B
250	SOCSUP3C	I2	686	Social support - spouse - 3C
251	SOCSUP3D	I2	688	Social support - spouse - 3D
252	SOCSUP4A	I2	690	Social support - relatives - 4A
253	SOCSUP4B	I2	692	Social support - relatives - 4B
254	SOCSUP4C	I2	694	Social support - relatives - 4C
255	SOCSUP4D	I2	696	Social support - relatives - 4D
256	PERSLTY1	I2	698	Personality - 1
257	PERSLTY2	I2	700	Personality - 2
258	PERSLTY3	I2	702	Personality - 3
259	PERSLTY4	I2	704	Personality - 4
260	PERSLTY5	I2	706	Personality - 5
261	PERSLTY6	I2	708	Personality - 6
262	PERSLTY7	I2	710	Personality - 7
263	PERSLTY8	I2	712	Personality - 8
264	PERSLTY9	I2	714	Personality - 9
265	JSLFEST1	I2	716	Job self-esteem - 1
266	JSLFEST2	I2	718	Job self-esteem - 2
267	JSLFEST3	I2	720	Job self-esteem - 3
268	JDISATF1	I2	722	Job dissatisfaction - 1
269	JDISATF2	I2	724	Job dissatisfaction - 2
270	JDISATF3	I2	726	Job dissatisfaction - 3
271	JDISATF4	I2	728	Job dissatisfaction - 4
272	BWLDDIS1	I2	730	Boredom, workload dissatisfaction - 1
273	BWLDDIS2	I2	732	Boredom, workload dissatisfaction - 2
274	BWLDDIS3	I2	734	Boredom, workload dissatisfaction - 3
275	BWLDDIS4	I2	736	Boredom, workload dissatisfaction - 4
276	BWLDDIS5	I2	738	Boredom, workload dissatisfaction - 5
277	BWLDDIS6	I2	740	Boredom, workload dissatisfaction - 6
278	BWLDDIS7	I2	742	Boredom, workload dissatisfaction - 7
279	AFTVST01	I2	744	Affective states - 1
280	AFTVST02	I2	746	Affective states - 2
281	AFTVST03	I2	748	Affective states - 3
282	AFTVST04	I2	750	Affective states - 4
283	AFTVST05	I2	752	Affective states - 5
284	AFTVST06	I2	754	Affective states - 6
285	AFTVST07	I2	756	Affective states - 7
286	AFTVST08	I2	758	Affective states - 8
287	AFTVST09	I2	760	Affective states - 9
288	AFTVST10	I2	762	Affective states - 10
289	AFTVST11	I2	764	Affective states - 11
290	AFTVST12	I2	766	Affective states - 12
291	AFTVST13	I2	768	Affective states - 13

FOREMAN FILE VARIABLES

Var #	Variable	Format	Begin Posit.	Description
292	SCONJOB1	I2	770	Somatic complaints on the job - 1
293	SCONJOB2	I2	772	Somatic complaints on the job - 2
294	SCONJOB3	I2	774	Somatic complaints on the job - 3
295	SCONJOB4	I2	776	Somatic complaints on the job - 4
296	SCONJOB5	I2	778	Somatic complaints on the job - 5
297	SCONJOB6	I2	780	Somatic complaints on the job - 6
298	SCONJOB7	I2	782	Somatic complaints on the job - 7
299	SCONJOB8	I2	784	Somatic complaints on the job - 8
300	SCONJOB9	I2	786	Somatic complaints on the job - 9
301	SCONJOB0	I2	788	Somatic complaints on the job - 10
302	SCOFJOB1	I2	790	Somatic complaints off the job - 1
303	SCOFJOB2	I2	792	Somatic complaints off the job - 2
304	SCOFJOB3	I2	794	Somatic complaints off the job - 3
305	SCOFJOB4	I2	796	Somatic complaints off the job - 4
306	SCOFJOB5	I2	798	Somatic complaints off the job - 5
307	SCOFJOB6	I2	800	Somatic complaints off the job - 6
308	SCOFJOB7	I2	802	Somatic complaints off the job - 7
309	SCOFJOB8	I2	804	Somatic complaints off the job - 8
310	SCOFJOB9	I2	806	Somatic complaints off the job - 9
311	LOQQST01	I2	808	Leadership opinion questionnaire - Q1
312	LOQQST02	I2	810	Leadership opinion questionnaire - Q2
313	LOQQST03	I2	812	Leadership opinion questionnaire - Q3
314	LOQQST04	I2	814	Leadership opinion questionnaire - Q4
315	LOQQST05	I2	816	Leadership opinion questionnaire - Q5
316	LOQQST06	I2	818	Leadership opinion questionnaire - Q6
317	LOQQST07	I2	820	Leadership opinion questionnaire - Q7
318	LOQQST08	I2	822	Leadership opinion questionnaire - Q8
319	LOQQST09	I2	824	Leadership opinion questionnaire - Q9
320	LOQQST10	I2	826	Leadership opinion questionnaire - Q10
321	LOQQST11	I2	828	Leadership opinion questionnaire - Q11
322	LOQQST12	I2	830	Leadership opinion questionnaire - Q12
323	LOQQST13	I2	832	Leadership opinion questionnaire - Q13
324	LOQQST14	I2	834	Leadership opinion questionnaire - Q14
325	LOQQST15	I2	836	Leadership opinion questionnaire - Q15
326	LOQQST16	I2	838	Leadership opinion questionnaire - Q16
327	LOQQST17	I2	840	Leadership opinion questionnaire - Q17
328	LOQQST18	I2	842	Leadership opinion questionnaire - Q18
329	LOQQST19	I2	844	Leadership opinion questionnaire - Q19
330	LOQQST20	I2	846	Leadership opinion questionnaire - Q20
331	LOQQST21	I2	848	Leadership opinion questionnaire - Q21
332	LOQQST22	I2	850	Leadership opinion questionnaire - Q22
333	LOQQST23	I2	852	Leadership opinion questionnaire - Q23
334	LOQQST24	I2	854	Leadership opinion questionnaire - Q24
335	LOQQST25	I2	856	Leadership opinion questionnaire - Q25
336	LOQQST26	I2	858	Leadership opinion questionnaire - Q26

FOREMAN FILE VARIABLES

Var #	Variable	Format	Begin Posit.	Description
337	LOQQST27	I2	860	Leadership opinion questionnaire - Q27
338	LOQQST28	I2	862	Leadership opinion questionnaire - Q28
339	LOQQST29	I2	864	Leadership opinion questionnaire - Q29
340	LOQQST30	I2	866	Leadership opinion questionnaire - Q30
341	LOQQST31	I2	868	Leadership opinion questionnaire - Q31
342	LOQQST32	I2	870	Leadership opinion questionnaire - Q32
343	LOQQST33	I2	872	Leadership opinion questionnaire - Q33
344	LOQQST34	I2	874	Leadership opinion questionnaire - Q34
345	LOQQST35	I2	876	Leadership opinion questionnaire - Q35
346	LOQQST36	I2	878	Leadership opinion questionnaire - Q36
347	LOQQST37	I2	880	Leadership opinion questionnaire - Q37
348	LOQQST38	I2	882	Leadership opinion questionnaire - Q38
349	LOQQST39	I2	884	Leadership opinion questionnaire - Q39
350	LOQQST40	I2	886	Leadership opinion questionnaire - Q40

SUPERVISOR OBSERVATION VARIABLES

Var #	Variable	Format	Begin Posit.	Description
351	ACTTIM01	F7.2	888	Time for discussion w/supv at bottom - bs
352	ACTTIM02	F7.2	895	Time for discussion w/supv at top - bs
353	ACTTIM03	F7.2	902	Time for pre-shift activities
354	ACTTIM04	F7.2	909	Time for man trip in
355	ACTTIM05	F7.2	916	Time for pre-section startup
356	ACTTIM06	F7.2	923	Time for face inspection
357	ACTTIM07	F7.2	930	Time for call out inspection report
358	ACTTIM08	F7.2	937	Time for face observation
359	ACTTIM09	F7.2	944	Time for work activity
360	ACTTIM10	F7.2	951	Time for leadership activities
361	ACTTIM11	F7.2	958	Time for normal shift activities
362	ACTTIM12	F7.2	965	Time for end shift activities
363	ACTTIM13	F7.2	972	Time for man trip out
364	ACTTIM14	F7.2	979	Time for fill out daily reports
365	ACTTIM15	F7.2	986	Time for supervisor meeting at top - es
366	ACTTIM16	F7.2	993	Time for shower
367	ACTTIM17	F7.2	1000	Time for dress
368	ACTTIM18	F7.2	1007	Time for supv meeting at bottom - es
369	ACTTIM19	F7.2	1014	Time for cage trip out
370	ACTTIM20	F7.2	1021	Not in use
371	ACTFRQ01	F5.0	1028	Freq of discussion w/supv at bottom - bs
372	ACTFRQ02	F5.0	1033	Freq of discussion w/supv at top - bs
373	ACTFRQ03	F5.0	1038	Freq of pre-shift activities
374	ACTFRQ04	F5.0	1043	Freq of man trip in
375	ACTFRQ05	F5.0	1048	Freq of pre-section startup
376	ACTFRQ06	F5.0	1053	Freq of face inspection
377	ACTFRQ07	F5.0	1058	Freq of call out inspection report
378	ACTFRQ08	F5.0	1063	Freq of face observation
379	ACTFRQ09	F5.0	1068	Freq of work activity
380	ACTFRQ10	F5.0	1073	Freq of leadership activities
381	ACTFRQ11	F5.0	1078	Freq of normal shift activities
382	ACTFRQ12	F5.0	1083	Freq of end shift activities
383	ACTFRQ13	F5.0	1088	Freq of man trip out
384	ACTFRQ14	F5.0	1093	Freq of fill out daily reports
385	ACTFRQ15	F5.0	1098	Freq of supervisor meeting at top - es
386	ACTFRQ16	F5.0	1103	Freq of shower
387	ACTFRQ17	F5.0	1108	Freq of dress
388	ACTFRQ18	F5.0	1113	Freq of supv meeting at bottom - es
389	ACTFRQ19	F5.0	1118	Freq of cage trip out
390	ACTFRQ20	F5.0	1123	Currently not in use
391	DELTIM01	F7.2	1128	Time for personal preparation
392	DELTIM02	F7.2	1135	Currently not in use
393	DELTIM03	F7.2	1142	Currently not in use
394	DELTIM04	F7.2	1149	Time obs power failure
395	DELTIM05	F7.2	1156	Time obs water delay

SUPERVISOR OBSERVATION VARIABLES

Var #	Variable	Format	Begin Posit.	Description
396	DELTIM06	F7.2	1163	Time obs equipment failure
397	DELTIM07	F7.2	1170	Currently not in use
398	DELTIM08	F7.2	1177	Time obs belt failure
399	DELTIM09	F7.2	1184	Currently not in use
400	DELTIM10	F7.2	1191	Currently not in use
401	DELTIM11	F7.2	1198	Currently not in use
402	DELTIM12	F7.2	1205	Time for count and/or order supplies
403	DELTIM13	F7.2	1212	Time for work stoppage
404	DELTIM14	F7.2	1219	Time for instruct workers
405	DELTIM15	F7.2	1226	Time for management interaction
406	DELTIM16	F7.2	1233	Time for study participation
407	DELTIM17	F7.2	1240	Time for mine reports
408	DELTIM18	F7.2	1247	Time for marking and measuring face
409	DELTIM19	F7.2	1254	Time for check on crew
410	DELTIM20	F7.2	1261	Currently not in use
411	DELTIM21	F7.2	1268	Currently not in use
412	DELTIM22	F7.2	1275	Time for measure ventltn/repair curtains
413	DELTIM23	F7.2	1282	Time for inspect section belt
414	DELTIM24	F7.2	1289	Time for safety talk with crew
415	DELTIM25	F7.2	1296	Time for interact with safety inspector
416	DELTIM26	F7.2	1303	Time for accident investigation
417	DELTIM27	F7.2	1310	Time for roof control investigations
418	DELTIM28	F7.2	1317	Currently not in use
419	DELTIM29	F7.2	1324	Time for gas check
420	DELTIM30	F7.2	1331	Time for lunch
421	DELFRQ01	F5.0	1338	Freq of personal preparation
422	DELFRQ02	F5.0	1343	Currently not in use
423	DELFRQ03	F5.0	1348	Currently not in use
424	DELFRQ04	F5.0	1353	Freq of obs power failure
425	DELFRQ05	F5.0	1358	Freq of obs water delay
426	DELFRQ06	F5.0	1363	Freq of obs equipment failure
427	DELFRQ07	F5.0	1368	Currently not in use
428	DELFRQ08	F5.0	1373	Freq of obs belt failure
429	DELFRQ09	F5.0	1378	Currently not in use
430	DELFRQ10	F5.0	1383	Currently not in use
431	DELFRQ11	F5.0	1388	Currently not in use
432	DELFRQ12	F5.0	1393	Freq of count and/or order supplies
433	DELFRQ13	F5.0	1398	Freq of work stoppage
434	DELFRQ14	F5.0	1403	Freq of instruct workers
435	DELFRQ15	F5.0	1408	Freq of management interaction
436	DELFRQ16	F5.0	1413	Freq of study participation
437	DELFRQ17	F5.0	1418	Freq of mine reports
438	DELFRQ18	F5.0	1423	Freq of marking and measuring face
439	DELFRQ19	F5.0	1428	Freq of check on crew

SUPERVISOR OBSERVATION VARIABLES

Var #	Variable	Format	Begin Posit.	Description
440	DELFRQ20	F5.0	1433	Currently not in use
441	DELFRQ21	F5.0	1438	Currently not in use
442	DELFRQ22	F5.0	1443	Freq of measure ventltn/repair curtains
443	DELFRQ23	F5.0	1448	Freq of inspect section belt
444	DELFRQ24	F5.0	1453	Freq of safety talk with crew
445	DELFRQ25	F5.0	1458	Freq of interact with safety inspector
446	DELFRQ26	F5.0	1463	Freq of accident investigation
447	DELFRQ27	F5.0	1468	Freq of roof control investigations
448	DELFRQ28	F5.0	1473	Currently not in use
449	DELFRQ29	F5.0	1478	Freq of gas check
450	DELFRQ30	F5.0	1483	Freq of lunch
451	AGGTIM01	F8.2	1488	Tot time for equipment failure obs
452	AGGTIM02	F8.2	1496	Tot time for safety activities
453	AGGTIM03	F8.2	1504	Tot time for system activities
454	AGGTIM04	F8.2	1512	Tot time for interaction with management
455	AGGTIM05	F8.2	1520	Tot time for interaction with workers
456	AGGTIM06	F8.2	1528	Tot time for work activities
457	AGGTIM07	F8.2	1536	Tot time for passive observation
458	AGGTIM08	F8.2	1544	Tot time for all other activities
459	AGGFRQ01	F6.0	1552	Tot freq of equipment failure obs
460	AGGFRQ02	F6.0	1558	Tot freq of safety activities
461	AGGFRQ03	F6.0	1564	Tot freq of system activities
462	AGGFRQ04	F6.0	1570	Tot freq of interaction with management
463	AGGFRQ05	F6.0	1576	Tot freq of interaction with workers
464	AGGFRQ06	F6.0	1582	Tot freq of work activities
465	AGGFRQ07	F6.0	1588	Tot freq of passive observation
466	AGGFRQ08	F6.0	1594	Tot freq of all other activities

COMBINED FOREMAN FILE VARIABLES

Var #	Variable	Format	Begin Posit.	Description
470	FLOQTSC	I4	1615	LOQ total score
471	SUPSEXP	I3	1619	Supv's total supervisory experience
472	SUPTEXP	I3	1622	Supv's total experience
473	FINDAC2	I3	1625	Index rating of accidents (#145)
474	ROLAMBEA	I3	1628	Agg - Role ambiguity (A)
475	ROLAMBPA	I3	1631	Agg - Role ambiguity (I)
476	RSPPPEREA	I3	1634	Agg - Responsibility for persons (A)
477	RSPPPERPA	I3	1637	Agg - Responsibility for persons (I)
478	RSPTNGEA	I3	1640	Agg - Responsibility for things (A)
479	RSPTNGPA	I3	1643	Agg - Responsibility for things (I)
480	QTYWLDEA	I3	1646	Agg - Quant workload (A)
481	QTYWLDPA	I3	1649	Agg - Quant workload (I)
482	JOBFAMBA	I3	1652	Agg - Job future ambiguity
483	UTLABTLA	I3	1655	Agg - Underutilization of abilities
484	VARWLDA	I3	1658	Agg - Variance in workload
485	PARTICPA	I3	1661	Agg - Participation with mgmt
486	ROLCONFA	I3	1664	Agg - Role conflict
487	INEQPAYA	I3	1667	Agg - Inequity in pay
488	REFDBA	I3	1670	Agg - Repetitiveness, exp & fdbk
489	SOCSUP1	I3	1673	Agg - Social support - supv
490	SOCSUP2	I3	1676	Agg - Social support - coworker
491	SOCSUP3	I3	1679	Agg - Social support - spouse
492	SOCSUP4	I3	1682	Agg - Social support - relatives
493	SOCSUPA	I3	1685	Agg - Social support - total
494	PERSLTYA	I3	1688	Agg - Personality
495	JSLFESTA	I3	1691	Agg - Job self-esteem
496	JDISATFA	F5.1	1694	Agg - Job dissatisfaction
497	BWLDDISA	I3	1699	Agg - Work boredom, etc
498	AFTVSTA	I3	1702	Agg - Affective states
499	SCONJOBA	I3	1705	Agg - Somatic complaints (on the job)
500	SCOFJOBA	I3	1708	Agg - Somatic complaints (off the job)
501	TONSPMAN	F6.2	1711	Tons per man (supv)
502	ROLAMB1	I3	1717	Composite - Role ambiguity #1
503	ROLAMB2	I3	1720	Composite - Role ambiguity #2
504	ROLAMB3	I3	1723	Composite - Role ambiguity #3
505	ROLAMB4	I3	1726	Composite - Role ambiguity #4
506	ROLAMBT	I3	1729	Composite - Role ambiguity sum
507	RSPPER1	I3	1732	Composite - Resp for persons #1
508	RSPPER2	I3	1735	Composite - Resp for persons #2
509	RSPPER3	I3	1738	Composite - Resp for persons #3
510	RSPPER4	I3	1741	Composite - Resp for persons #4
511	RSPPERT	I3	1744	Composite - Resp for persons sum
512	RSPTNG1	I3	1747	Composite - Resp for things #1
513	RSPTNG2	I3	1750	Composite - Resp for things #2

COMBINED FOREMAN FILE VARIABLES

Var #	Variable	Format	Begin Posit.	Description
514	RSPTNG3	I3	1753	Composite - Resp for things #3
515	RSPTNGT	I3	1756	Composite - Resp for things sum
516	QTYWLD1	I3	1759	Composite - Quant workload #1
517	QTYWLD2	I3	1762	Composite - Quant workload #2
518	QTYWLD3	I3	1765	Composite - Quant workload #3
519	QTYWLD4	I3	1768	Composite - Quant workload #4
520	QTYWLD5	I3	1771	Composite - Quant workload #5
521	QTYWLD6	I3	1774	Composite - Quant workload #6
522	QTYWLDT	I3	1777	Composite - Quant workload sum
523	ISTYPEA	I3	1780	"Involved striving" (#259 + #260 + #262)
524	JBOREDOM	I3	1783	Job boredom (#272 - #275)
525	WLDISSAT	I3	1786	Workload dissatisfaction (#276 - #278)
526	DEPRESS	I3	1789	Depression (#283 - #288)
527	ANXIETY	I3	1792	Anxiety (#279 - #282)
528	IRRITATE	I3	1795	Irritation (#289 - #291)

"Dummy" or constructed variables which are found
in the working files but not in the database

SHIFTDY - IF SHIFTDAY (Variable #21) = 3 (3 Prod. shifts worked/day)
THEN SHIFTDY = 1;
ELSE SHIFTDY = 0;

NONUNDY - IF MINETYP (Variable #19) = 2 (2 = Non-union)
THEN NONUNDY = 1;
ELSE NONUNDY = 0;

SEAMDPDY - IF SEAMDIP (Variable #37) ≠ 4 (4 = Seam has no dip)
THEN SEAMDPDY = 1;
ELSE SEAMDPDY = 0;

STATUSDY - IF STATUS (Variable #133) = 2 (Foreman status 2 = fill-in)
THEN STATUSDY = 1;
ELSE STATUSDY = 0;

ILDY - IF STATCOD (Variable #2) = 1 (State code 1 for mine =
location in Illinois)
THEN ILDY = 1;
ELSE ILDY = 0;

OHDY - IF STATCOD (Variable #2) = 2 (State code 2 for mine =
location in Ohio)
THEN OHDY = 1;
ELSE OHDY = 0;

CAPTVDY - IF CAPTIVE (Variable #22) = 1 (Captive refers to customer
 THEN CAPTVDY = 1; owning the coal mine)
 ELSE CAPTVDY = 0;

FLOORHDI - IF FLOORH20 (Variable #34) $\neq$ 3 (Floor water code 3 =
 THEN FLOORHDI = 1; dry conditions)
 ELSE FLOORHDI = 0;

MINPLNDY - IF MINPLAN (Variable #43) = 4,5 (Section operating in rooms = 4,
 THEN MINPLNDY = 1; operating in pillars = 5)
 ELSE MINPLNDY = 0;

COALTYDY - IF COALTYP (Variable #20) = 3 (Response 3 indicates that coal
 THEN COALTYDY = 1; is sold in both the steam and
 ELSE COALTYDY = 0; metallurgical markets.)

RIBCNDY - IF RIBCOND (Variable #47) = 2 (Response 2 indicates that
 THEN RIBCNDY = 1; rib failures occasionally stop
 ELSE RIBCNDY = 0; the miner.)

GASMDY - IF GASMONIT (Variable #39) = 1,2 (A response of 1 or 2 indi-
 THEN GASMDY = 1; cates that methane liberation
 ELSE GASMDY = 0; does impact on the continuous
 mining rate.)

INCNTPDY - IF INCNTPLN (Variable #15) = 2 (Response 2 indicates that the
 THEN INCNTPDY = 1; mine has a production incentive
 ELSE INCNTPDY = 0; plan.)

SELCPRDY - IF SELLCPRC (Variable #18) = 2 (Response 2 indicates that the
 THEN SELCPRDY = 1; mine has a formal selection
 ELSE SELCPRDY = 0; procedure for section foremen.)

MANGPRDY - IF MANGPAPR (Variable #78) = 2 (Response 2 indicates that the
 THEN MANGPRDY = 1; section foreman has a second
 ELSE MANGPRDY = 0; level of certification.)

PRODACCI - Variable combining the supervisor's production and accident
 indices (#92 and #473) (%).

Abbreviations Used in Variable Names

Acc	= Accident
Avg	= Average
Bs	= Begin shift
CC	= Clean Coal
Co	= Company
Cos	= Companies
Es	= End shift
Exp	= Expressiveness
Fdbk	= Feedback
Freq	= Frequency
Hrs	= Hours
IE	= Industrial Engineering
Mgmt	= Management
Min	= Minute
Mths	= Months
Obs	= Observing
%	= Percentile
Prod	= Production
Quant	= Quantitative
Relatns	= Relations
Resp	= Responsibility
Supt	= Superintendent
Supv	= Supervisor
Ventltn	= Ventilation
W/	= With

APPENDIX E
GLOSSARY OF MINING AND
STATISTICAL TERMS

GLOSSARY

ABSOLUTE VALUE ()	- Numerical unity only (i.e., if a number is negative, the negative sign is ignored).
BELT OR BELT CONVEYOR	- An endless belt on which coal or other materials can be carried which is generally constructed of flame resistant material or of reinforced rubber or rubber-like substance.
BOLT	- A long, self-locking steel bolt inserted in a drilled hole used to support the mine roof.
BOLTER	- A machine which is used to insert roof bolts or rock bolts.
BOLTING PATTERN	- The intervals at which roof bolts are inserted.
CAPTIVE MINE	- A mine owned or controlled by another concern and operated for its needs rather than for an open market.
COAL MINE	- An area of land and all structures, facilities, machinery, tools, equipment, shafts, slopes, tunnels, excavations, and other property, real or personal, placed upon, under, or above the surface of such land by any person, used in, or to be used in, or resulting from, the work of extracting in such area bituminous coal, lignite, or anthracite from its natural deposits in the earth by any means of method, and the work of preparing the coal so extracted, and includes custom coal preparation facilities.
CORRELATION COEFFICIENT -	A measure of the relative importance of the dependent variable to the independent variable in the linear relationship.
COLLINEARITY	- Lying on or passing through the same straight line, having axes lying end to end in a straight line.
CONFIDENCE LEVEL	- The probability, $1-x$, that a series of estimated parameter values would actually capture the unknown parameter.
CONTINUOUS MINER	- A machine that constantly extracts ore (usually, but not always, coal) while it loads it. This is differentiated from a conventional or cyclic unit which must stop the extraction process in order for loading to commence.

CONTINUOUS VALUES	- A series of digits, each digit representing how many units of a certain size are involved. What makes the series continuous is that the size of the unit can be reduced to a number of smaller units through a linear transformation of the series.
CORRELATION	- The relationship among two or more variables; an interdependence between variables.
CROSSCUT	- A passageway driven between the entry and its parallel air course or air courses for ventilation purposes. Also, a tunnel driven from one seam to another through or across the intervening measures; sometimes called Crosscut Tunnel. In vein mining an entry perpendicular to the vein.
CROSSCUT CENTERS	- The distance between the midpoint of one crosscut and the midpoint of the next crosscut.
CROSS ENTRY	- An entry running at an angle with the main entry.
CUT	- In coal mining, to mechanically slice a coal seam.
DEGREE OF FREEDOM	- The number of independent measurements that are available for estimating a statistical parameter. Abbreviated df.
DEPENDENT VARIABLE	- Those numerical values, usually designated by Y, which represent a dimension of reality that can change either from object to object or from time to time for given objects and are to be predicted and explained by those numerical values, usually designated by X, representing another dimension of reality known as the independent variable.
DIP	- The inclination of a geologic structure (bed, vein, fault, etc.) from the horizontal; dip is always measured downward at right angles to the strike. The complement of dip is called hade in older mining literature.
DRIFT (COAL)	- An entry above water level and generally on the slope of a hill driven horizontally into the coal seam.
DUMMY VARIABLE	- An arbitrary mathematical symbol or variable that can be replaced by another without affecting the value of the expression in which it occurs.
ENTRY	- An underground passage used for haulage, ventilation, or as a manway; a coal heading; a working place where the coal is extracted from the seam in the initial mining.

ENTRY CENTERS	- The distance between the midpoint of one entry and the midpoint of the next entry.
FACE	- The principal operating place in a mine. The working place where fresh ore or coal is exposed and being extracted. A mine may have many operating faces.
FACE POSITION	- A mining job in which the worker is stationed at the site of the coal extraction.
FLOOR	- Any material that is put back in place of the extracted ore to provide ground support.
GAS MONITOR	- A sensor which determines the level of methane gas and disengages the cutter if the gas exceeds the specified level.
GENERAL INSIDE POSITION	- A mining job in which the worker is stationed inside the mine but not at the face.
GENERAL OUTSIDE POSITION	- A mining job in which the worker is stationed outside the mine.
GRADE	- The percentage of each valuable mineral in an ore.
HSAC	- Health and Safety Analysis Center.
INDEPENDENT VARIABLE	- Those numerical values, usually designated by X, which represent a dimension of reality that can either change from object to object or from time to time for given objects and are to be used to predict and explain those numerical values, usually designated by Y, representing another dimension of reality known as the dependent variable.
LOAD	- The act of transferring broken material into a haulage device.
MAIN ENTRY	- A main haulage road. Where the coal has cleats, main entries are driven at right angles to the face cleats.
MAINS	- Major thoroughfares or passageways within the mine.
MANTRIP	- Transportation of men, by rail or rubber tire, to and from work area.
MEAN	- The expected value of a random variable. The moment of central tendency. The average. The first moment about zero measurement on the frequency distribution curve.

METHANE (CH ₄)	- The most common explosive gas found in coal mines; it is tasteless, colorless, odorless, and nontoxic. Methane mixtures are called "firedamp".
METHANE MONITOR	- An electronic detector mounted on a piece of mining equipment that detects and monitors methane.
MILLER	- A coal extraction machine that works by grinding the coal from the face.
MINE	- An economically viable plant for the extraction of minerals from the earth. A mine includes all the equipment, structures and buildings involved in this process.
MINE ROOF	- The layer of hardened clay, limestone, sandstone, or other material that lies over the coal bed; rock or other material above the coal seam.
PANEL	- A coal mining block that generally comprises one operating unit.
PANEL ENTRY	- The last branch of the haulage or entry system in a coal mine.
PARTING	- 1. A small joint in coal or rock. 2. A layer of rock in a coal seam. 3. A side track or turnout in a haulage road.
PILLAR	- An area of coal or ore left to support the overlying strata in a mine; sometimes left permanently to support surface works.
PROBABILITY	- A quantitative measure of the chance or likelihood of an event occurring. The probability of a certain event is 1.0. The probability of an impossible event is 0.
REGRESSION	- A functional relationship between two or more correlated variables empirically determined from data and used to predict values of one variable when given values of the others.
REGRESSION ANALYSIS	- The analysis of the association among several variables.
RIB	- The side of a pillar or the wall of an entry. The solid coal on the side of any underground passage.
RIPPER	- A coal, or other soft ore, extraction machine that works by tearing the coal from the face.

ROOF	- The stratum overlying a coal seam; the overhead surface of a coal working place.
ROOF BOLT OR ROCK BOLT	- A long steel bolt inserted in a drilled hole used to support mine roof; the unit consists of the bolt, steel bearing plate, and expansion shell.
ROOM	- An exploitation area in certain types of coal mines; rooms are separated by pillars; a set of rooms and pillars form a panel.
SAMPLING DISTRIBUTION	- The range and relative frequency of all possible chance-determined numerical values when an infinite number of random samples of a specific size is taken repeatedly from a specified population and a given statistical measure is applied to each one of the random samples.
SEAM	- A stratum or bed of coal.
SHAFT	- Vertical opening through coal mine strata used for ventilation or drainage and/or for hoisting of men or materials.
SHUTTLE CAR	- A trackless, one unit, self-powered haulage device used on short runs in bedded deposits to transfer broken material from the loading machine to the end of the conveyor.
SIGNIFICANCE LEVEL	- The measure by which a result is likely to be obtained by chance.
SLOPE	- An inclined tunnel leading to a seam.
STANDARD DEVIATION	- The root mean square deviation from the arithmetic mean. The square root of the variance.
SUBMAINS	- Thoroughfares or passageways which run perpendicular to the mains.
VARIANCE	- The measure of dispersion about the mean. The square of the standard deviation. The mean value of squares of the deviations of a set of observations from their arithmetic mean.

APPENDIX F
ESTIMATED REGRESSION EQUATIONS

Estimated regression equation for production per shift (tons)

Variable description	Estimated coefficient
MINE CHARACTERISTICS	
Number of underground hourly workers.....	¹ .48
Non-union mine.....	² 148.81
Selection procedure.....	² 92.16
Shifts per day.....	² -63.49
Mine supt.'s LOQ consideration score.....	-3.16
Mine supt.'s LOQ structure score.....	³ 6.39
SECTION CHARACTERISTICS	
Seam depth.....ft..	¹ -.24
Cut depth.....ft..	² 5.10
Gas monitor, 1 if stops miner.....	¹ 68.19
Number of entries.....	¹ 17.73
Mine plan, 1 if a "room" or "pillaring".....	¹ 58.18
Man-trip time.....min..	¹ -3.23
Dinner time.....min..	¹ -3.53
Number of roof bolters.....	³ -76.33
CREW CHARACTERISTICS	
Crew size.....	² 19.49
Time crew has been together.....mths..	¹ 1.26
Number of minority workers in crew.....	² 27.60
SUPERVISOR CHARACTERISTICS	
Nonsupervisory experience this company.....yr..	2.29
Experience with this crew.....mths..	-.64
Total training time, previous 12 months.....hr..	³ .07
Time for interaction with workers..... min..	.28
Quantitative workload.....	-9.19
Repetitiveness, expressiveness & feedback.....	2.54
Job self-esteem.....	³ 8.83
Anxiety.....	³ 4.23
Constant.....	-61.40
Observations.....	132
R squared.....	.78

- ¹ Statistically significant from zero at the 1 percent level.
- ² Statistically significant from zero at the 5 percent level.
- ³ Statistically significant from zero at the 10 percent level.

Variable description	Estimated coefficient
SECTION CHARACTERISTICS	
Seam depth.....ft..	-.004
Cut depth.....ft..	-.22
Gas monitor, 1 if stops mines.....	¹ 23.99
Number of entries.....	2.96
Mine plan, 1 if room or pillaring.....	² 12.32
Man-trip time.....min..	² -.65
Dinner time.....min..	-.21
Number of roof bolters.....	10.02
Seam dip, 1 if some dip.....	² -15.27
Bolt length.....ft..	¹ -5.43
Continuous miner age.....yr..	³ -1.33
CREW CHARACTERISTICS	
Crew size.....ft..	-2.09
Time crew has been together.....mths..	² .34
Number of minority workers in crew.....	1.80
SUPERVISOR CHARACTERISTICS	
Total experience this company.....yr..	-.26
Experience with this crew.....mths..	-.13
Total training time, previous 12 months..... hr..	.02
Time for interaction with workers min..	² .13
Quantitative workload.....	-2.30
Repetitiveness, expressiveness, & feedback.....	.85
Job self-esteem.....	³ 2.84
Anxiety.....	-.84
Somatic complaints off the job.....	² 3.01
Depression.....	1.59
Constant.....	22.15
Observations.....	132
R squared.....	.37

- ¹ Statistically significant from zero at the 1 percent level.
² Statistically significant from zero at the 5 percent level.
³ Statistically significant from zero at the 10 percent level.

Estimated regression equation for accidents

Variable description	Estimated coefficient
MINE CHARACTERISTICS	
Illinois.....	¹ 3.101
Supervisor turnover in past year.....	¹ .433
Selection procedure.....	1.595
Mine supt.'s LOQ consideration score.....	³ -.089
Mine supt.'s LOQ structure score.....	.104
CREW CHARACTERISTICS	
Average experience of the crew.....yr..	-.100
Time crew has been together.....mths..	² .031
Crew turnover.....	¹ .470
SUPERVISOR CHARACTERISTICS	
Supervisor's total experience.....yr..	³ -.079
Time for interaction with workers.....min..	² .020
Time for work activities.....min..	.012
Role ambiguity (ideal).....	² .405
Responsibility for persons (actual).....	³ .216
Responsibility for persons (ideal).....	.122
Responsibility for things (ideal).....	² -.309
Variance in workload.....	³ .272
Inequity in pay.....	² .193
Social support - spouse.....	¹ -.348
Composite role ambiguity.....	-.180
Involved striving.....	-.204
Job boredom.....	² -.241
Workload dissatisfaction.....	.231
Anxiety.....	³ .179
Constant.....	-6.925
Observations.....	123
R squared.....	.64

- ¹ Statistically significant from zero at the 1 percent level.
² Statistically significant from zero at the 5 percent level.
³ Statistically significant from zero at the 10 percent level.

Variable description	Estimated coefficient
SECTION CHARACTERISTICS	
Seam depth.....ft..	³ .030
Entry center.....ft..	-.015
Entry width.....ft..	3.126
Cut depth.....ft..	-.526
Seam height.....in..	.093
CREW CHARACTERISTICS	
Average experience of the crew.....yr..	³ 1.528
Time crew has been together.....mths..	-.120
Crew turnover.....	-1.949
Number of minority workers in the crew.....	³ -6.781
SUPERVISOR CHARACTERISTICS	
Supervisor's total experience.....yr..	-.402
Nonsupervisory exp. other companies.....yr..	2.014
Total training time..... hr..	-.030
Time for interaction with workers.....min..	-.022
Time for work activities.....min..	¹ -.287
Role ambiguity (ideal).....	² -3.474
Responsibility for persons (actual).....	¹ -3.562
Responsibility for persons (ideal).....	.548
Responsibility for things (ideal).....	.432
Variance in workload.....	.154
Inequity in pay.....	-.342
Social support - spouse.....	¹ 3.183
Composite role ambiguity.....	1.623
Involved striving.....	1.393
Job boredom.....	³ 1.861
Workload dissatisfaction.....	-1.881
Anxiety.....	-1.490
Constant.....	41.72
Observations.....	123
R squared.....	.41

¹ Statistically significant from zero at the 1 percent level.

² Statistically significant from zero at the 5 percent level.

³ Statistically significant from zero at the 10 percent level.

Estimated regression equation for superintendent's
rank of the first-line supervisor

Variable description	Estimated coefficient
SECTION CHARACTERISTICS	
Man-trip time.....min..	² -.61
SUPERVISOR CHARACTERISTICS	
Nonsupervisory experience this company.....yr..	1.20
Experience with this company.....yr..	³ 1.13
Experience with this crew.....mths..	² .28
Mine manager's papers, 1 if has papers.....	³ 9.43
Mine face experience with this company.....yr..	² -1.88
Responsibility for persons (actual).....	-1.52
Job future ambiguity.....	² -1.55
Underutilization of abilities.....	1.13
Role conflict.....	¹ -2.92
Repetitiveness, expressiveness, & feedback.....	³ 1.34
Social support - spouse.....	² -4.29
Social support - total.....	³ 1.02
Job self-esteem.....	1.54
Somatic complaints on the job.....	³ -2.03
Composite responsibility for persons.....	³ 1.66
Depression.....	² 1.94
Production index.....	¹ .33
Accidents index.....	-.04
Constant.....	36.04
Observations.....	120
R squared.....	.44

- ¹ Statistically significant from zero at the 1 percent level.
² Statistically significant from zero at the 5 percent level.
³ Statistically significant from zero at the 10 percent level.

APPENDIX G
SUMMARY OF SIGNIFICANT
COEFFICIENTS

Summary of significant coefficients: Mine Characteristics

Variable	Significant coefficients	Possible explanation of observed relationship
Number of underground hourly workers	¹ 1.48	Provides additional resources to support the production process. Extra workers can compensate for absenteeism and assist with face tasks.
Non-union mine	¹ 148.81	Characteristics of non-union mines which may increase production include: less restrictive work rules, better labor management relations, more innovations, smaller more family oriented mines, and better work habits.
Selection procedure	¹ 92.16	Mines with selection procedures may have better and more clearly defined supervisory positions, take greater care in selection, and have higher expectations for supervisors.
Shifts per day	¹ -63.49	A third production shift decreases time available for maintenance procedures and for non-production work on the section.
Mine superintendent's LOQ structure score	¹ 6.39	Indicates that the superintendent is more task oriented which should be reflected in more follow up on details and stronger reliance on standard procedures.
Mine superintendent's LOQ consideration score	³ -.089	Indicates that the superintendent has more concern for other people. This should be reflected in taking action to prevent accidents.
Illinois	³ 3.101	May be the result of different geological conditions not captured by other variables or differences in state safety regulations.

- 1 Production
- 2 Production index
- 3 Accidents
- 4 Accident index
- 5 Superintendent's rank of the supervisor

Summary of significant coefficients: Section Characteristics--Continued

Variable	Significant coefficients	Possible explanation of observed relationship
Number of roof bolters	1-76.33	This variable indicates not only the number of roof bolters (1 or 2 roof bolters) but also the type of roof bolter (single or twin boom bolter). The coefficient observed suggests that a single unit-twin boom roof bolter is more productive than two single boom roof bolters.
Seam dip	2-15.27	Sections operate more efficiently on a flat surface than on a surface that dips in either direction.
Bolt length	2-5.43	Longer bolt lengths require longer bolting times which interferes with the mining cycle. This is also an indication of poorer roof conditions which has a negative effect on production.
Continuous miner age	2-1.33	As a continuous miner gets older, its reliability and cutting ability are diminished. Newer vintage models may also be designed more efficiently having a positive impact on production.

- 1 Production
- 2 Production index
- 3 Accidents
- 4 Accident index
- 5 Superintendent's rank of the supervisor