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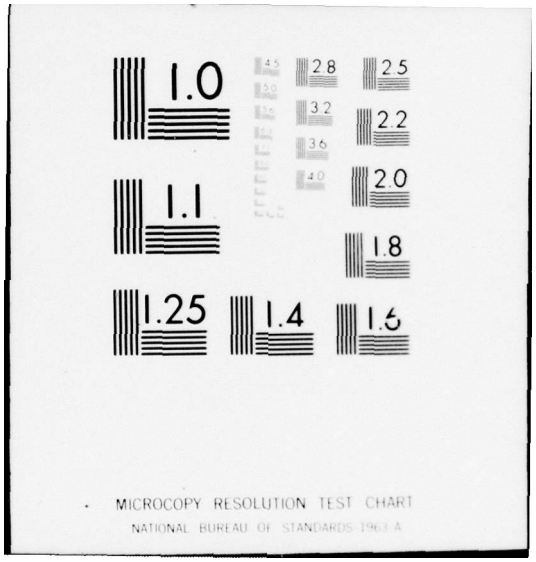
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HUMAN RESOURCE FACTORS AND PERFORMANCE RELATIONSHIPS IN NUCLEAR MISSILE HANDLING TASKS

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The objective was to determine quantitative relationships between human resource variables and technician performance on maintenance tasks for nuclear missile systems. Human resource variables relevant to maintenance operations were identified. Instruments for measuring the human resource variables were developed. Task performance measures were developed. An eleven-category taxonomy was developed for coding the maintenance tasks. Data on task performance, human resource variables, and technician opinions were collected from Air Force records or from technicians working at five Air Force bases. Statistical analyses of the data were performed. The results indicate that task performance capability is significantly related to a number of human resource variables such as: satisfaction with the Air Force in general, satisfaction with assignment locality, interest during high school

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in extracurricular activities, amount of trait fatigue, months in career field, willingness to assume responsibility, level of motivation, and level of work team morale. Mathematical equations were developed which use human resource data to predict task performance proficiency. Results also indicate that technicians across three career fields, five Air Force bases, and three missile systems have the opinion that the following factors have the most influence on task performance: team cohesiveness, emotional stability, fatigue, equipment reliability, weather conditions, and equipment operability. Task performance reliability values were calculated for ten of the eleven maintenance task categories. Those values ranged from .9688 for service tasks to 1.0000 for test tasks.

SUMMARY

Problem and Objective

At the request of the Air Force Weapons Laboratory, Kirtland Air Force Base, New Mexico, a research effort was initiated to gain a better understanding of the role the human plays in nuclear safety. In the first part of the research, already published, 13 human resource factors were identified which were thought to be relevant to nuclear safety. Five of these factors were quantitatively related to measures of nuclear hazard potential and task times for a series of ground handling and maintenance tasks associated with the B-52/short range attack missile (SRAM) system. These relationships were developed to assess the feasibility of using this type of data as input to a computer simulation technique to be used for system safety analyses.

The quantitative relationships established between the human resource factors and maintenance safety performance in the first study were based on the subjective estimates of human factors specialists in the laboratory. The study reported here was designed to collect field data to empirically establish these relationships. These more valid equations representing the relationships could be incorporated into the simulation program as well as used in other engineering analyses of nuclear systems safety and performance.

Approach

The approach was an extension of the earlier study and used the maintenance and ground handling tasks associated with the B-52/SRAM system. The 13 human resource factors identified in the first investigation were re-examined for use in this study. Measurement instruments were developed for each selected human resource factor. Biographic data forms were developed. Task performance measures were developed which included the number of task errors and task completion times reported on standardized Air Force task evaluation forms, and supervisor rankings of accuracy and speed of task performance. The three-category maintenance task taxonomy developed in the first study was reevaluated and expanded to 11 categories of maintenance tasks.

Data on task performance, human resource factors and biographic variables were collected from 135 SRAM technicians at five Air Force bases. In addition, opinion data on the influence of human resource factors and equipment/environmental factors were collected from 230 SRAM, Minuteman III, and GENIE AIR-2A technicians at the five Air Force bases to provide an indication of generalizability of the results across missile systems, career fields and bases.

Results and Conclusions

An insufficient amount of task error and time data were available and resulted in performance measures with little variability among maintenance technicians. Consequently, it was not possible to conduct many of the planned analyses, especially those relating performance to the 11-category maintenance task taxonomy. However, analyses relating supervisor rankings of performance to human resource factors were performed.

The results of the analyses of supervisor rankings indicated that those technicians ranked high had more months of experience, higher aptitude levels, were more emotionally stable, reported fewer fatigue symptoms, had higher levels of military morale and tended to be more satisfied with their work group than did those technicians ranked low on these performance measures.

Correlation analyses indicated that the number of years an individual spent in the Air Force, the number of months an individual spent in his career field, the ability to handle responsibility, the level of military morale and the level of group morale were all positively correlated with ranked accuracy and speed of task performance. The human resource factors which correlated negatively with task performance included trait anxiety level and the number of fatigue symptoms reported.

Stepwise multiple regression analyses were conducted to develop equations for predicting the combined effect of the human resource factors on task performance. Equations were developed to predict ranked accuracy of task performance and ranked speed of task performance for two groups of SRAM technicians.

Opinion data indicate that missile technicians from three systems, three career fields and five Air Force bases agreed as to the effect of human resource and equipment/environmental factors on task performance. Their opinion was that the human resource factors of team cohesiveness, emotional stability and psychological fatigue had the most influence on task performance. The opinion data also indicate that the equipment/environmental factors of equipment reliability, weather conditions and operation of equipment had the most influence on task performance.

Task performance reliability values were calculated for 10 of the 11 categories of maintenance tasks using the limited amount of available error data. These values ranged from .9688 for service tasks to 1.0000 for test tasks.

PREFACE

This study was performed by Systems Research Laboratories, Inc., 2800 Indian Ripple Road, Dayton, Ohio. Technical direction was provided by the Advanced Systems Division, Air Force Human Resources Laboratory (AFHRL), Wright-Patterson Air Force Base, Ohio. The study was requested by Technology Need TN-AFWL-0508-72-02, a Human Performance Model for Nuclear Safety Engineering Application. The TN was initiated by the Air Force Weapons Laboratory (AFWL), Kirtland Air Force Base, New Mexico. Contractor funds were provided by AFWL.

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Systems Research Laboratories, Inc. (SRL) performed the research under Contract F33615-76-C-0042 with Dr. Norman R. Potter as Principal Investigator and Mr. Daniel W. Sauer as Associate Principal Investigator. Ms. Wendy Bohnett Campbell was also an Associate Principal Investigator with SRL during much of the study.

The authors wish to acknowledge the many individuals who contributed to this effort. Appreciation is extended to the numerous Strategic Air Command personnel in units at Minot Air Force Base, North Dakota; Grand Forks Air Force Base, North Dakota; Wurtsmith Air Force Base, Michigan; Kincheloe Air Force Base, Michigan; and K. I. Sawyer Air Force Base, Michigan; and Aerospace Defense Command personnel in units at Grand Forks Air Force Base and K. I. Saywer Air Force Base for their assistance and participation in the data collection phase. Special appreciation is extended to CMSGT Fred M. Duncan (retired) of the SRAM Program Office, Wright-Patterson Air Force Base, Ohio. His consultation provided a great deal of insight into the work environment of the SRAM missile technicians and, we feel, made our data collection effort more meaningful to field personnel. Appreciation is extended to Maj. Ronald L. McPherson, Strategic Air Command Liaison to the SRAM Program Office, Wright-Patterson Air Force Base, Ohio and Lt. Col. John E. Mantei, Air Defense Command Representative to ASD, Wright-Patterson Air Force Base, Ohio for their support in arranging data collection visits to the various Air Force bases. The counsel and support of Mr. James Sweeney and Mr. William Barry of the Air Force Weapons Laboratory was extremely valuable.

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INTRODUCTION

Background

The Air Force Weapons Laboratory (AFWL), Kirtland Air Force Base, New Mexico, has identified a need to consider more carefully the role of the human in nuclear weapons systems safety. Specifically, AFWL is concerned with the ground handling (maintenance) tasks involving nuclear weapons. One of the ongoing missions of that Laboratory is to conduct Technical Nuclear Safety Analyses (TNSA) of new and modified nuclear weapons systems. The TNSAs are not designed to analyze the role of humans and determine their respective impacts on system safety but, rather, to carefully check out system hardware and operational procedures. In fact, the TNSAs have been performed using the premise that the human is 100 percent reliable. In other words, it has been assumed that the personnel would always be able to execute every task faultlessly every time. Obviously, this is not a valid assumption. Because of the need to better understand human performance and safety, the Air Force Human Resources Laboratory (AFHRL), Brooks Air Force Base, Texas, was asked to participate with the AFWL in a program to find a more realistic relationship between human and nuclear safety.

During the period February 1974 through October 1975, a study was performed to assess the feasibility of quantifying human resource factors, establishing quantitative relationships between these human resource factors and nuclear system safety, and using these data in a computer simulation method suitable for analyzing nuclear system maintenance operations (Askren, Campbell, Seifert, Hall, Johnson, & Sulzen, 1976). The study was conducted in four phases.

First, the human factors considered relevant to safety in nuclear maintenance operations were identified and defined. Thirteen factors were identified by a panel of psychologists and human factors specialists. They were: motivation, group cohesiveness, behavioral/emotional stability, fatigue, leadership, organizational structure, task complexity, written manuals, job skill proficiency, aptitude, training, work experience, and environmental conditions (e.g., temperature and wind). Each of these 13 factors had to be quantified for use in the computer simulation model. An extensive literature search was conducted to establish whether there were existing quantitative relationships between each factor and performance. Emphasis was placed on locating a measurement device for each of the factors which would yield a single value representing a subject's score or "quantity" of that factor.

Next, a nuclear system which was representative of current Air Force operations was chosen as a test bed. The B-52/short range attack missile (SRAM) system was selected. Maintenance and ground handling tasks involving the SRAM were put into a task network. Each of the tasks had four characteristics which were used to describe it in the network. They were: time required to complete the task; the Air Force specialty code (AFSC) representing the career field involved in the task; a value which represented how hazardous the task was; and a classification into one of three maintenance task categories (transport, checkout, or assemble/disassemble). For example, one task in the SRAM network entitled "Mate to Booster" took 55 minutes to accomplish, was performed by technicians in career field 462X0, had a hazard score of 85 (on a scale from 0-100 regarding hazard potential), and was considered an assemble/disassemble task. Each of the 35 SRAM tasks was described in a similar manner.

Due to resource constraints, only five of the human resource factors were chosen for final participation in the feasibility study (motivation, work experience, fatigue, written manuals, and environment). Since it was also impossible to collect real human resource factor or performance data on subjects because of resource limitations, an alternative scheme was devised for the third phase. Experienced human factors personnel were asked to postulate relationships that they believed existed between each of the five factors and maintenance task performance was measured by time and hazard. Since it was considered likely that factors affect performance differently depending on the type of task being performed, the relationships were quantified according to whether the tasks were transport, checkout, or assemble/disassemble. Thus, the raters estimated 30 relationships: five factors by two performance measures by three maintenance categories.

In the fourth phase of the study, a computer simulation model was used to integrate all the maintenance and performance data. The SRAM task network was inserted into the computer with each task assigned the four descriptors: time, crew type, hazard value, and maintenance task category. Then, equations representing the relationships between the five human resource factors, and time and hazard, were inserted into the computer. The function of the System Analysis of Integrated Networks of Tasks (SAINT) computer simulation model was to cycle through the network, for example, 500 times, and determine how a crew possessing given "characteristics" of motivation, work experience, fatigue, and using a given quality of written manuals under given environmental conditions would perform. In this way different crew, environmental, and written manual conditions could be simulated and the effects on performance could be observed from the outputs given by the computer simulation model.

The results reflected changes in overall maintenance time and hazard values with different input conditions. This was expected, as the relationships between performance and the human resource factors

postulated by raters had shown that performance deteriorates with decreasing "amounts" of motivation and work experience.

Although the results of the effort could not be used to make predictions about task time and hazards in the operational environment, the results did prove the feasibility of quantifying human resource factors and investigating their relationships to task performance. As may be expected, this feasibility study led to a desire to collect actual human resource factor and task performance data, and determine the real-world relationships for nuclear maintenance operations.

Purpose

The purpose of the current study was to determine the relationships between human resource factors and task performance through the collection and analysis of actual field data. The equations representing these relationships would provide a more accurate representation of human performance in system safety analyses. The study was also designed to identify any additional human resource factors or equipment factors related to task performance, to assess the relative influence of human resource factors and equipment factors on task performance and to begin to assess the generalizability of the relationships between human resource factors and task performance for application to other missile systems.

RESEARCH APPROACH

The general research approach was to collect human resource data and task performance data from Air Force missile technicians, and analyze these data to determine the relationships between the human resource factors and task performance. The human resource factors and the maintenance task categories developed for the earlier study (Askren, et al., 1976) were reevaluated or refined to ensure that they were compatible with the objectives of the current study. In addition, instruments were identified or developed to measure the human resource factors. An opinion questionnaire was developed to determine the human resource and equipment factors which missile technicians felt influenced task performance.

Human resource data, task performance data, and opinion data were collected from SRAM technicians while opinion data only were collected from AIR-2A GENIE and Minuteman III missile technicians.

Human Resource Factors and Measures

Ten human resource factors considered relevant to task performance were selected for examination in this study (Table 1). After the factors had been identified, it was necessary to locate or develop an appropriate measure for each. The measures included psychological tests, supervisor ratings and biographic data. They were consolidated into a questionnaire booklet and were administered to each missile technician. The following is a list of the ten human resource factors and their measures.

Aptitude. The Airman Qualifying Examination (AQE) is presently administered to all Air Force recruits. Scores are determined for four subscales reflecting mechanical, electronics, administrative, and general aptitudes. The individual's score measuring general aptitude was used as the aptitude measure for this study. Scores could range from a low of zero to a high of 95.

Career field training and experience. Career field training and experience represents general experience in an Air Force specialty code (AFSC). Technicians indicated when they were assigned to their present AFSC in the biographic data section of the questionnaire (see Biographic Information Form, Appendix A). This information was used to calculate the number of months each individual had spent in his AFSC.

Emotional stability. It is clear that personnel working with nuclear weapons should be emotionally stable and not susceptible to excess anxiety or tension states. To measure anxiety and general stability, two existing psychological tests were chosen. They were the State-Trait Anxiety Inventory (Spielberger, Gorsuch, & Lushene, 1970) and the Gordon Personal Profile (Gordon, 1963). The State-Trait Anxiety Inventory was designed to yield two measures of anxiety. State anxiety, measured by the subject's responses to 20 statements, indicated

TABLE 1. HUMAN RESOURCE FACTORS

APTITUDE: The natural ability or talent to do the job.
CAREER FIELD TRAINING AND EXPERIENCE: The amount of training time and job time spent in the AF career field(s).
EMOTIONAL STABILITY: The levels of stress, tension, and anxiety present in individuals, with lower levels characteristic of greater emotional stability.
FATIGUE: The subjective feelings of boredom, weariness, and disinclination toward activity.
LEADERSHIP: The styles and patterns of behavior exhibited by the supervisor(s).
MILITARY MORALE AND ATTITUDE: Personal feelings and opinions of the airmen toward the formal military organization.
MOTIVATION: The degree of willingness to start work and keep on working. The amount of effort expended in performing assigned tasks.
ORGANIZATIONAL STRUCTURE: The "climate" or tone of the squadron in terms of policies, actions, and attitudes handed down to the airmen.
SYSTEMS TRAINING AND EXPERIENCE: The amount of training time and work done in direct connection with the missile system.
TEAM COHESIVENESS: The mutual respect for work team members and degree to which team members want to remain in the same work group.

the level of anxiety experienced at a particular time. The missile technicians were instructed to respond to the statements as if they had just completed a task evaluation. Trait anxiety, also measured by responses to 20 statements, indicated the normal or usual anxiety level for each individual. Technicians were instructed to respond to the statements as if they were working under their normal routine. Responses to the statements were given numerical values and summed to produce a score for state anxiety and a score for trait anxiety for each individual.

The Gordon Personal Profile was chosen primarily because it has a subscale which directly measures an individual's level of emotional stability. This test also yields measures on three other personality characteristics: the responsibility score, which measures perseverance and determination; the ascendancy score which indicates the degree to which an individual takes an active role in group activities and is self-assured and assertive in his relationships with others; and the sociability score which measures the degree to which an individual likes to be with and work with people. Scores from all four subscales were included in the analysis.

Fatigue. Through preliminary interviews with SRAM technicians it was learned that physical fatigue was rarely an issue with the maintenance tasks under consideration. Much more important was the psychological fatigue which appeared to evolve from lack of challenging work and resulting boredom. An instrument, developed by Yoshitake (1971) was used to measure the degree of fatigue through responses to a list of 30 statements. The instrument was modified and presented twice to maintenance personnel with different instructions for completion (Appendix A). The first presentation was given to determine the subjects' general fatigue levels and the second was given to determine their fatigue levels after an evaluation.

Leadership. Leadership style was measured to establish a relationship between the type of leader and the performance of personnel in his unit. The Leader Behavior Description Questionnaire - Form XII (Stogdill, 1963) was administered to all subjects. It contained 100 items which list qualities and characteristics of the leader. The extent to which the leader displays each of these qualities or characteristics was classified as either: always, often, occasionally, sometimes or never. This instrument yielded scores on 12 subscales which describe different aspects of the leader's behavior. A list and definition of the subscales can be found in Appendix A.

Military morale and attitude. This factor attempted to investigate how the airmen's attitudes about the Air Force in general are related to task performance. To measure this factor, an existing instrument (Tuttle, Gould, & Hazel, 1975) was selectively modified (Occupational Opinion Scale, Appendix A). Tuttle et al. (1975) reported research for the Air Force identifying important aspects of job satisfaction for the development of an occupational attitude inventory. From that inventory, 26 items which measured five different areas of satisfaction were selected

for use in this study. The five measures used to represent military morale and attitude in this study were satisfaction with: (a) Air Force unit policies and practices, (b) assignment locality, (c) pay and benefits, (d) promotion opportunity, and (e) social status. Technicians indicated whether they were "extremely dissatisfied," moderately dissatisfied," "moderately satisfied" or "extremely satisfied" in response to the 26 items. These responses were scored and summed for each area of satisfaction. A total score was also calculated.

Motivation. Although motivation is not a well-defined concept, it is thought to be highly related to job performance. Motivation seems to be best measured when actually rated in terms of observable behaviors specific to the Job (Landy & Guion, 1970). The questionnaire developed to measure this factor (Appendix A) asked the supervisors to rate their technicians in the areas of job curiosity, persistence, professional identification, team attitude, organizational identification and self-starting ability. Supervisors indicated the type of behavior each subordinate would exhibit in response to a given situation. For example, the statement "While working on a long task, the team ran out of a crucial lubricant and no additional supplies were available at the shop" described the situation for rating the persistence dimension of motivation. The supervisor's rating of each man's behavior under these circumstances was made on a continuum containing the descriptors "willing to go to another shop to get the lubricant necessary to complete the job" at the high end of the motivation continuum and "use this as an excuse to stop work on the task and leave the problem for someone else" at the low end of the motivation continuum. The supervisor could indicate any position along the continuum between the two statements. His ranking was then coverted to a value between zero (low motivation) and 100 (high motivation) and used as the measure for that item.

Organizational structure. This factor, as defined in this study, did not deal with the Air Force as a whole, but rather with the unit where the airmen work. There are often policy setting and "climates" which could radically differ between units of assignment and these "tones" could influence performance. To measure this factor, an organizational climate inventory (Appendix A) was adapted from a similar measure developed by Litwin and Stringer (1968). The technicians would "strongly agree," "agree," "disagree," or "strongly disagree" that the statements presented in the inventory were descriptive of their squadron. The inventory produced scores for each individual on their perceptions of nine aspects of organizational climate including structure, responsibility, reward, risk, warmth, support, standards, conflict, and identity. Definitions for each aspect are presented in Appendix A.

Systems training and experience. This factor represented the amount of direct experience a technician had with the SRAM system specifically. Experience with other weapons systems and general AFSC experience would be included in the career field training and experience factor. To measure system training and experience, technicians indicated the date

when they were first assigned to SRAM on the biographic form (Appendix A). This date was used to derive the number of months in SRAM.

Team cohesiveness. Most weapons handling tasks are performed in a structured team format with each person having specific tasks assigned. Because the team works so closely together, it was decided that team or group cohesiveness could be a potential human resource factor. The Scale of Group Morale (Goldman, 1958) which was developed to measure the "degree of cohesiveness that exists in a group" was used to measure team cohesiveness. The instrument was composed of 20 statements designed to produce four measures of group morale or cohesiveness: the degree to which group activity satisfies individual motives, the degree to which the group satisfies needs for interpersonal relations, homogeneity of attitudes of group members, and satisfaction with group leader. Technicians could "strongly agree," "agree," "disagree," or "strongly disagree" that the statements presented in the scale were descriptive of their work group. Five scores were calculated: one for each measure of group morale and a total group morale score.

A summary of the human resource factor measures and their subscores is presented in Table 2.

Biographic/Demographic Data

Biographic and demographic data were collected in addition to measures of the human resource factors to determine if these data may be related to or predictive of task performance. Data included age, marital status, number of dependents, type of high school curriculum, number of extracurricular activities, type of post-high school education activities and type of housing currently occupied. The biographic information form used to collect these data is presented in Appendix A.

Opinion Questionnaire

An opinion questionnaire, called the Missile Maintenance Survey (Appendix A), was designed to determine how missile technicians viewed the influence on task performance of human resource and equipment/environmental factors, to assess the relative influence of human resource versus equipment/environmental factors on task performance, and to identify any other human resource and equipment factors not previously listed. The survey was designed with three sections to obtain this information.

The first section asked technicians to rate, on a scale of zero to 100, the influence of 10 human resource factors (see Table 1) on task performance. In addition they were asked to identify any additional human resource factors not included in the survey. These additional factors were also rated as to their influence on task performance.

The second section asked technicians to rate, on a scale of zero to 100, the influence of nine equipment/environmental factors (Table 3) on

TABLE 2. SUMMARY OF HUMAN RESOURCE FACTOR MEASURES AND THEIR SUBSCORES

Human Resource Factors	Measure/Subscores
Aptitude	AQE General Aptitude Score
Career Field Training and Experience	Months in AFSC
Emotional Stability	State-Trait Anxiety Inventory Gordon Personal Profile Ascendancy Emotional Stability Responsibility Sociability
Fatigue	Fatigue Symptom Checklist
Leadership	Leader Behavior Description Questionnaire Form XII Representation Demand Reconciliation Tolerance of Uncertainty Persuasiveness Initiation of Structure Tolerance of Freedom Role Assumption Consideration Production Emphasis Predictive Accuracy Integration Superior Orientation
Military Morale and Attitude	Occupational Opinion Scale Air Force Policies and Practices Assignment Locality Pay and Benefits Promotion Opportunity Social Status Total Score

TABLE 2. SUMMARY OF HUMAN RESOURCE FACTOR MEASURES AND THEIR SUBSCORES (Continued)

Human Resource Factors	Measure/Subscores
Motivation	Supervisor Ratings Job Curiosity Persistence Professional Identification Team Attitude Organizational Identification Self-Starter Overall
Organizational Structure	Organizational Climate Inventory Structure Responsibility Reward Risk Warmth Support Standards Conflict Identity
Systems Training and Experience	Months in SRAM
Team Cohesiveness	Scale of Group Morale Individual Motives Interpersonal Relations Homogeneity of Attitude Satisfaction with Leader

TABLE 3. EQUIPMENT/ENVIRONMENTAL FACTORS

CLOTHING TYPES	Is bulky clothing or clumsy headgear required? How much does the clothing restrict movement?
EQUIPMENT RELIABILITY	Does the equipment work when you need it?
EQUIPMENT SAFETY FEATURES	Are handholds placed where needed? Are sharp edges on equipment a problem? Are non-slip surfaces placed where you need them?
LIGHTING CONDITIONS	Is there enough light to see what you are doing? Are shadows a problem?
NOISE LEVEL	How disturbing is the noise on the job site?
OPERATION OF EQUIPMENT	Is operating the equipment difficult or easy? How much test equipment and tools have to be used and are they all easy or difficult to operate?
TECH ORDERS	Are the procedures and steps listed in the best order and presented in the best way possible?
WEATHER CONDITIONS	Is the temperature too hot or cold to work effectively? Does the wind, rain, ice, and snow hinder you?
WORK PLACE SIZE AND SHAPE	Is there enough room to work on the equipment? Are all the pieces easily reached?

task performance. The technicians were again asked to identify any additional equipment/environmental factors not included in the survey and rate the influence of these additional factors on task performance.

The third section asked the technicians to rank (on separate lists) the five most influential human resource factors and the five most influential equipment/environmental factors. Finally, they were asked to rank the human resource factors and equipment/environmental factors on the same list in order of influence on task performance.

Reevaluation of Task Performance Measures

The task performance measures used in the earlier study, task completion time and hazard potential were estimated data and not compatible with the objectives of the current study. Actual measures of an individual's task performance were necessary to empirically determine the relationships between the human resource factors and task performance. This type of task performance data was available for SRAM technicians through the Strategic Air Command (SAC) Maintenance Standardization and Evaluation Program (MSEP) as described in SAC Regulation 66-6, Volume II. Under this program, personnel are subjected to annual inspections on one or more of the standardized maintenance tasks by the SAC Maintenance Standardization and Evaluation Team (MSET). They are also inspected on the standardized tasks several times throughout the year by local quality control inspection teams. Both the MSET and local inspections are conducted using the same performance criteria. The results of both MSET and local inspections are recorded on Air Force Form 2416 (Personnel/Crew Evaluation Report) and are kept on file at the squadron for at least one year. After examination of several completed Personnel/Crew Evaluation Reports, it was decided to extract three performance measures from each individual's evaluation form: the number of technical order errors made, the number of safety errors made, and the number of reliability errors made. Although the evaluation program does not require task completion times to be recorded, several evaluators had recorded these times on the evaluation form. When time was reported, it was collected for this study as an additional task performance measure. A list of SRAM MSET evaluation tasks is presented in Appendix B.

The first data collection trip revealed that the number of errors reported was less than the early review of sample evaluations had indicated. The low number of errors resulted in performance measures with little variability and, consequently, limited the value of these measures for computing the relationships between the human resource factors and task performance. It was therefore necessary to devise two additional measures of task performance. These measures were supervisor rankings and ratings of their subordinates on speed of task performance and accuracy of task performance (Appendix B). Speed and accuracy of task performance were selected because it appeared that both qualities were important if the squadron was to perform safely and reliably while under the time pressures of operational commitments.

Reevaluation of Maintenance Task Categories

It was recognized in the earlier study (Askren et al., 1976) that the human resource factors may have differential effects on task performance depending on the skill demands of a particular task. For example, a technician's aptitude may have little impact on task performance when the task is towing a SRAM missile. Conversely, his aptitude may have a significant effect on task performance when the task is troubleshooting a malfunction in the SRAM guidance system. To allow for these differential effects to be recognized each task was placed into one of three categories (transport, checkout, assemble/disassemble), and relationships between the human resource factors and task performance were estimated for each category.

For this study, it appeared that the three original categories of tasks were too broad in terms of the types of skills each contained and would hamper efforts to refine the human resources-performance relationships. Therefore, several existing task taxonomies (Farina, 1969; Miller, 1971a, 1971b; Teichner & Whitehead, 1971) and task classification schemes (Foley, 1973; Ostrofsky, 1976) were examined for use in this study. Generally, the task taxonomies were unsuitable for this effort primarily because they were designed to cover a much broader group of tasks and because the terms and definitions of the taxonomies required a great deal of interpretation on the part of the user when applying these schemes to the SRAM maintenance task network. It was determined that the categories and terms of the taxonomy for this study should be easily understood and easily applied by engineers, designers, and others interested in studying performance on Air Force maintenance tasks. For this reason, a maintenance task taxonomy was specifically developed to meet the objectives of this study by combining elements of the maintenance task classification schemes of Foley (1973) and Ostrofsky (1976). The taxonomy (Table 4) developed contained 11 maintenance task categories with category labels and definitions directly related to maintenance tasks.

Use of Taxonomy in Determining Relationships Between Human Resource Factors and Task Performance

To determine if the relationships between the human resource factors and task performance varied for different kinds of tasks, it was first necessary to identify which of the 11 task categories were included in each MSET evaluation. Errors reported on an MSET evaluation could then be classified as errors in particular task categories. The number of errors reported for each task category could be used to determine the relationships between the human resource factors and performance for each task category. For example, Table 5 identifies the number of subtasks (grouped into task categories) for each team member for MSET evaluation task 1101(A), Loading B-52 AGM-69 Launcher (Technical Order 1B-52D-16). A team member's performance measure for each task category would be the proportion of those subtasks performed correctly. If team member 1 made

TABLE 4. MAINTENANCE TASK TAXONOMY

ALIGN	The tasks required to bring part of a system in line with another part of the system.
CALIBRATE/ADJUST	The tasks required to regulate or bring the performance of a given level of the system to within acceptable output tolerance.
HANDLE	The tasks required to convey or move parts or equipment from one place or position to another.
INSPECT	Observation or measurement to determine the condition or status of the system or a part of the system.
INSTALL	The tasks required to install or connect parts of the system.
OPERATE	Use of controls, switches, or tools to effect changes or movements of the system or parts of the system.
REMOVE	The tasks required to remove or disconnect portions of the system.
REPAIR	The tasks required to restore a given level of the system to operating conditions.
SERVICE	The tasks required to replenish consumables needed to keep a given level of the system in operating condition.
TEST	The use of measuring devices to determine the condition of the system or a portion of the system.
TROUBLESHOOT	The tasks which isolate a fault or failure to the desired level within the system.

TABLE 5. NUMBER AND TYPE OF SUBTASKS PERFORMED BY EACH TEAM MEMBER FOR MSET TASK 1101(A) LOADING B-52 AGM-69 LAUNCHER

Task Taxonomy Categories	Team Member 1	2	3	4	Total Subtasks	Percent of MSET Task 1101(A)
Align	8	2	3	3	16	8.2
Calibrate/Adjust	1	2	0	2	5	2.6
Handle	6	12	9	7	34	17.3
Inspect	4	10	2	12	28	14.3
Install	6	13	6	9	34	17.3
Operate	1	2	24	8	35	17.9
Remove	5	11	12	12	40	20.4
Repair	0	0	0	1	1	0.5
Service	1	0	1	0	2	1.0
Test	0	1	0	0	1	0.5
Troubleshoot	0	0	0	0	0	
TOTAL	32	53	57	54	196	100.0

an align error and no errors on any of his other assigned subtasks, his performance scores would be 87.5 (7 ÷ 8) for align and 100 for all other assigned subtasks. These measures would be used in analyses to determine the relationships between the human resource factors and performance on the 11 types of maintenance task categories.

Field Data Collection

A total of 230 Air Force missile technicians participated in the study: 85 missile mechanics (AFSC 462X0) and 55 missile technicians (AFSC 463X0) working on the SRAM system, 18 missile mechanics (AFSC 462X0) and 20 missile technicians (463X0) working on the AIR-2A GENIE system, and 24 missile technicians (AFSC 463X0) and 28 missile technicians (AFSC 443X0) working on the Minuteman MKIII reentry vehicle. The technicians were assigned to one of five Air Force bases: Minot AFB, North Dakota; Grand Forks AFB, North Dakota; Wurtsmith AFB, Michigan; Kincheloe AFB, Michigan; and K.I. Sawyer AFB, Michigan. Table 6 shows the number of technicians, classified by missile system and skill code, who participated at each base.

TABLE 6. NUMBER OF TECHNICIANS AND SPECIALTY CODES FROM EACH AIR FORCE BASE

		Air Force Bases					
System	AFSC	Minot	Grand Forks	Wurtsmith	Kincheloe	K.I. Sawyer	Total
SRAM	462X0	19	16	20	15	15	85
	463X0	13	10	12	9	11	55
GENIE	462X0	9	--	--	--	9	18
	463X0	10	--	--	--	10	20
Minuteman	463X0	16	8	--	--	--	24
	443X0	17	11	--	--	--	28
	TOTAL	84	45	32	24	45	230

Collection of human resource data and opinion data. The questionnaire booklet containing the psychological tests, biographic data forms and the Missile Maintenance Survey was administered to all SRAM technicians in a group setting. Verbal instructions were given to supplement the written instructions. Participants were encouraged to ask questions at any time and were urged to take sufficient time to answer each item completely. The missile technicians from the Minuteman III and GENIE systems were administered the Missile Maintenance Survey in a group setting. Upon completion of the survey the technicians were released to their normal duties.

While the SRAM technicians were completing the questionnaire booklets, their supervisors received instructions as to the proper use of the motivation rating forms. After the supervisors understood the rating procedure, each supervisor rated each of his men who had completed a questionnaire booklet.

This approach presented a problem with collecting measures of h resource factors. Several of the factors such as motivation, fatig , and anxiety can fluctuate with time. Ideally, the human resource factor measures and performance measures should be collected simultaneously. However, within the resource constraints of this study, the most efficient way to collect a great deal of performance data was to rely on records of past task evaluations. This meant that measures of several of the time-dependent human resource factors would not accurately reflect the state of the individual at the time of his evaluation. To compensate for this, personnel completing the portions of the questionnaire dealing with time-dependent factors were instructed to recall their last evaluation and answer the items as if they had just returned from the evaluation.

Collection of performance data. Performance measures were collected from each SRAM technician's Personnel/Crew Evaluation Reports, Air Force Form 2416. Depending on the length of time an individual had been with the squadron, the number of reports per individual ranged from one to over ten covering the previous 12-month period. These evaluations could reflect performance on one to six different types of MSET tasks. The number of technical order errors, safety errors and reliability errors reported for each evaluation task was recorded. If time to complete the task was reported on the evaluation form, it was also recorded as a performance measure.

Additional performance indicators were collected in the form of supervisor's ranking of his technicians on the accuracy of their task performance in general, and ranking on speed of their task performance in general. A performance score for accuracy of task performance and a score for speed of task performance was assigned to each individual by calculating his percentile rank on each of the two rankings.

RESULTS

An examination of the data collected from the Personnel/Crew Evaluation Reports indicated that low numbers of technical order errors, safety errors and reliability errors were reported. For example, of 195 MSET task 1101(A) evaluations collected, 110 had zero errors, 45 had one error, 24 had two errors, 11 had three errors, and five had four or more errors. Other MSET task evaluations contained similar numbers of errors. As a result of the low number of errors, the planned statistical analyses relating the human resource factors to task performance errors could not be conducted. Therefore, the analyses were conducted using the supervisor's rankings of accuracy and speed as the task performance measures.

Characteristics of Technicians Ranked High on Performance Versus Technicians Ranked Low on Performance

The first analyses conducted were to compare the characteristics of technicians ranked by the supervisors as high on task performance with technicians ranked low on task performance. Four comparisons were made: (a) 462X0 SRAM technicians ranked high on accuracy of task performance were compared with 462X0 SRAM technicians ranked low on accuracy of task performance, (b) 462X0 SRAM technicians ranked high on speed of task performance were compared with 462X0 SRAM technicians ranked low on speed of task performance, (c) 463X0 SRAM technicians ranked high on accuracy of task performance were compared with 463X0 SRAM technicians ranked low on accuracy of task performance, and (d) 463X0 SRAM technicians ranked high on speed of task performance were compared with 463X0 SRAM technicians ranked low on speed of task performance.

The SRAM technicians who were ranked in the upper 27 percent of the supervisor's rankings on accuracy and speed were placed in the high performer groups. Technicians ranked in the lower 27 percent of the supervisor's rankings were placed in the low performer groups. Technicians ranked high and technicians ranked low were compared on measures of the various psychological, experiential and biographic factors. The t-test was used to compare the differences between the mean values of factors measured on an interval scale, while the chi-square statistic was used to analyze nominal level data. The number (n) of technicians in the high and low comparison groups were equal.

Tables 7 and 8 contain the human resource factors and their values which were significantly different between the high- and low-ranked 462X0 technician for accuracy of task performance and speed of task performance. Human resource factors which did not differ significantly between the high- and low-ranked technicians were not included in the tables.

When ranked on accuracy of task performance (Table 7), the high performers, compared to the low performers, had spent less time on

TABLE 7. AFSC 462XO TECHNICIANS: HIGH PERFORMERS VERSUS LOW PERFORMERS ON ACCURACY OF TASK PERFORMANCE

Human Factors Variables	High Performers n = 17		Low Performers n = 17		P
Interval Data	Mean	Standard Deviation	Mean	Standard Deviation	
Months on Present Team	3.2	2.18	5.4	3.18	<.05
Times on Sick Call	0.8	1.60	2.1	2.02	<.05
Extracurricular Service Clubs	0.24	0.44	0.0	0.00	<.05
Extracurricular Interest Clubs	0.5	0.62	0.1	0.24	<.05
Fatigue - Trait	1.6	2.21	4.9	3.12	<.01
Fatigue - State	1.7	1.61	3.6	3.48	<.05
Occupational Opinion Scale:					
Satisfaction with Air Force Policies	19.2	2.92	15.3	4.12	<.01
Satisfied with Assignment Locality	15.5	4.38	11.0	3.92	<.01
Satisfaction with Promotional Opportunities	12.6	2.89	9.5	3.76	<.01
Total Score	62.6	12.86	50.1	11.58	<.01
Group Morale Level:					
Satisfies Individual Motives	9.1	3.44	5.2	2.74	<.001
Homogeneity of Attitude	13.9	2.82	11.3	3.69	<.05
Total Score	53.4	10.91	42.4	10.54	<.01
AQE Scores	69.4	13.91	57.6	19.13	<.05
Motivation:					
Job Curiosity	72.4	16.02	43.5	18.69	<.01
Persistence	77.1	15.21	47.9	28.62	<.01
Professional Identification	69.7	15.96	48.8	25.59	<.01
Team Attitude	63.2	13.22	45.3	24.6	<.01
Organizational Identification	69.7	15.86	48.2	19.20	<.01
Self-Starter	62.9	18.21	44.4	27.49	<.01
Overall	73.2	13.46	45.6	27.49	<.01

p = probability that the observed differences between the factors are due to chance variation

TABLE 8. AFSC 462X0 TECHNICIANS: HIGH PERFORMERS VERSUS LOW PERFORMERS ON SPEED OF TASK PERFORMANCE

Human Factors Variables	High Performers n = 17		Low Performers n = 17		P
Interval Data	Mean	Standard Deviation	Mean	Standard Deviation	
Times on Sick Call	0.9	1.68	2.2	1.89	<.05
Extracurricular Service Clubs	0.2	0.44	0.0	0.00	<.05
Gordon Personal Profile:					
Emotional Stability	28.2	6.29	21.9	10.52	<.05
Responsibility	27.2	4.86	21.6	9.49	<.05
Ascendancy	20.5	3.68	15.7	7.50	<.05
Fatigue - Trait	2.3	2.64	5.0	3.12	<.05
Occupational Opinion Scale:					
Satisfaction with Assignment Locality	15.4	4.46	11.9	3.30	<.05
Group Morale Level:					
Satisfies Individual Motives	8.6	3.57	5.7	2.84	<.05
Total Score	52.1	11.78	43.4	9.89	<.05
Motivation:					
Job Curiosity	65.9	22.24	48.2	22.00	<.01
Persistence	72.1	20.70	54.8	31.84	<.01
Professional Identification	67.6	16.12	50.6	28.17	<.01
Team Attitude	57.9	19.04	51.8	25.18	<.05
Organizational Identification	64.1	20.33	52.4	18.30	<.05
Overall	66.8	19.76	52.6	27.45	<.01

P = probability that the observed differences between the factors are due to chance variation

their present team, had fewer occasions to report to sick call, participated in more extracurricular service and interest clubs prior to joining the Air Force and reported fewer symptoms of psychological fatigue. The high-ranked performers also reported higher levels of military morale than did the low-ranked performers. Specifically, the high performers were more satisfied with Air Force policies, their assignment locality and promotion opportunities. Higher levels of group morale were also characteristic of the high-ranked group. In particular, the high-ranked group obtained more satisfaction from their group membership and perceived that attitudes of other group members were more similar to their attitudes. In terms of aptitude, as measured by the general AQE score, the high-ranked group had higher AQE scores than the low-ranked group.

When the performance measure was speed of task performance (Table 8), a somewhat different set of characteristics distinguished the high performer from the low performer. Like the high-ranked performer on accuracy of task performance, the high-ranked performer on speed of task performance had fewer occasions to go to sick call, participated in more extracurricular service clubs prior to joining the Air Force, reported fewer fatigue symptoms, was more satisfied with his assignment locality and reported higher levels of group morale than the low-ranked performer. In this comparison, three personality variables distinguish the high from the low performer. The high-ranked performer scored higher on emotional stability, responsibility and ascendancy subscores of the Gordon Personal Profile. The higher scores for the high performer indicated that he was more emotionally stable and well balanced and experienced lower anxiety and nervous tension levels than the low-ranked technician. He also handled responsibility better than the low-ranked performer and tended to be more self-assured, more assertive in relationships with others and took a more active role in the group.

The motivation measures differed significantly between the high and low performer groups for both performance measures. For all but one of the measures of motivation, the high-ranked performer was rated as exhibiting significantly higher levels of motivation than the low-ranked technician.

Comparisons between the 463X0 SRAM technicians ranked high or low on accuracy of task performance are presented in Table 9. The high-ranked performer participated in more extracurricular individual sports, such as tennis, swimming, track and wrestling, than did the low-ranked performer. Unlike the 462X0 technicians, the 463X0 technician rated high on accuracy of task performance, reported higher state anxiety levels and less satisfaction with Air Force promotion opportunities. In terms of post-high school education activities, a much larger percentage of high-ranked technicians pursued these activities than did the low-ranked technicians.

TABLE 9: AFSC 463X0 TECHNICIANS: HIGH PERFORMERS VERSUS LOW PERFORMERS ON ACCURACY OF TASK PERFORMANCE

Human Factors Variables	High Performers n = 16		Low Performers n = 16		P
Interval Data	Mean	Standard Deviation	Mean	Standard Deviation	
Extracurricular Individual Sports	0.80	0.94	0.1	0.35	<.05
State Anxiety	44.07	11.19	32.5	17.82	<.05
Occupational Opinion Scale:					
Satisfaction with Promotional Opportunities	8.40	2.68	10.5	3.00	<.05
Motivation:					
Job Curiosity	79.3	22.35	47.0	28.34	<.01
Persistence	89.3	15.10	41.3	28.12	<.01
Professional Identification	67.7	24.41	40.3	20.99	<.01
Team Attitude	75.3	20.57	47.7	23.21	<.01
Organizational Identification	58.7	20.13	37.3	23.06	<.01
Self-Starter	79.7	21.67	48.0	29.87	<.01
Overall	78.3	23.8	44.7	23.79	<.01
Nominal Data	Frequency	Percentage	Frequency	Percentage	
Post-High School Education:					<.05
None	2	13	9	60	
Vocational	1	7	1	7	
College	10	67	4	27	
Junior College	2	13	0	0	
Other/Correspondence	0	0	1	7	

P = probability that the observed differences between the factors are due to chance variation

Comparisons between the 463XO technicians ranked high or low on speed of task performance are presented in Table 10. High-ranked technicians had more career field training and experience as measured by months in career field and more system training and experience as measured by months in SRAM. Several demographic and biographic variables differed between the high and low groups. A larger percentage of the high-ranked technicians were married while a larger percentage of the low-ranked technicians were single. Comparison of high school curriculums indicated that a much larger percentage of high-ranked technicians followed a college preparatory curriculum. On another education measure, 81 percent of the high-ranked technicians reported some type of post-high school education activity while only 25 percent of the low-ranked performers reported post-high school education activity.

In terms of motivation levels, the results of the comparisons are similar to the comparisons for the 462XO technicians. High-ranked technicians on accuracy or speed of task performance had significantly higher motivation ratings than the technicians ranked low on these performance measures.

Correlations Between Human Resource Factors/Biographic Variables and Supervisor Rankings of Accuracy and Speed of Task Performance

Product-moment correlations (McNemar, 1962) were calculated between the human resource factors/biographic variables and the supervisor rankings of accuracy and speed of task performance for both the 462XO and the 463XO SRAM technicians. The correlation coefficients for all analyses are presented in Table 11. An examination of this table reveals that many of the correlations are low and not significantly different from zero. In these cases, no significant relationships were indicated between the human resource factors/biographic variables and measures of task performance. Significant positive correlations indicated that as values of the human resource factor or biographic variables increased for an individual, the ranking he got on the performance measure also tended to increase. A significant negative correlation indicated that as values of the human resource factor or biographic variables increased for an individual, the performance ranking he got tended to decrease.

The human resource factors/biographic variables positively related to at least one performance measure for both the 462XO and the 463XO technicians included years of military service, months in career field, responsibility score from the Gordon Personal Profile, several measures of satisfaction with the Air Force, measures of group morale, and measures of motivation. As technicians spent more years in the Air Force and more months in their career field, they tended to be ranked higher on one or both of the performance measures. Those technicians who scored high on their ability to handle responsibility also tended to be ranked higher on the performance measures. As satisfaction with the Air Force and assignment locality increased, the technicians tended

TABLE 10. AFSC 463X0 TECHNICIANS: HIGH PERFORMERS VERSUS LOW PERFORMERS ON SPEED OF TASK PERFORMANCE

Human Factors Variables	High Performers n = 16		Low Performers n = 16		P
Interval Data	Mean	Standard Deviation	Mean	Standard Deviation	
Months in Career Field	36.00	22.208	19.063	15.115	<.05
Months in SRAM	24.188	14.914	13.813	13.780	<.05
Motivation:					
Job Curiosity	88.4	10.60	54.4	26.54	<.01
Persistence	94.1	7.51	51.6	29.42	<.01
Professional Identification	80.3	11.32	47.2	20.73	<.01
Team Attitude	83.8	12.45	55.6	24.96	<.01
Organizational Identification	69.7	13.84	44.1	25.25	<.01
Self-Starter	90.0	11.55	54.7	31.28	<.01
Overall	88.1	10.94	54.7	24.05	<.01
Nominal Data	Frequency	Percentage	Frequency	Percentage	
Marital Status:					<.05
Single	3	19	11	69	
Married	11	69	3	19	
Divorced	2	13	2	13	
High School Curriculum:					<.05
General	1	6	6	38	
College Preparatory	14	18	7	44	
Vocational	1	6	3	19	
Agricultural	0	0	0	0	
Post-High School Education:					<.05
None	3	19	11	69	
Vocational	1	6	0	0	
College	9	56	4	25	
Junior College	3	19	0	0	
Other/Correspondence	0	0	1	6	

P = probability that the observed differences between the factors are due to chance variation

TABLE 11. CORRELATIONS BETWEEN HUMAN RESOURCE FACTORS AND SPEED AND ACCURACY OF TASK PERFORMANCE

Human Resource Factors	462X0 SRAM Technicians n = 64		463X0 SRAM Technicians n = 55	
	Speed	Accuracy	Speed	Accuracy
Age	-.10	-.13	.08	.10
Years of Service	.28*	.24	.17	.34*
Number of Reenlistments	.10	.08	.27*	.26*
Months in Career Field	.25*	.20	.29*	.32*
Months in SRAM	.14	.07	.24	.25
Months on Present Team	-.21	-.22	-.07	.10
Number of Times to Sick Call	-.22	-.22	.01	-.08
Number of Team Sports	-.05	-.11	-.05	-.16
Number of Individual Sports	.14	.08	.28*	.18
Number of Service Clubs	.25*	.20	-.05	.02
Number of Interest Clubs	.26*	.32*	-.01	.08
Trait Anxiety Level	-.36*	-.24	-.32*	-.15
State Anxiety Level	-.15	-.04	.15	.20
Gordon Personal Profile: Sociability	.11	.13	-.11	-.27*
Emotional Stability	.30*	.23	.21	.04
Responsibility	.34*	.29*	.27*	.11
Ascendancy	.28*	.23	.05	.02
Fatigue Symptoms - Trait	-.41*	-.40*	-.05	-.09
Fatigue Symptoms - State	-.29*	-.26*	.12	-.02

TABLE 11. CORRELATIONS BETWEEN HUMAN RESOURCE FACTORS AND SPEED AND ACCURACY OF TASK PERFORMANCE (continued)

Human Resource Factors	462XO SRAM Technicians n = 64		463XO SRAM Technicians n = 55	
	Speed	Accuracy	Speed	Accuracy
LBDQ: Representation	.09	.22	-.08	-.36*
Demand Reconciliation	.10	.18	.16	-.03
Tolerance of Uncertainty	.10	.18	-.04	-.25
Persuasiveness	-.00	.13	.28*	-.06
Initiation of Structure	.10	.22	.18	-.10
Tolerance of Freedom	.15	.26*	.05	-.14
Role Assumption	.11	.21	.14	-.08
Consideration	.03	.13	.15	-.23
Production Emphasis	.02	.14	-.08	-.03
Predictive Accuracy	-.02	.10	.12	-.14
Integration	.07	.19	.06	-.25
Superior Orientation	.09	.21	.16	-.10
Occupational Opinion:				
Air Force Policy and Practices	.19	.27*	.43*	-.01
Assignment Locality	.35*	.39*	.43*	.23
Pay and Benefits	.15	.18	.15	.03
Promotion Opportunities	.20	.28*	.12	-.16
Social Status	.22	.24	.36*	.00
Total	.27*	.34*	.33*	-.03
Organizational Climate:				
Structure	.09	.12	.09	-.09
Responsibility	-.14	-.07	-.21	-.29*
Rewards	.08	.06	.18	-.13
Risk	-.11	-.05	-.06	-.25

TABLE 11. CORRELATIONS BETWEEN HUMAN RESOURCE FACTORS AND SPEED AND ACCURACY OF TASK PERFORMANCE (continued)

Human Resource Factors	462XO SRAM Technicians n = 64		463XO SRAM Technicians n = 55	
	Speed	Accuracy	Speed	Accuracy
Warmth	.27*	.29*	.05	-.24
Support	.06	.08	.20	-.17
Standards	.13	.18	.20	-.14
Conflicts	.10	.11	.07	-.20
Identity	.12	.22	.17	-.23
Group Morale:				
Satisfying Individual Motives	.34*	.41*	.29*	-.07
Homogeneity of Attitude	.30*	.32*	.27*	.08
Satisfaction with Interpersonal Relations	.23	.22	.34*	.00
Satisfaction with Leader	.11	.15	.33*	.00
Total	.33*	.37*	.43*	.03
General AQE Score	.16	.22	.26*	.17
Motivation:				
Job Curiosity	.37*	.46*	.53*	.57*
Persistence	.31*	.37*	.61**	.71**
Professional Identification	.29*	.32*	.42*	.51*
Team Attitude	.16	.24	.41*	.50*
Organizational Identification	.32*	.37*	.38*	.45*
Self-Starter	.12	.23	.43*	.54*
Overall	.29*	.38*	.52*	.61**

*$p \leq .05$, the probability that the values of the coefficients are due to chance variation

**$p \leq .01$, the probability that the values of the coefficients are due to chance variation

to get higher rankings on the performance measures. As technicians perceived group membership to satisfy more of their individual motives, and as they perceived more similarity between group members' attitudes and their own attitudes, they tended to be ranked higher on the performance measures.

A significant negative correlation occurred between trait anxiety level and task performance rankings. Individuals with high levels of trait anxiety, tended to be ranked lower on speed of task performance. Although the correlations between accuracy of task performance and trait anxiety were not significant, they also represented a negative relationship.

The remainder of the correlation coefficients may be interpreted in a manner similar to the preceding interpretations.

Correlation coefficients were also calculated between the human resource factors/biographic variables and task completion time. Since data were available for only a limited number of MSET tasks, these correlations were not interpreted. These results are presented in Table C-1 in Appendix C.

Regression Equations to Predict Task Performance

In the original analysis plan, regression equations were to be developed to predict task errors and task completion times for each of the 11 categories of maintenance subtasks. It was also planned to use these equations in the SAINT computer simulation program developed in the earlier study (Askren et al., 1976) to predict human performance on maintenance tasks. However, the limited amount of time data and the low numbers of technical order, safety and reliability errors reported on the Personnel/Crew Evaluation Reports precluded these analyses.

Consequently, stepwise multiple regression analyses (see Draper & Smith, 1966) were conducted using supervisor rankings of accuracy and speed of task performance as the performance criterion measures. The intent of these analyses was to determine the combinations of human resource factors/biographic variables which were related to and predictive of these performance measures. Since these performance measures were not compatible with the SAINT computer simulation model, no attempt was made to integrate the equations with the SAINT model.

The stepwise multiple regression analyses yielded four equations which predict supervisor rankings of technician performance: (a) accuracy of task performance for the 462X0 SRAM technicians, (b) speed of task performance for the 462X0 SRAM technicians, (c) accuracy of task performance of the 463X0 SRAM technicians, and (d) speed of task performance for the 463X0 SRAM technicians.

Six human resource/biographic factors were found to be predictive of ranked accuracy of task performance for 462X0 technicians. The multiple regression equation resulting from this analysis was:

$$\hat{y} = 14.3824 + .8249X_1 + .3540X_2 - .4368X_3 - .3263X_4 + .3817X_5 - .2338X_6$$

where

$\hat{y}$ = predicted value of supervisor's ranking of accuracy of task performance - 462X0 technician

X_1 = motivation - job curiosity

X_2 = satisfaction with assignment locality

X_3 = motivation - self-starter

X_4 = organizational climate - reward

X_5 = group morale - satisfies individual motives

X_6 = satisfaction with pay

The multiple correlation coeffieient (R) between the six factors and ranked accuracy of task performance was R = .7176. The proportion of variance (R^2) in ranked accuracy of task performance accounted for by the six factors was .5147.

Seven human resource factors/biographic variables were predictive of ranked speed of task performance for 462X0 technicians. The resulting equation was:

$$\hat{y} = 33.1879 - .3193X_1 + .1933X_2 + .2132X_3 + .2456X_4 - .2241X_5 + .2218X_6 + .1702X_7$$

where

$\hat{y}$ = predicted value of supervisor's ranking of speed of task performance - 462X0 technicians

X_1 = number of trait fatigue symptoms

X_2 = satisfaction with assignment locality

X_3 = number of extracurricular service clubs

X_4 = group morale - homogeneity of attitude

X_5 = organizational climate - risk

X_6 = Gordon Personal Profile - ascendancy score

X_7 = number of extracurricular interest clubs

The multiple correlation coefficient (R) between the seven factors and ranked speed of task performance was R = .6743. The proportion of variance (R^2) accounted for in ranked speed of task performance was .4546.

For the 463X0 technicians, the multiple regression equation for predicting ranked accuracy of task performance was:

$$\hat{y} = 13.5316 + .7897X_1 - .3111X_2 + .1991X_3 + .1588X_4$$

where

$\hat{y}$ = predicted value of supervisor's ranking of accuracy of task performance - 463X0 technicians

X_1 = motivation - persistence

X_2 = group morale - satisfaction with leader

X_3 = number of extracurricular interest clubs

X_4 = number of extracurricular individual sports

The multiple correlation coefficient was R = .7802 and R^2 = .6087.

The multiple regression equation for predicting ranked equal speed of task performance for the 463X0 technicians was:

$$\hat{y} = 70.8817 + .6173_1 - .4230X_2 + .3109X_3 - .3353X_4 + .3272X_5 + .2168X_6$$

where

$\hat{y}$ = predicted value of supervisor's ranking of speed of task performance - 463X0 technicians

X_1 = motivation - persistence

X_2 = LBDQ - consideration

X_3 = number of extracurricular interest clubs

X_4 = organizational climate - conflict

X_5 = organizational climate - structure

X_6 = years of service

The multiple correlation coefficient was $R = .7805$ and $R^2 = .6091$.

Stepwise multiple regression analyses were also performed, using task completion time as the performance measure. Since the amount of time data was limited, it restricted these analyses to a small number of MSET tasks. Summaries of these analyses are contained in Table C-2 through C-7 of Appendix C.

Summary of the Human Resource Factor - Task Performance Analyses

Table 12 summarizes the results of the preceding three analyses. Only factors related to task performance as a result of one or more of the preceding analyses are included in the table. The X symbol in the table indicates that a statistically significant ($p \leq .05$ or $p \leq .01$) relationship was found between the human resource variable and supervisor rankings.

Examination of the table reveals the number of times a human resource factor or biographic variable was found significantly related to task performance as a result of twelve separate analyses. Factors which appeared in four or more analyses included extracurricular activities, such as interest and service clubs; trait fatigue; satisfaction with the Air Force in general and satisfaction with assignment locality in particular; group morale measures; months in career field; individual responsibility score; and all the motivation measures.

Evaluation of Human Resource and Equipment/Environmental Factors Across Missile Systems

The missile Maintenance Survey was administered to all SRAM, Minuteman III and GENIE personnel with four objectives: to identify those human and equipment/environmental factors which experienced technicians felt influenced performance; to identify additional factors not identified by the research team; to obtain a preliminary assessment of generalizability of the factors over several missile systems; and to assess the relative influence of human and equipment/environmental factors on task performance.

TABLE 12. SUMMARY OF HUMAN RESOURCE FACTORS RELATED TO TASK PERFORMANCE AS IDENTIFIED BY THREE ANALYSIS TECHNIQUES

Human Resource Factors	High Performer - Low Performer Comparisons				Correlation Analyses				Multiple Regression Analyses				Number of Analyses in which Factor Appeared
	462X0		463X0		462X0		463X0		462X0		463X0		
	A	S	A	S	A	S	A	S	A	S	A	S	
Years of Service						X	X					X	3
Number of Reenlistments							X	X					2
Months in Career Field				X		X	X	X					4
Months in SRAM				X									1
Months on Present Team	X												1
Number of Times to Sick Call	X	X											2
Number of Individual Sports			X					X			X		3
Number of Service Clubs	X	X				X				X			4
Number of Interest Clubs	X				X	X				X	X	X	6
Trait Anxiety Level						X		X					2
State Anxiety Level			X										1
Gordon Personal Profile: Sociability							X						1
Emotional Stability		X				X							2
Responsibility		X			X	X		X					4
Ascendancy		X					X			X			3

TABLE 12. SUMMARY OF HUMAN RESOURCE FACTORS RELATED TO TASK PERFORMANCE AS IDENTIFIED BY THREE ANALYSIS TECHNIQUES (Continued)

Human Resource Factors	High Performer - Low Performer Comparisons				Correlation Analyses				Multiple Regression Analyses				Number of Analyses in which Factor Appeared
	462XO		463XO		462XO		463XO		462XO		463XO		
	A	S	A	S	A	S	A	S	A	S	A	S	
Fatigue Symptoms - Trait	X	X			X	X				X			5
Fatigue Symptoms - State	X				X	X							3
LBDQ: Representation							X						1
Persuasiveness								X					1
Tolerance of Freedom					X								1
Consideration												X	1
Occupational Opinion: Air Force Policy and Practices	X				X			X					3
Assignment Locality	X	X			X	X		X	X	X			7
Pay and Benefits									X				1
Promotion Opportunities	X		X		X								3
Social Status								X					1
Total	X				X	X		X					4
Organizational Climate: Structure												X	1
Responsibility							X						

TABLE 12. SUMMARY OF HUMAN RESOURCE FACTORS RELATED TO TASK PERFORMANCE AS IDENTIFIED BY THREE ANALYSIS TECHNIQUES (Continued)

Human Resource Factors	High Performer - Low Performer Comparisons				Correlation Analyses				Multiple Regression Analyses				Number of Analyses in which Factor Appeared
	462XO		463XO		462XO		463XO		462XO		463XO		
	A	S	A	S	A	S	A	S	A	S	A	S	
Reward									X				1
Risk										X			1
Warmth					X	X							2
Conflict												X	1
Group Morale: Satisfying Individual Motives	X	X			X	X		X	X				6
Homogeneity of Attitude	X				X	X		X		X			5
Satisfaction with Interpersonal Relations								X					1
Satisfaction with Leader								X			X		2
Total	X	X			X	X		X					5
General AQE Score	X							X					2
Motivation Ratings: Job Curiosity	X	X	X	X					X				5
Persistence	X	X	X	X							X	X	6
Professional Identification	X	X	X	X									4
Team Attitude	X	X	X	X									4

TABLE 12 . SUMMARY OF HUMAN RESOURCE FACTORS RELATED TO TASK PERFORMANCE AS IDENTIFIED BY THREE ANALYSIS TECHNIQUES (Continued)

Human Resource Factors	High Performer - Low Performer Comparisons				Correlation Analyses				Multiple Regression Analyses				Number of Analyses in which Factor Appeared
	462X0		463X0		462X0		463X0		462X0		463X0		
	A	S	A	S	A	S	A	S	A	S	A	S	
Organizational Identification	X	X	X	X									4
Self-Starter	X		X	X					X				4
Overall	X	X	X	X									4
High School Curriculum				X									1
Post-High School Curriculum			X	X									2
Marital Status				X									1

A = Supervisor Ranked Accuracy of Task Performance

S = Supervisor Ranked Speed of Task Performance

X = Significant ($p \leq .05$ or $p \leq .01$) Statistical Relationship Found

The mean rating scores for each factor were calculated and rank ordered. The human resource factors were ranked from one (the factor technicians felt most influenced performance) to ten (the factor technicians felt least influenced performance). The nine equipment/environmental factors were similarly ranked. The results of the rankings are contained in Table 13. It can be seen that, for all technicians, the human resource factors of team cohesiveness, emotional stability, and fatigue were rated as having the most influence on task performance. Organizational structure, military morale and attitude, and aptitude were rated as having the least influence on task performance.

It is interesting to note the degree to which the opinion data and the SRAM field data agree in identifying the human resource factors relevant to task performance. Comparisons between the technicians' ratings of several human resource factors and the number of times these factors were found to be related to task performance in the previous analyses give an indication of the extent of agreement between the two sets of data. Team cohesiveness and fatigue were ranked one and three in terms of influence on task performance. These factors were also found to be related to task performance in five or more of the analyses. However, while the opinion data indicated that emotional stability was a human resource factor rated high in terms of influence on performance, measures of emotional stability were related to performance in only one or two of the analyses. Organizational structure and aptitude, rated low in influence on performance were related to performance in only one or two of the analyses. Military morale and attitude also received low ratings from the technicians. However, overall measures of military morale and satisfaction with assignment locality in particular were found to be related to task performance in four and seven analyses, respectively.

For the equipment/environmental factors, equipment reliability, weather conditions, and operation of equipment were rated as having the most influence on performance. Work place size and shape, and clothing types were rated as having the least influence on performance.

Few additional human resource or equipment/environmental factors were identified. The factors which appeared most often and the number of times they were mentioned are presented in Table 14.

To assess the degree of agreement among technicians the human resource factors and equipment/environmental factors were compared among systems, career fields, and bases. Similar rankings among technicians from different systems, career fields or bases would indicate similar opinions on the importance of the influence these factors had on performance. When compared in this manner, the rankings of the human resource and equipment/environmental factors among these groups were essentially similar to the rankings presented in Table 13. Tables 15 through 20 contain the Spearman rank correlation coefficients among the rankings.

TABLE 13. RANKED INFLUENCE OF HUMAN RESOURCE FACTORS AND EQUIPMENT/ ENVIRONMENTAL FACTORS ON MAINTENANCE PERFORMANCE[1]

Human Resource Factors	Rank[2]	Equipment/Environmental Factors	Rank[2]
Team Cohesiveness	1	Equipment Reliabiltiy	1
Emotional Stability	2	Weather Conditions	2
Fatigue	3	Operation of Equipment	3
Systems Training/Experience	4	Technical Orders	4
Leadership	5	Lighting Conditions	5
Motivation	6	Noise Level	6
Career Field Training	7	Equipment Safety Features	7
Organizational Structure	8	Work Place Size/Shape	8
Military Morale/Attitude	9	Clothing Types	9
Aptitude	10		

[1]Data based on opinion data from SRAM, Minuteman and GENIE technicians (n = 230).

[2]Factors ranked 1 had most influence on performance. Factors ranked 9 or 10 had least influence.

TABLE 14. ADDITIONAL FACTORS IDENTIFIED BY MAINTENANCE TECHNICIANS AS HAVING AN INFLUENCE ON MAINTENANCE PERFORMANCE

Factor	Number of Times Mentioned
Military Regulations and Procedures	13
Usefulness of Maintenance Equipment	9
Personal Life	8
Respect and Reinforcement from Superiors	7
Communication Between Supervisor and Technicians	6
Feelings of Self-Accomplishment/Pride	6
Maturity of Technician	6
Fellow Crew Members	6
Cooperation Between Shops	5
Equipment/Parts Availability	5
Shift Work	5
Equipment Serviceability	5

TABLE 15. SPEARMAN RANK CORRELATION COEFFICIENTS FOR RANKINGS OF HUMAN RESOURCE FACTORS OVER MISSILE SYSTEMS

Missile System	SRAM	Minuteman	GENIE
SRAM			
Minuteman	0.794**		
GENIE	0.820**	0.636*	

*p ≤ .05
**p ≤ .01

TABLE 16. SPEARMAN RANK CORRELATION COEFFICIENTS FOR RANKINGS OF EQUIPMENT/ENVIRONMENTAL FACTORS OVER MISSILE SYSTEMS

Missile System	SRAM	Minuteman	GENIE
SRAM			
Minuteman	0.767*		
GENIE	0.783**	0.700*	

*p ≤ .05
**p ≤ .01

TABLE 17. SPEARMAN RANK CORRELATION COEFFICIENTS FOR RANKINGS OF HUMAN RESOURCE FACTORS OVER CAREER FIELDS

Career Field	462X0	463X0	443X0
462X0			
463X0	0.903**		
443X0	0.885**	0.709*	

*p ≤ .05
**p ≤ .01

TABLE 18. SPEARMAN RANK CORRELATION COEFFICIENTS FOR RANKINGS OF EQUIPMENT/ENVIRONMENTAL FACTORS OVER CAREER FIELDS

Career Field	462XO	463XO	443XO
462XO			
463XO	0.542		
443XO	0.717*	0.683*	

*p ≤ .05

TABLE 19. SPEARMAN RANK CORRELATION COEFFICIENTS FOR RANKINGS OF HUMAN RESOURCE FACTORS OVER BASES

Bases	Minot	Grand Forks	Wurtsmith	Kincheloe	K.I. Sawyer
Minot					
Grand Forks	0.964**				
Wurtsmith	0.779*	0.772**			
Kincheloe	0.609**	0.764**	0.924**		
K.I. Sawyer	0.800**	0.591*	0.691*	0.852**	

*p ≤ .05

**p ≤ .01

TABLE 20. SPEARMAN RANK CORRELATION COEFFICIENTS FOR RANKINGS OF EQUIPMENT/ENVIRONMENTAL FACTORS OVER BASES

Bases	Minot	Grand Forks	Wurtsmith	Kincheloe	K.I. Sawyer
Minot					
Grand Forks	0.917**				
Wurtsmith	0.650*	0.783**			
Kincheloe	0.683*	0.783**	0.833**		
K.I. Sawyer	0.733*	0.883**	0.783**	0.583	

*p ≤ .05

**p < .01

Almost all rankings were significantly positively correlated, indicating that regardless of system, career field or base assignment, the technicians agreed on the relative influence the factors had on performance. The probability (p) that the values of these coefficients were due to chance variation is noted in the tables. The rankings for each group are contained in Tables C-8 through C-10 of Appendix C.

Due to apparent misinterpretation of the survey instructions, responses to the items designed to assess the relative influence of human resources versus equipment factors were not usable.

Task Performance Reliability Values

Some additional findings resulted from an examination of the MSET evaluations for the 462X0 SRAM technician. A measure of task performance reliability was calculated for each category of maintenance subtasks. This value was simply a proportion of correctly performed subtasks out of the total number of subtasks attempted. For example, an individual who performed 90 of 100 subtasks correctly would have a task performance reliability value of 0.90.

Since the technical orders for the 462X0 technicians specifically outlined each team member's assigned subtasks, the 462X0 MSET evaluations yielded the most accurate data for calculating these values. Table 21 contains the task performance reliability values for 10 of the 11 categories of maintenance subtasks. Since there were no troubleshooting tasks reported for the 462X0 SRAM technicians, task performance reliability values could not be calculated for this category of maintenance subtasks. The value .9871 represents the task performance reliability value based on all subtasks combined and represents a general task performance reliability value.

Most of the values were less than 1.0, and those values which did equal 1.0 were based on relatively few data points. When confidence intervals were calculated for those categories of subtasks with values less than 1.0, for only two categories of subtasks, align and calibrate/adjust did the upper limit of the confidence interval equal 1.0.

TABLE 21. TASK PERFORMANCE RELIABILITY VALUES[1]

Subtask Category	Number Attempted	Number Correct	Task Performance Reliability Value	Confidence Interval (95%)
Align	785	783	0.9974	1.0000-0.9942
Calibrate/Adjust	427	425	0.9953	1.0000-0.9888
Handle	2332	2309	0.9901	0.9941-0.9861
Inspect	1986	1958	0.9859	0.9911-0.9807
Install	2303	2265	0.9835	0.9887-0.9783
Operate	2690	2664	0.9903	0.9943-0.9863
Remove	2319	2275	0.9801	0.9866-0.9754
Repair	29	29	1.0000	--
Service	160	155	0.9688	0.9957-0.9418
Test	47	47	1.0000	--
Troubleshoot	--	--	--	--
Total - all tasks	13078	12910	0.9871	0.9881-0.9861

[1] Based on data from 287 MSET evaluations of 80 462X0 technicians.

DISCUSSION

The results of this research have identified some of the human resource factors and biographic variables associated with human performance on missile maintenance and handling tasks. It has also produced additional findings in the form of task performance reliability values. The research method, investigating a number of human resource factor/task performance relationships simultaneously, appears to offer a great deal of utility in future work of this kind.

One of the largest obstacles this research had to deal with was the lack of reported task performance errors. Sample data sets provided by the Air Force during early research planning had produced an expectation that sufficient error data would be available.

The absence of error data resulted in an inability to perform many of the planned analyses. It was not possible, for example, to develop predictive equations for performance on each of the 11 maintenance task categories. These equations would have been used in the SAINT computer modeling program described in the earlier study (Askren et al., 1976). Since the equations could not be calculated, it was also not possible to determine if the prediction equations differed among maintenance task categories. Any differences found among these equations could have been used to evaluate the utility of the task classification scheme.

The analyses conducted using the supervisor rankings of accuracy and speed of task performance, however, allowed many of the original goals to be accomplished. The research effort identified those human resource factors and biographic variables related to the various measures of performance. In addition, the nature of the human resource factors and biographic variables related to task performance suggests potential applications for these relationships.

The relationships between supervisor rankings of task performance and several of the human resource factors appear to have potential applications in selection of missile technicians. Based on SRAM technician data, those who attained high scores on the general AQE test, those who have followed a more academically oriented high school curriculum and those who have some post-high school education would be more likely to be ranked in the group of high performers. Other selection criteria could be based on measures of emotional stability such as anxiety level and the ability to handle responsibility. The individual who reports lower trait anxiety levels, higher state anxiety levels and a willingness to assume higher levels of responsibility tends to be ranked higher on task performance. It is recognized that a number of selection procedures and criteria are currently in use for all Air Force personnel. Nevertheless, the

relationships which emerged from these kinds of analyses can serve to validate or supplement current selection procedures and criteria.

The study results also suggest that the human resource factors/performance relationships could have applications for leaders at the squadron level. Motivation, military morale, fatigue, and levels of team cohesiveness were factors related to performance for SRAM personnel in this study. Consideration of these factors at the local squadron level might suggest: squadron policy changes which would be aimed at improving morale; changes in work schedules directed at reducing fatigue; and increased attention to work team selection to improve group morale.

The reader should be cautioned on the interpretation of human resource factors which were not found to be related to task performance. Although an examination of Table 12 could result in research priorities assigned to those factors which appeared in several analyses, the other factors should not be ignored. It would be premature, on the basis of this study, to state that leadership style and organizational climate, for example, were not significantly related to task performance. Certainly, additional research needs to be conducted to establish the validity and generalizability of relationships.

The task performance reliability values seem to have potential application to system safety analyses. The reliability value based on all tasks combined could better represent overall human performance for missile handling tasks. Certainly the human reliability value of 1.0, the value typically used in systems safety analyses, does not accurately reflect the reliability of human performance. It is cautioned that the reliability values reported here should be validated through collection of additional task error data.

Another product of this research effort which seems to have utility for future studies is the research approach itself. This study investigated simultaneously a number of factors and variables which were potentially related to task performance. The fact that this study was in large part exploratory dictated this type of approach. However, it would appear that future research using this approach may well be instrumental in identifying the combinations of human resource factors which are related to task performance, the relative influence of various factors on performance, and the interactions between factors. In multidimensional systems it would appear that taking a multidimensional approach to the investigation of human resource factors which affect performance would be worthwhile.

CONCLUSIONS AND RECOMMENDATIONS

The analysis of the data collected for this research effort indicates that the following conclusions can be made:

1. The comparisons of the high performer and the low performer maintenance technicians indicate that the high performing technician has more experience, a higher aptitude level, is more emotionally stable, reports fewer fatigue symptoms, has higher levels of military morale and tends to be more satisfied with his work group.

2. The correlation analyses indicate that significant positive correlations occur between supervisor rankings of task performance and years in the Air Force, months in career field, ability to handle responsibility, military morale, and group morale. Significant negative correlations occur between rankings of task performance and trait anxiety level, and number of trait fatigue symptoms.

3. Stepwise multiple regression analyses can be used to develop equations which predict task performance. The equations could be used in system safety and performance studies.

4. The summary of analyses, Table 12, indicates those human resource factors which are likely to be related to maintenance task performance. The priorities for future research in this area should be established with consideration given to these findings.

5. Opinion data indicate that missile technicians from three systems, three career fields and five Air Force bases agreed as to the effect of human resource and equipment/environmental factors on task performance. Their opinion was that the human resource factors of team cohesiveness, emotional stability and psychological fatigue had the most influence on task performance. The opinion data also indicate that the equipment/environmental factors of equipment reliability, weather conditions and operation of equipment had the most influence on task performance.

6. The task performance reliability values calculated indicate that human performance in a system analysis study should be represented by a reliability value of less than 1.0. The approach used in this study allows these values to be determined for a variety of tasks.

7. The general research approach appears to have utility for identifying the human resource factors related to performance and for quantifying these relationships.

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TO 21M-AGM69A-2-1 - Organizational Maintenance Instructions -- AGM-69A Missile

APPENDIX A

HUMAN RESOURCE FACTORS MEASUREMENT INSTRUMENTS

BIOGRAPHIC INFORMATION FORM

DATE_____

NAME_____

SOCIAL SECURITY NUMBER ___ - ___ - ____

SHOP CHIEF (Name and Grade)_____

DATE OF BIRTH _____/_____/_____

DATE OF ENLISTMENT _____/_____
Month Year

HOW MANY TIMES HAVE YOU REENLISTED?

0 1 2 3 4 5 6 Over 6

LIST YOUR PRIMARY AFSC_____ DUTY AFSC_____ SECONDARY AFSC_____

WHEN WERE YOU ASSIGNED TO YOUR DUTY AFSC? _____/_____
Month Year

WAS YOUR DUTY AFSC YOUR FIRST CHOICE OF CAREER FIELDS? (Circle One) YES NO

IF POSSIBLE WOULD YOU CHANGE EITHER YOUR DUTY OR PRIMARY AFSC TO ANOTHER CAREER FIELD? YES NO

WHICH NEW CAREER FIELD WOULD YOU CHOOSE? _____

WHEN WERE YOU FIRST ASSIGNED TO SRAM? _____/_____
Month Year

WHICH OTHER BASES HAVE YOU WORKED ON SRAM AND HOW LONG DID YOU WORK AT EACH BASE?

Base	Months
(Current) _____	_____
_____	_____
_____	_____
_____	_____
_____	_____

IF YOU WORK WITH A TEAM, HOW LONG HAVE YOU BEEN WITH YOUR PRESENT TEAM?

_____
Months

ARE YOU: _____Married _____Single _____Divorced _____Widowed (Check one)

NUMBER OF DEPENDENTS? _____

HOW MANY DEPENDENTS PRESENTLY LIVE WITH YOU? _____

DO YOU LIVE: _____In Base Housing

(Check one) _____Off Base

IF YOU LIVE OFF BASE, DO YOU: _____ Rent

_____ Own

DO YOU LIKE YOUR CURRENT LIVING ARRANGEMENTS? YES NO

HOW MANY TIMES DID YOU GO TO SICK CALL IN THE PAST YEAR (Circle one)

NONE 1 2 3 4 5 Over 5

DURING HIGH SCHOOL WHICH CURRICULUM DID YOU FOLLOW?

_____ General _____ Vocational

_____ College Prep. _____ Agricultural

WHAT WAS YOUR OVERALL GRADE POINT AVERAGE?

_____ A _____ C

_____ A-B _____ C-D

_____ B _____ D

_____ B-C _____ Below D

HAVE YOU HAD ANY EDUCATION PAST HIGH SCHOOL (list the type of school: Vocational, College, or Jr. College, and your major)_____

_____

HOW MANY YEARS? _____ DID YOU FINISH? YES NO

IF NO, WHY NOT?_____

LIST ALL THE CLUBS, ORGANIZATIONS, AND SPORTS YOU PARTICIPATED IN PRIOR TO JOINING THE AIR FORCE. (Briefly describe the activity: varsity football, member of radio club, secretary of jr. class) _____

_____

_____

MISSILE MAINTENANCE SURVEY

INTRODUCTION

You are being asked by the Air Force to help them in identifying the human factors which need to be considered in both the design and tional handling of a nuclear weapons system. In other words, you are being asked what factors most influence maintenance performance. This input could have an influence on the way the equipment is designed in the future. The Air Force is interested in providing its technicians with the safest and best possible equipment. In order to do this, better information concerning present operations is needed. Since you perform maintenance and handling operations on nuclear weapons systems every day, you are being asked to share your views with Air Force planners and equipment designers.

In order to provide the information in the form needed for analysis and recommendation, you are asked to follow the questionnaire instructions very carefully.

If you have any questions about any part of the instructions, please ask one of the interviewers before going on.

MPC Survey Control No. 76-126

INSTRUCTIONS

1. There is no time requirement for completing this form. Take your time. Do not rush.

2. If you have a question at any time, please ask the interviewer.

3. The purpose of this survey is to find out your opinion on the extent to which each factor named can have an influence on maintenance performance in the SRAM/Minuteman/Genie system.

4. You are being asked to indicate your opinion by placing an "X" at the point along the line which would best match your feelings about the item being discussed. The way in which this is done is shown in the following example.

Let's suppose you were being asked about vanilla ice cream.
Question a) When you eat ice cream how often do you choose VANILLA?

If you had placed the "X" along the line in the position shown, you would have been saying that most of the time you choose it, but occasionally you might eat another flavor.

Let's look at one more example:
Question b) When you eat ice cream how often do you choose CHOCOLATE?

If you had placed the "X" in the above position, you would be saying that you would rather have some other flavor and that you only choose it once in a while. You will be asked to follow this same procedure in giving your opinions about the influence of certain factors on maintenance performance in SRAM/Minuteman/ Genie operations.

The 10 factors that you will evaluate first are identified below. These factors describe characteristics of people, and for each one, a definition is given. If you would like more information about any of the factors please ask the interviewer.

APTITUDE: The natural ability or talent to do the job.

CAREER FIELD TRAINING AND EXPERIENCE: The amount of training time and job time spent in the AF career field(s).

EMOTIONAL STABILITY: The general level of stress, tension, and anxiety present.

FATIGUE: The subjective feelings of boredom, weariness, and disinclination toward activity.

LEADERSHIP: The styles, patterns of behavior exhibited by the supervisor(s).

MILITARY MORALE AND ATTITUDE: Personal feelings and opinions of the airmen toward the formal military organization.

MOTIVATION: The degree of willingness to start work and keep on working. The amount of effort expended in performing assigned tasks.

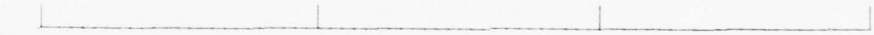
ORGANIZATIONAL STRUCTURE: The "climate" or tone of the squadron in terms of policies, actions, and attitudes handed down to the airmen.

SYSTEMS TRAINING AND EXPERIENCE: The amount of training time and work done in direct connection with the missile system.

TEAM COHESIVENESS: The mutual respect for work team members and degree to which team members want to remain in the same work group.

Please notice that for each of the 10 factors the rating procedure is the same --- each point on the scale has the same description. The meaning along the line is the same: ranging from "not at all influences maintenance performance" at the extreme left to "completely influences maintenance performance" at the extreme right.

The rating line for each of the 10 factors looks like this:



Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

Let's look at one more example. What if the question were this -- Question c) If a THREE STAR GENERAL were closely watching you in your maintenance task, to what extent would this influence your job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

The technician responding in the manner of the example would be telling us -- "You better believe that is going to almost completely influence the way I do my job."

Notice that the technician is <u>not</u> telling us that he will work better or that he will work more poorly -- only that the presence of this condition (the general looking over his shoulder) <u>does</u> <u>influence</u> his performance.

Now -- please consider each of the following questions. Give us YOUR opinion on how much each factor influences maintenance performance.

1. To what extent do you feel APTITUDE influences maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

2. To what extent do you feel CAREER FIELD TRAINING AND EXPERIENCE influences maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

3. To what extent do you feel EMOTIONAL STABILITY influences maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

4. To what extent do you feel FATIGUE influences maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

5. To what extent do you feel LEADERSHIP influences maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

6. To what extent do you feel MILITARY MORALE AND ATTITUDE influences maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

7. To what extent do you feel MOTIVATION influences maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

8. To what extent do you feel ORGANIZATIONAL STRUCTURE influences maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

9. To what extent do you feel SYSTEMS TRAINING AND EXPERIENCE influences maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

10. To what extent do you feel TEAM COHESIVENESS influences maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

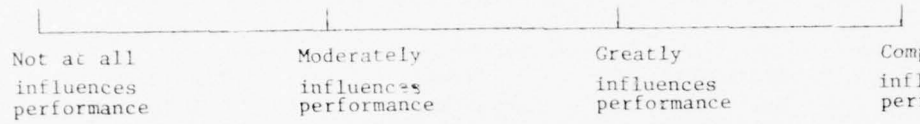
In addition to the factors listed, you may think of some human factors that we did not list which you feel also contribute to maintenance performance. In the space provided below name any such factors and give a brief definition.

11. _____:

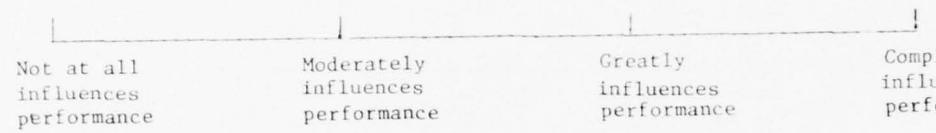
12. _____:

Now, please rate each of these factors (if you listed any) according to how much you feel it influences maintenance job performance.

11. To what extent do you feel _____ influences maintenance job performance?



12. To what extent do you feel _____ influences maintenance job performance?



In addition to the 10-12 factors which describe characteristics of people, other factors, related to conditions and equipment, can play a part in how well a job is done. Some of these factors are:

CLOTHING TYPES: Is bulky clothing or clumsy headgĕar required? How much does the clothing restrict movement?

EQUIPMENT RELIABILITY? Does the equipment work when you need it?

EQUIPMENT SAFETY FEATURES: Are hand holds placed where needed? Are sharp edges on equipment a problem? Are non-slip surfaces placed where you need them?

LIGHTING CONDITIONS: Is there enough light to see what you are doing? Are shadows a problem?

NOISE LEVEL: How disturbing is the noise on the job site?

OPERATION OF EQUIPMENT: Is operating the equipment difficult or easy? How much test equipment and tools have to be used and are they all easy or difficult to operate?

TECH ORDERS: Are the procedures and steps listed in the best order and presented in the best way possible?

WEATHER CONDITIONS: Is the temperature too hot or cold to work effectively? Does the wind, rain, ice, and snow hinder you?

WORK PLACE SIZE AND SHAPE: Is there enough room to work on the equipment? Are all the pieces easily reached?

Other factors like this may be very important to performance of your job. In the space provided below please list and give your definition of important equipment factors we have not included.

_____:

_____:

_____:

If you listed any factors on the lines above, please list them again in the blank spaces provided below at 13, 14, and 15.

13. _____

14. _____

15. _____

16. Clothing Types

17. Equipment Reliability

18. Equipment Safety Features

19. Lighting Conditions

20. Noise Level

21. Operation of Equipment

22. Tech Orders

23. Weather Conditions

24. Work Place Size and Shape

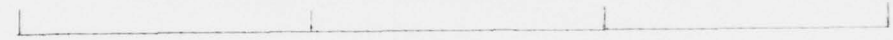
Next, please rate each of the factors listed above in terms of its effect on maintenance job performance. Follow the same procedure you used for the 10-12 previous human factors.

If you did not add any factors in spaces 13, 14, or 15 then start with item 16. If you added any, list them and rate them here.

13. To what extent do you feel _____ influences maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

14. To what extent do you feel _____ influences maintenance job performance?

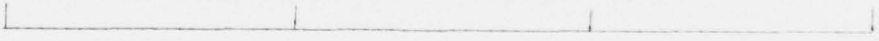


Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

15. To what extent do you feel _____ influences maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

16. To what extent do you feel CLOTHING TYPES influence maintenance job performance?

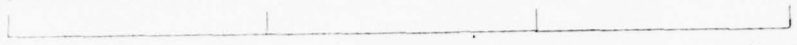


Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

17. To what extent do you feel EQUIPMENT RELIABILITY influences maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

18. To what extent do you feel EQUIPMENT SAFETY FEATURES influence maintenance job performance?



Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

19. To what extent do you feel LIGHTING CONDITIONS influence maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

20. To what extent do you feel NOISE LEVEL influences maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

21. To what extent do you feel OPERATION OF EQUIPMENT influences maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

22. To what extent do you feel TECH ORDERS influence maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

23. To what extent do you feel WEATHER CONDITIONS influence maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

24. To what extent to you feel WORK PLACE SIZE AND SHAPE influences maintenance job performance?

Not at all influences performance	Moderately influences performance	Greatly influences performance	Completely influences performance

Now -- Go back to Items 1 through 12.

Pick the 5 items where you placed the "X" nearest to the extreme RIGHT. List both the ITEM NUMBER and title in the spaces below (example).

C THREE STAR GENERAL

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

Next -- Go back to Items 13 through 24.

From these items pick the 5 where you placed the "X" nearest to the extreme RIGHT. List both the ITEM NUMBER and TITLE in the spaced below.

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

Finally -- Consider ONLY the 10 items you have just written above. Rank the 10 items together in terms of how much you feel each one influences maintenance job performance. Listed below are ranks 1-10 (1 means the factor has the most influence of all factors on maintenance job performance - 10 least influence).

Rank	Factor Number
1	_____
2	_____
3	_____
4	_____
5	_____
6	_____
7	_____
8	_____
9	_____
10	_____

You have now completed this questionnaire. Thank you very much for your cooperation.

SELF-EVALUATION QUESTIONNAIRE FF1

DIRECTIONS: The statements listed below describe the ways people may feel while working. Read each statement and check all those which describe how you generally feel when you are at work.

_____ Can't seem to think
_____ Lack patience
_____ Feel a little hoarse
_____ Have a headache
_____ Feel unsteady on my feet
_____ Body feels generally tired
_____ Can't think clearly; have "cobwebs"
_____ Lack self-confidence
_____ Feel thirsty
_____ Want to lie down
_____ Don't want to talk anymore
_____ Seems hard to sit or stand up straight
_____ Find it hard to breathe
_____ Feel drowsy
_____ Feel sick to my stomach; nauseous
_____ Feel stiff and cramped in the shoulders
_____ Eyelids twitch
_____ Seem to have no interest in things
_____ Feel like yawning
_____ Feel anxious about things
_____ Feel dizzy
_____ Eyes feel strained
_____ Seem to forget things
_____ Legs feel tired
_____ Hard to hold my head up; feels heavy
_____ Arms and legs feel "shaky"
_____ Feel aches and pains in my back
_____ Feel clumsy and rigid when moving around
_____ Unable to concentrate for very long
_____ Feel nervous

SELF-EVALUATION QUESTIONNAIRE FF2

DIRECTIONS: The statements listed below describe the ways people may feel while working. Try to remember back to the last time you were evaluated by the MSET team. Can you recall how you felt that specific day? Read each statement and check all those below which describe the way you feel as if you had just walked in and sat down after an evaluation.

_____ Can't seem to think
_____ Lack patience
_____ Feel a little hoarse
_____ Have a headache
_____ Feel unsteady on my feet
_____ Body feels generally tired
_____ Can't think clearly; have "cobwebs"
_____ Lack self-confidence
_____ Feel thirsty
_____ Want to lie down
_____ Don't want to talk anymore
_____ Seems hard to sit or stand up straight
_____ Find it hard to breathe
_____ Feel drowsy
_____ Feel sick to my stomach; nauseous
_____ Feel stiff and cramped in the shoulders
_____ Eyelids twitch
_____ Seem to have no interest in things
_____ Feel like yawning
_____ Feel anxious about things
_____ Feel dizzy
_____ Eyes feel strained
_____ Seem to forget things
_____ Legs feel tired
_____ Hard to hold my head up; feels heavy
_____ Arms and legs feel "shaky"
_____ Feel aches and pains in my back
_____ Feel clumsy and rigid when moving around
_____ Unable to concentrate for very long
_____ Feel nervous

LEADER BEHAVIOR DESCRIPTION QUESTIONNAIRE - FORM XII SUBSCALES

REPRESENTATION - speaks and acts as the representative of the group. (5 items)

DEMAND RECONCILIATION - reconciles conflicting demands and reduces disorder to system. (5 items)

TOLERANCE OF UNCERTAINTY - is able to tolerate uncertainty and postponement without anxiety or upset. (10 items)

PERSUASIVENESS - uses persuasion and argument effectively; exhibits strong convictions. (10 items)

INITIATION OF STRUCTURE - clearly defines own role, and lets followers know what is expected. (10 items)

TOLERANCE OF FREEDOM - allows followers scope for initiative, decision, and action. (10 items)

ROLE ASSUMPTION - actively exercises the leadership role rather than surrendering leadership to others. (10 items)

CONSIDERATION - regards the comfort, well being, status, and contributions of followers. (10 items)

PRODUCTION EMPHASIS - applies pressure for productive output. (10 items)

PREDICTIVE ACCURACY - exhibits foresight and ability to predict outcomes accurately. (5 items)

INTEGRATION - maintains a closely knit organization; resolves intermember conflicts. (5 items)

SUPERIOR ORIENTATION - maintains cordial relations with superiors; has influence with them; is striving for higher status. (10 items)

ORGANIZATIONAL CLIMATE SCALE DESCRIPTIONS

STRUCTURE - the feeling airmen have about the number of rules, regulations and constraints in the squadron. Is the organization rigid and formal or loose and informal?

RESPONSIBILITY - the feeling of being your own boss and making your own decisions.

REWARD - the feeling of being rewarded for a job well done; that positive rewards rather than punishments are used.

RISK - the sense of riskiness or challenge in the job. Is the emphasis on taking calculated risks or playing it safe?

WARMTH - the feeling of good fellowship in the work group; the emphasis on being well like; the prevalence of friendly, informal social groups.

SUPPORT - perceived helpfulness of supervisors; emphasis on mutual support from above and below.

STANDARDS - perceived importance of implicit and explicit performance goals and standards; emphasis on doing a good job.

CONFLICT - the feeling that supervisors and other workers want to hear different opinions; getting problems out in the open rather than smoothing them over or ignoring them.

IDENTITY - esprit de corp; the feeling that you belong to a squadron and that you are a valuable member of a working team.

ORGANIZATIONAL CLIMATE INVENTORY

DIRECTIONS: You may agree or disagree with each of the following statements. If you strongly agree with the statement, write SA (for Strongly Agree) in the space on the left. If you just agree with the statement, place an A (for Agree) in the space. If you disagree write a D (Disagree), and write an SD if you Strongly Disagree.

_____ 1 The jobs in this squadron are clearly defined and logically structured.
_____ 2 In this squadron it is sometimes unclear who has the formal authority to make a decision.
_____ 3 The policies and organization structure of the squadron have been clearly explained.
_____ 4 Red-tape is kept to a minimum in this squadron.
_____ 5 Excessive rules, administrative details, and red-tape make it difficult for new and original ideas ro receive consideration.
_____ 6 Our productivity sometimes suffers from lack of organization and planning.
_____ 7 In some of the projects I've been on, I haven't been sure exactly who my boss was.
_____ 8 Our management isn't so concerned about formal organization and authority, but concentrates instead on getting the right people together to do the job.
_____ 9 We don't rely too heavily on individual judgment in this squadron; almost everything is double checked.
_____10 Around here management resents your checking everything with them; if you think you've got the right approach you just go ahead.
_____11 Supervision in this squadron is mainly a matter of setting guidelines for your subordinates; you let them take responsibility for the job.
_____12 You won't get ahead in this squadron unless you stick your neck out and try things on your own sometimes.
_____13 Our philosophy emphasizes that people should solve their problems by themselves.
_____14 There are an awful lot of excuses around here when somebody makes a mistake.
_____15 One of the problems in this squadron is that individuals won't take responsibility.
_____16 We have a promotion system here that helps the best man to rise up to the top.
_____17 In this squadron the rewards and encouragements you get usually outweigh the threats and the criticism.
_____18 In this squadron people are rewarded in proportion to the excellence of their job performance.
_____19 There is a great deal of criticism in this squadron.
_____20 There is not enough reward and recognition given in this squadron for doing good work.
_____21 If you make a mistake in this squadron, you will be punished.
_____22 The philosophy of our management is that in the long run we get ahead faster by playing it slow, safe, and sure.
_____23 Our business has been built up by taking calculated risks at the right time.

Page 2 Organizational Climate Inventory

_____24 Decision making in this squadron is too cautious for maximum effectiveness.
_____25 Our management is willing to take a chance on a good idea.
_____26 We have to take some pretty big risks occasionally to keep ahead of the competition in the business we're in.
_____27 A friendly atmosphere prevails among the people in this squadron.
_____28 This squadron is characterized by a relaxed, easy-going working climate.
_____29 It's very hard to get to know people in this squadron.
_____30 People in this squadron tend to be cool and aloof toward each other.
_____31 There is a lot of warmth in the relationships between management and workers in this squadron.
_____32 You don't get much sympathy from higher-ups in this squadron if you make a mistake.
_____33 Management makes an effort to talk with you about your career aspirations within the squadron.
_____34 People in this squadron don't really trust each other enough.
_____35 The philosophy of our management emphasizes the human factor, how people feel, etc.
_____36 When I am on a difficult assignment, I can usually count on getting assistance from my boss and co-workers.
_____37 In this squadron we set very high standards for performance.
_____38 Our management believes that no job is so well done that it couldn't be done better.
_____39 Around here there is a feeling of pressure to continually improve our personal and group performance.
_____40 Management believes that if the people are happy, productivity will take care of itself.
_____41 To get ahead in this squadron it's more important to get along than it is to be a high producer.
_____42 In this squadron people don't seem to take much pride in their performance.
_____43 The best way to make a good impression around here is to steer clear of open arguments and disagreements.
_____44 The attitude of our management is that conflict between competing units and individuals can be very healthy.
_____45 We are encouraged to speak our minds, even if it means disagreeing with our superiors.
_____46 In management meetings the goal is to arrive at a decision as smoothly and quickly as possible.
_____47 People are proud of belonging to this squadron.
_____48 I feel that I am a member of a well functioning team.
_____49 As far as I can see, there isn't very much personal loyalty to the company.
_____50 In this squadron people pretty much look out for their own interests.

OCCUPATIONAL OPINION SCALE

DIRECTIONS: Below are a list of items which ask you to indicate your attitude about specific aspects of your present job. Read each statement carefully and decide whether you are satisfied or dissatisfied with that aspect of your present job. Choose the phrase which best represents your attitude and place your answers in the spaces provided at the left.

Mark ED if you are EXTREMELY DISSATISFIED.
Mark MD if you are MODERATELY DISSATISFIED.
Mark MS if you are MODERATELY SATISFIED
Mark ES if you are EXTREMELY SATISFIED.

_____ 1 The geographical area to which you are assigned
_____ 2 The chance to get ahead on the job
_____ 3 The amount of "red tape" connected with your work
_____ 4 The amount of money you can make in the Air Force
_____ 5 The opportunity for promotions in your career field
_____ 6 The way your unit handles required General Military Training and Physical Fitness testing
_____ 7 Travel (PCS) opportunities for personnel in your specialty
_____ 8 The BX and Commissary facilities at your base
_____ 9 Your pay compared to what you could make on the outside
_____ 10 Your unit's policy for assigning additional duties
_____ 11 Your social position in the Air Force as a result of your job
_____ 12 The way your preferences are considered by your unit
_____ 13 The similarity between your assignment and your assignment preference
_____ 14 Your fringe benefits compared to fringe benefits offered by a civilian job
_____ 15 The adequacy of information you receive about unit policies
_____ 16 The status given a military man by the civilian community
_____ 17 The leave policy of your unit
_____ 18 The relationship between your job performance and chances for promotion
_____ 19 The size of the surrounding community
_____ 20 The retirement income you would receive from an Air Force career
_____ 21 The Weighted Airman Promotion System (WAPS)
_____ 22 The feeling you get from wearing the Air Force uniform
_____ 23 Your promotion opportunities in the Air Force compared to those in a civilian occupation
_____ 24 The consideration given you as a person by the Air Force
_____ 25 The recreational opportunities provided by the surrounding community
_____ 26 The quality of base quarters, barracks, or civilian housing in which you live.

MOTIVATION INDEX

_____
Name of airman to be rated

DIRECTIONS: You are being asked to rate the motivation level of each of your subordinates. One form will be filled out for every individual. Two examples of behavior are given for eacn item. Place an X along the line at the point which best represehts this airman's typical behavior. Your responses are for research purposes only and will not become part of the airman's personnel record. The type of motivation each question is designed to measure is written along each rating scale.

1. When working with the missile, this man would be likely to:

Job Curiosity

seek out information about other parts of the missile and try to find out how his tasks fit into the whole system.

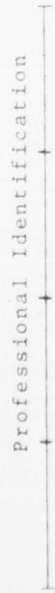
work only on his task and would not care how his work relates to the whole system.

2. While working on a long task, the team ran out of a crucial lubricant and no additional supplies were available in the shop. This man would be likely to:

willingly go to another shop to get the lubricant necessary to complete the job.

use this as an excuse to stop work on the task and leave the problem for someone else.

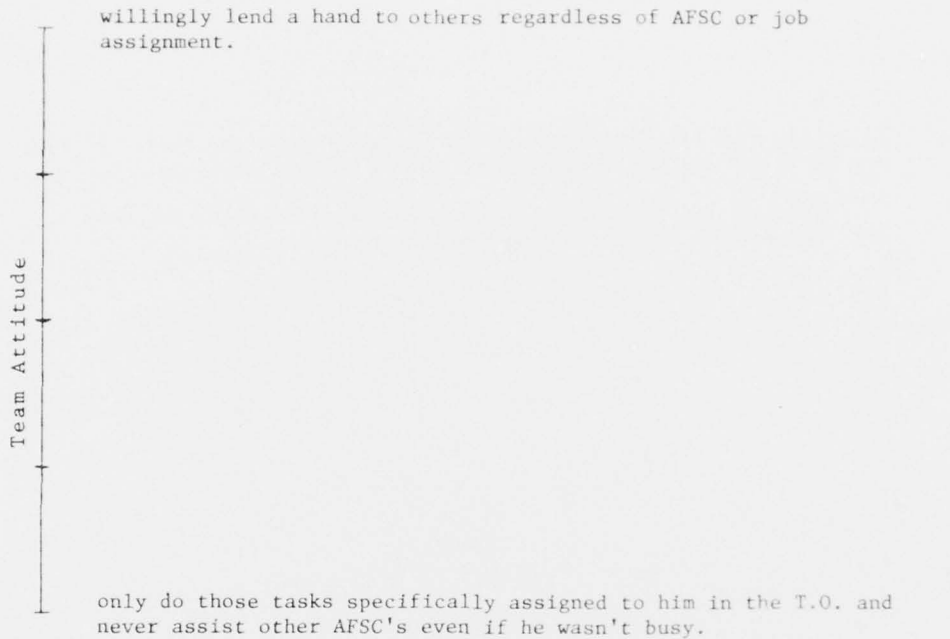
3. This man would be likely to:



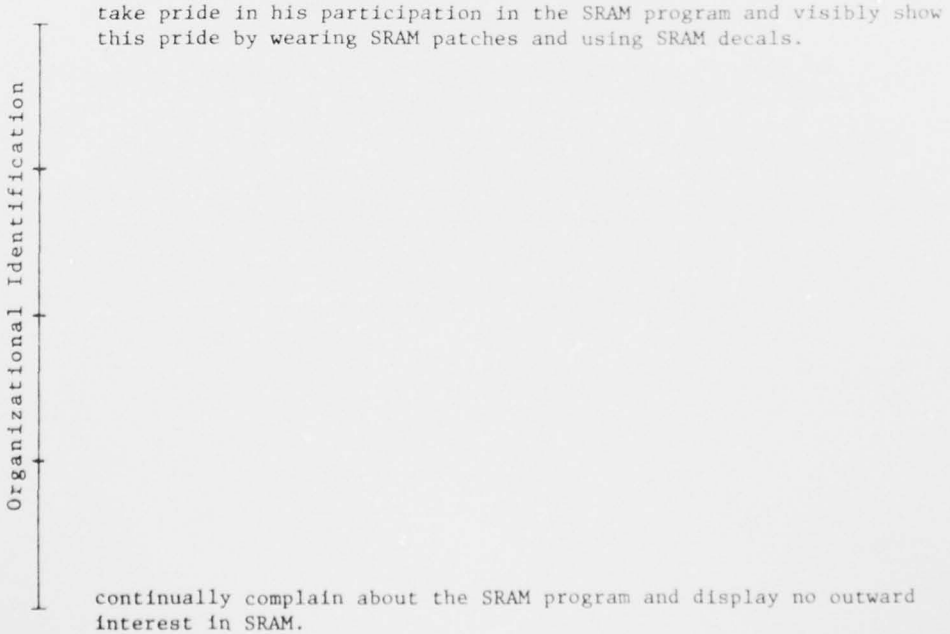
show pride in his AFSC, training, and job, and consider his daily work worthwhile to the Air Force.

consider his AFSC "worthless" and possibly degrading. Also, he would consider his job unnecessary busy work which did not use his talents.

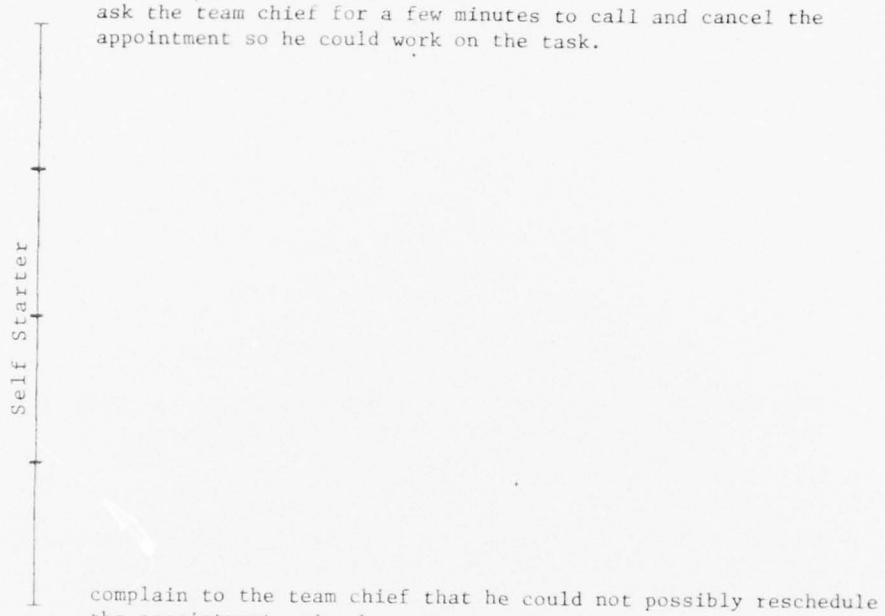
4. When working on a job which could overlap with another AFSC, the man would be likely to:



5. This man would be likely to:



6. An urgent work order has unexpectantly come down to the shop. If this man had a routine dental appointment, he would be likely to:



7. Overall, how would you rate this man's work motivation?

APPENDIX B

TASK PERFORMANCE MEASURES

TABLE B-1. SRAM MSET TASKS FOR 462XO AND 463XO TECHNICIANS

MSET Task Number	MSET Task Title
1101 (A)	Loading B-52 AGM-69 Launcher
1102 (B)	Unloading B-52 AGM-69 Launcher
1105 (A)	Loading B-52 AGM-69 Missile
1106 (B)	Unloading B-52 AGM-69 Missile
1109 (A)	Loading B-52 AGM-69 Payload
1110 (B)	Unloading B-52 AGM-69 Payload
1165 (B)	B-52 AGM-69 Pre-Maintenance
1166 (B)	B-52 AGM-69 Post-Maintenance
1320 (A)	AGM-69 Store Maintenance
1322 (B)	AGM-69 Payload Mate
1323 (B)	AGM-69 Payload Demate
1324 (B)	Mate of Stores to Pylon/Rotary Launcher
1325 (B)	Demate of Stores from Pylon/Rotary Launcher
1455 (B)	MAU-12B/A Ejector Maintenance
1458 (C)	AGM-69 Roll Transfer
1460 (C)	Hydraulic Fluid Level Check (AGM-69)
1461 (C)	Rocket Motor Pressure Check (AGM-69)
1903 (C)	Transfer of Large Diameter Weapons or Warheads, with or without Clip-in Assemblies and Multiple Weapons in Clip-in Assemblies, Revolving Launchers or Pylons to or from a Vehicle or Munitions Trailer.
1905 (C)	Operation of a Cargo or Two Vehicle Loaded with or Towing Nuclear Weapons

PERFORMANCE RANKINGS

A necessary part of our research plan is a performance rank for each individual who completes a questionnaire. Since you have worked with these people and are familiar with their work habits, you are most qualified to rank their performance.

One aspect of performance that we are interested in is speed or how quickly an individual accomplishes a task. To help you rank your subordinates on this aspect of performance, imagine that you must assign one individual to a task in which time is extremely important. The sooner the task is completed the better. Accuracy is secondary. List below, in order of choice (first choice, second choice, third choice, and so on), the people you would assign to this job. After you have ranked all of your men, select one of the following adjectives which would describe their general overall performance on tasks where speed is important. The adjectives are:

Outstanding (O), Very Good (VG), Average (A), Below Average (BA), and Poor (P)

Write the adjective symbol in the blank line to the right of the individual's name.

Performance Rank	Name	Performance Adjective
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Performance Rank	Name	Performance Adjective
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

Another aspect of performance that we are interested in is the quality of the individual's work. We are interested in the accuracy and care an individual puts into his work as well as the reliability of the completed product or task. To help you rank your subordinates on this aspect of performance, imagine that you must assign one individual to a task in which quality, accuracy, and reliability are extremely important. There are no time pressures to complete the task. List below, in order of choice (first choice, second choice, third choice, and so on), the people you would assign to this job. After you have ranked all of your men, select one of the following adjectives which would describe their general overall performance on tasks where accuracy, care, and reliability are important. The adjectives are:

Outstanding (O), Very Good (VG), Average (A), Below Average (BA), and Poor (P)

Write the adjective symbol in the blank to the right of the individual's name.

Performance Rank	Name	Performance Adjective
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

APPENDIX C

SUPPLEMENTARY DATA

TABLE C-1. CORRELATIONS BETWEEN TASK COMPLETION TIME AND HUMAN RESOURCE FACTORS

Human Factors Variables	Task Completion Time For MSET Tasks:					
	1101 n=163	1102 n=49	1322 n=38	1323 n=37	1324 n=36	1325 n=36
Years of Service	-.00	.22	-.06	-.21	.08	.36*
Months in Career Field	.04	.30*	.06	-.15	.15	.39*
Months in SRAM	-.07	.30*	-.13	-.51*	.18	.21
Months on Present Team	.07	-.04	.07	-.39*	.05	.34*
Times at Sick Call	.06	.18	-.13	-.11	.18	-.38*
Number of Team Sports	-.05	-.17	-.07	-.14	.26	.03
Number of Individual Sports	.03	.16	.47*	.43*	.13	.01
Number of Service Clubs	.07	.24	-.42*	-.09	-.08	-.33*
Number of Interest Clubs	.06	.21	-.09	.08	.01	-.08
Trait Anxiety	.12	.27*	-.20	-.20	.00	.07
State Anxiety	.06	.05	.04	-.06	-.12	.14
Gordon Personal Profile:						
Sociability	-.00	-.11	.30	.34*	-.10	.07
Emotional Stability	-.13	-.11	.19	.04	-.14	.01
Responsibility	-.08	-.08	.03	.04	-.10	-.15
Ascendancy	-.06	-.01	.08	.05	-.17	.04
Fatigue Trait	.04	.24	.15	.26	.08	.34*
Fatigue State	.03	.11	.20	.41*	-.16	.27*
LBDQ:						
Representation	-.10	-.17	.24	.28	.07	.15
Reconciliation	-.05	-.03	.26	.30	.56*	.06
Tolerance of Uncertainty	-.09	-.08	.18	.17	.31	-.00
Persuasion	-.07	-.13	.41*	.50*	.42*	.07
Structure	-.13	-.19	.48*	.54*	.44*	.18
Tolerance of Freedom	-.04	.10	.11	.18	-.05	.08
Role Assumption	-.09	-.18	.26	.42*	.50*	.01
Consideration	-.02	.03	.42*	.48*	.28	.11
Production Emphasis	-.10	.03	.60*	.47*	.20	.17
Predictive Accuracy	-.06	.11	.46*	.43*	.49*	.12

TABLE C-1. CORRELATIONS BETWEEN TASK COMPLETION TIME AND HUMAN RESOURCE FACTORS (Continued)

Human Factors Variables	Task Completion Time For MSET Tasks: 1101 n=163	1102 n=49	1322 n=38	1323 n=37	1324 n=36	1325 n=36
Integration	-.07	-.11	.34*	.45*	.47*	.16
Superior Orientation	-.03	.13	.28	.46*	.28*	-.00
Occupational Opinion Scale:						
Air Force Policies	.07	-.04	.25	.35*	-.18	-.39*
Assignment Locality	.00	-.08	.13	.07	-.10	-.16
Pay and Benefits	.11	.00	.02	.19	.17	-.05
Promotional Opportunities	.09	.01	.32*	.41*	.09	-.32*
Social Status	-.09	-.06	.12	.20	-.12	-.32*
Total Score	.07	-.01	.21	.27	.02	-.33*
Organizational Climate:						
Structure	.07	-.00	.36*	.50*	.18	-.14
Responsibility	.03	-.00	.13	.04	-.21	-.18
Reward	.08	-.02	.29	.27	.07	-.16
Risk	-.03	-.05	.03	.05	-.21	-.10
Warmth	.02	-.29*	.36*	.24	-.10	.08
Support	.01	-.17	.30	.31*	-.07	-.07
Standards	.07	-.06	.33*	.15	-.02	.02
Conflict	.08	.15	.19	.18	-.12	-.13
Identify	-.02	-.09	.45*	.36*	.11	-.15
Group Morale Level:						
Satisfies Individual Motives	-.09	-.08	.33*	.29	.07	-.28
Homogeneity of Attitude	-.08	-.24	.14	.21	.02	-.28
Satisfaction with Interpersonal Relations	-.09	-.08	.20	.25	-.13	-.01
Satisfaction with Leader	.06	-.14	.26	.24	.26	.08
Total Score	-.07	-.18	.29	.26	.09	-.13
General AQE Score	-.03	.03	.07	.10	-.26	.06
Motivation Ratings:						
Job Curiosity	.08	-.17	.21	.15	-.17	-.24

TABLE C-1. CORRELATIONS BETWEEN TASK COMPLETION TIME AND HUMAN RESOURCE FACTORS (Continued)

Human Factors Variables	Task Completion Time For MSET Tasks:					
	1101 n=163	1102 n=49	1322 n=38	1323 n=37	1324 n=36	1325 n=36
Persistence	.15	-.00	-.01	.08	.05	-.27
Professional Identity	.09	-.25	.40*	.25	-.06	-.27
Team Attitude	.11	.01	.23	.30	.10	-.46*
Organizational Identity	.02	-.24	.14	.14	.07	-.49*
Self Starter	.06	-.13	.25	.39*	.04	-.37*
Overall	.13	.00	.16	.31*	.06	-.46*
Temperature	.09	.05	--	--	--	--
Age	-.07	-.18	.11	-.06	.20	-.01

* $p \leq .05$

n = the number of MSET evaluations

Definition of terms appearing in Tables C-2 through C-7.

Beta weight. The value by which a predictor variable (human resource factor) is weighted in a multiple regression equation.

R The multiple correlation coefficient between the set of predictor variables (human resource factors) and the criterion variable (task completion time).

R^2 This value represents the proportion of variance in the criterion measure (task completion time) accounted for by the set of predictor variables (human resource factors).

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HUMAN RESOURCE FACTORS AND PERFORMANCE RELATIONSHIPS IN NUCLEAR--ETC(U)
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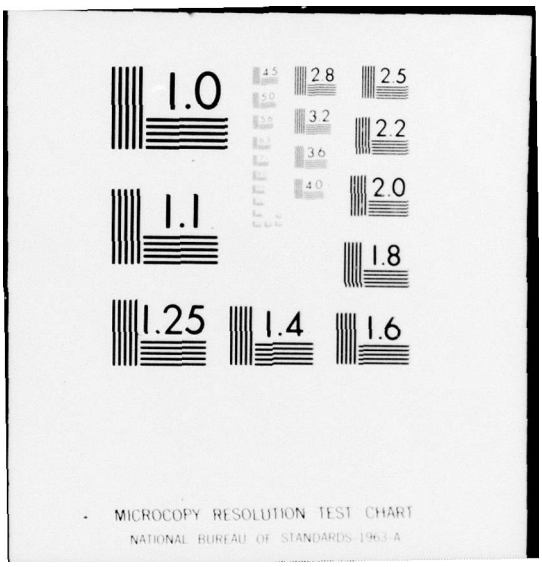
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4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TABLE C-2. HUMAN RESOURCE FACTORS PREDICTIVE OF TIME TO COMPLETE TASK 1101

Human Resource Factors	Beta Weights
Interest Club Officer	0.2516
Occupational Opinion Scale: Pay and Benefits	0.2708
Occupational Opinion Scale: Social Status	-0.2408
Organizational Climate Scale: Reward	0.1649
Group Morale Level: Satisfied with Interpersonal Relations	-0.1405

$R = 0.3618$
$R^2 = 0.1309$

TABLE C-3. HUMAN RESOURCE FACTORS PREDICTIVE OF TIME TO COMPLETE TASK 1102

Human Resource Factors	Beta Weights
Months in SRAM	0.3389
Organizational Climate Scale: Warmth	-0.6592
Organizational Climate Scale: Structure	0.4911
Extracurricular Service Clubs	0.4090
Motivation Ratings: Organizational Identity	-0.1554
Group Morale Level: Satisfied with Interpersonal Relations	0.5145
Group Morale Level: Homogeneity of Attitude	-0.3861

$R = 0.6942$
$R^2 = 0.4819$

TABLE C-4. HUMAN RESOURCE FACTORS PREDICTIVE OF TIME TO COMPLETE TASK 1322

Human Resource Factors	Beta Weights
LBDQ: Production Emphasis	0.7409
Extracurricular Service Clubs	-0.2681
Motivation Ratings: Professional Identity	0.4637
Trait Fatigue	0.2203
Group Morale Level: Satisfied with Individual Motives	-0.3230

$R = 0.8180$
$R^2 = 0.6691$

TABLE C-5. HUMAN RESOURCE FACTORS PREDICTIVE OF TIME TO COMPLETE TASK 1323

Human Resource Factors	Beta Weights
LBDQ: Structure	0.3846
Months in SRAM	-0.3791
State Fatigue	0.2404
Motivation Rating: Job Curiosity	0.3206
Organizational Climate Scale: Structure	0.3887
Organizational Climate Scale: Standards	-0.3111

$R = 0.8330$
$R^2 = 0.6938$

TABLE C-6. HUMAN RESOURCE FACTORS PREDICTIVE OF TIME TO COMPLETE TASK 1324

Human Resource Factors	Beta Weights
LBDQ: Reconciliation	0.6965
LBDQ: Tolerance of Freedom	-0.2764
Extracurricular Team Sports	0.2370

$R = 0.6821$
$R^2 = 0.4652$

TABLE C-7. HUMAN RESOURCE FACTORS PREDICTIVE OF TIME TO COMPLETE TASK 1325

Human Resource Factors	Beta Weights
Motivation Rating: Organizational Identity	-0.5747
Months in Career Field	0.4772
Extracurricular Service Clubs	-0.3308
Trait Fatigue	0.3721
Organizational Climate Scale: Standards	0.4813
Organizational Climate Scale: Responsibility	-0.2655

$R = 0.8695$
$R^2 = 0.7560$

TABLE C-8. RANKINGS OF INFLUENCE OF HUMAN RESOURCE FACTORS AND EQUIPMENT/ENVIRONMENTAL FACTORS ON PERFORMANCE BY MISSILE SYSTEM

Human Resource Factors	Missile System		
	SRAM	GENIE	Minuteman
Aptitude	10	7	10
Career Field Training	7	6	7
Emotional Stability	2	2	6
Fatigue	3	5	1
Leadership	5	8	5
Military Morale and Attitude	9	10	8
Motivation	6	4	4
Organizational Structure	8	9	9
Systems Training and Experience	4	3	2
Team Cohesiveness	1	1	3
Equipment/Environmental Factors			
Clothing Types	9	9	9
Equipment Reliability	1	1	1
Equipment Safety Features	7	8	7
Lighting Conditions	6	2	5
Noise Level	4	5	8
Operation of Equipment	3	4	4
Technical Orders	5	7	3
Weather Conditions	2	3	2
Workplace Size and Shape	8	6	6

Factors ranked 1 had most influence on performance. Factors ranked 10 or 9 had least influence.

TABLE C-9. RANKINGS OF INFLUENCE OF HUMAN RESOURCE FACTORS AND EQUIPMENT/ENVIRONMENTAL FACTORS ON PERFORMANCE BY CAREER FIELDS

Human Resource Factors	Career Fields 462X0	463X0	443X0
Aptitude	10	9	8
Career Field Training	7	7	5
Emotional Stability	2	4	6
Fatigue	3	2	3
Leadership	4	5	7
Military Morale and Attitude	8	10	9
Motivation	6	6	4
Organizational Structure	9	8	10
Systems Training and Experience	5	3	2
Team Cohesiveness	1	1	1
Equipment/Environmental Factors			
Clothing Type	8	9	8
Equipment Reliability	2	1	2
Equipment Safety Features	6	8	6
Lighting Conditions	4	7	5
Noise Level	5	6	9
Operation of Equipment	3	3	4
Technical Orders	7	2	3
Weather Conditions	1	4	1
Workplace Size and Shape	9	5	7

Factors ranked 1 had most influence on performance. Factors ranked 10 or 9 had least influence.

TABLE C-10. RANKINGS OF INFLUENCE OF HUMAN RESOURCE FACTORS AND EQUIPMENT/ENVIRONMENTAL FACTORS ON PERFORMANCE BY BASE

Human Resource Factors	Bases				
	Minot	Grand Forks	Wurtsmith	Kincheloe	K.I. Sawyer
Aptitude	10	10	9	9	10
Career Field Training	7	6	7	6	6
Emotional Stability	6	7	2	2	2
Fatigue	4	3	3	3	3
Leadership	3	4	6	5	4
Military Morale and Attitude	9	8	8	10	9
Motivation	5	5	5	7	8
Organizational Structure	8	9	10	8	5
Systems Training and Experience	2	2	4	4	7
Team Cohesiveness	1	1	1	1	1
Equipment/Environmental Factors					
Clothing Types	9	9	9	9	9
Equipment Reliability	1	1	1	1	3
Equipment Safety Features	8	6	5	6	5
Lighting Conditions	5	5	7	3	7
Noise Level	7	7	3	4	6
Operation of Equipment	4	3	4	5	1
Technical Orders	3	4	6	7	4
Weather Conditions	2	2	2	2	2
Workplace Size and Shape	6	8	8	8	8

Factors ranked 1 had most influence on performance. Factors ranked 10 or 9 had least influence.

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