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APTITUDE REQUIREMENTS BASED ON TASK DIFFICULTY: METHODOLOGY FOR--ETC(U)
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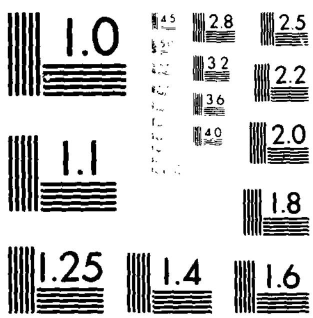

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APTITUDE REQUIREMENTS BASED ON TASK DIFFICULTY METHODOLOGY FOR EVALUATION

By

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The development and application of a technology designed for the evaluation of the difficulty of Air Force jobs in conjunction with the aptitude level required for the job is described. The technology developed makes use of computed variables and task factor data collected by the Air Force Occupational Measurement Center as well as benchmark difficulty data collected by contract personnel experts for the specialties under study. The application of this technology provides a unique method of determining and comparing the learning difficulty of Air Force tasks and jobs, both within and across career specialties. Analyses have indicated high interrater reliabilities for both supervisory and benchmark ratings. A two-variable multiple regression equation was developed for each of the specialties studied. Relatively high correlations were obtained between the two ratings indicating that independent

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raters tend to agree with supervisors. These equations resulted in estimates of average task difficulty per unit time (ATDPUT) values for each job in each specialty. The value of these estimates and implications for their use are discussed.

SUMMARY

Objective

The purpose was to develop and test an objective procedure to determine the relative difficulty of Air Force jobs. Also investigated were (a) the measurement of task difficulty to allow comparability across specialties, (b) the quantitative appraisal of job demands based on component tasks being performed, and (c) the comparability of job difficulty to job aptitude requirement.

Background

The present work is the culmination of a long stream of research and development examining methodologies for systematically determining relative aptitude requirements of Air Force jobs. Such methodologies are needed since there are no empirically based procedures for establishing, adjusting, or verifying the aptitude cutoff score requirements published in Air Force Regulations.

Early research in this area offered substantial support for the use of time-to-learn as a key element in measuring the ability requirements of Air Force jobs. In addition, the level of aptitude required for successful performance of a task was found to be conceptually inseparable from the time required to learn to perform the task at a satisfactory level. Thus, a benchmark scaling technique, in which anchor tasks are used to describe each level on the scale, was developed to measure relative difficulty from which relative aptitude requirements could be inferred. These results may be used by Air Force managers to establish entry-level aptitude requirements and to assign individuals to career specialities more accurately.

Approach

The study was based on task-level specifications of learning difficulty. The specifications were provided by two complementary sources of expert ratings. One source included occupational survey data, that is routinely collected on most Air Force jobs. Such data contain relative ratings of task difficulty collected from knowledgeable supervisory personnel within each specialty. Secondly, contract job analysts provided benchmark ratings of selected tasks across specialties. Collection of benchmark data permitted the development of techniques for calibrating the supervisors' ratings to a standard reference base such that tasks in one specialty could be compared to tasks in other specialties. Data on the relative time spent by job incumbents on each task also were available in the occupational survey data. These data were used to weight the relative difficulty of each task when computing aggregate estimates of learning difficulty for each enlisted specialty.

Specifics

The Comprehensive Occupational Data Analysis Programs (CODAP) package was used for the analysis of task level data. Interrater reliability and correlation techniques were used to assess the agreement among supervisors and job analysts in the ratings of task difficulty. Regression equations were used to calibrate relative ratings on the benchmark scale. The calibrated ratings then were combined with average time-spent data to determine the relative difficulty of individual jobs and specialty groups. The resultant values were designated ATDPUTS (average task difficulty per unit time spent).

Both supervisory ratings and the contract job analyst ratings proved to be highly reliable. In addition, a high degree of relationship was shown between the supervisory ratings and the contract job analyst ratings. The benchmark scales provided a highly reliable means of obtaining task diffculty ratings that were comparable across specialties.

Conclusions/Recommendations

The methodology developed and implemented can be applied objectively to evaluate the relative aptitude requirements of Air Force jobs. Air Force managers now have systematic and empirical data with which to order jobs relative to each other based on the level of talent required. It is recommended that this methodology be considered for use in operational realignment of current aptitude requirements.

PREFACE

The purpose of this research effort was to develop and apply a methodology for the evaluation of aptitude requirements for Air Force enlisted specialties based on task difficulty. This effort was the initial phase of a project in response to RPR 73-17, Minimum Aptitude Requirements for Airmen AFSCs, to derive empirically-based minimum aptitude requirements for Air Force enlisted specialties. The research is in support of the Force Acquisition and Distribution System subthrust, and Manpower and Force Management thrust.

Dr. Raymond E. Christal of the Air Force Human Resources Laboratory (AFHRL) deserves specific credit for the evolution of this research from an original concept for determining aptitude requirements to the development of a complex methodology which allows assessment of the learning difficulty of each individual job in the Air Force. He is due special recognition for working very closely and conscientiously with the authors throughout the period of this report. Acknowledgement is also due Mr. Fred Hart, Kinton, Inc., Alexandria, VA, for leading a very large and complex data collection effort and to Mrs Nancy Perrigo of AFHRL for laying the early groundwork for the project. Special appreciation goes to the Air Force Manpower and Personnel Center Directorate of Personnel Resources and Distribution (AFMPC/MPCR), Utilization Policy and Control Division (AFMPC/MPCRP), and USAF Classification Branch (AFMPC/MPCRPCP) for their long-standing support of this project under RPR 73-17. Finally, this project could not have been successfully completed without the expert programming and seemingly continuous consultation of Mr. Johnny Weissmuller of AFHRL.

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APTITUDE REQUIREMENTS BASED ON TASK DIFFICULTY: METHODOLOGY FOR EVALUATION

I. INTRODUCTION

Eligibility for entry into the various Air Force career ladders is based primarily on the minimum aptitude score cutoff on one or more of the composites of the Armed Services Vocational Aptitude Battery (ASVAB) (AFR 39-1, 1977). There are four ASVAB composites in use by the Air Force: Mechanical, Administrative, General, Electronics. An individual's percentile score on these composites is the principal factor for determining eligibility for entry level jobs. Although this report is primarily a description of methodology and procedure for the evaluation of aptitude requirements, the essential problem being examined is the validity of the relative ordering of assigned ASVAB minimums in comparison with the computed relative order of difficulty of the jobs based on work performed.

The correlation of success in training with aptitude composite scores and the technical school pass/fail rates are the primary data used by the Air Force to set aptitude minimums. Relative correspondence between success in training and each of the aptitude composites is used to establish the aptitude area (M, A, G, or E) for a specific specialty, and the pass/fail rate is used to adjust the minimum cutoff score (Maginnis, Uchima, & Smith, 1975a, 1975b, 1975c). Although this appears to be a valid and empirically based decision logic, there exist some deep-seated problems. The standards for successful completion of courses appear to be arbitrarily set and tend to fluctuate with the number of trainees needed. This problem is further compounded by a training time and aptitude trade-off. That is, an unsuccessful trainee, rather than being washed-out, may be recycled through the same course until a passing score is achieved. Thus, a potential failure has been converted to a successful completion by allowing more time to learn. Christal (1976) presents a detailed description of the problems in the prediction of training success from aptitude test scores.

The consequences of setting appropriate aptitude levels for entry into Air Force specialties (AFSs) go beyond the immediate impact on training outcomes. For example, lowering a requirement from the 80th to the 60th percentile could double the number of eligible volunteers for a particular occupation (Christal, 1974). Inappropriate assignment of aptitude requirements can have a significant impact on job attitudes—individuals assigned to jobs that do not fully utilize their talents tend to experience boredom; individuals assigned to positions requiring more talent than they have tend to experience a sense of frustration (Locke, 1976). Both circumstances can adversely affect absenteeism, retention, and learning rate (Brayfield & Crockett, 1955; Taylor & Weiss, 1972; Waters & Roach, 1971, 1973; Wyatt, Langdon, & Stock, 1937). The data collected in this study go beyond the training school setting and reflect the actual difficulty of a given job in the operational setting.

The overall objective of the present effort was to design, develop, and test a methodology that could be applied effectively and objectively to determine the relative difficulty of Air Force jobs. The two major sub-objectives were to develop procedures for (a) the measurement of task difficulty such that tasks would be comparable across specialties and (b) the quantitative appraisal of job demands based on component tasks being performed.

II. APPROACH

Conceptual Framework

Empirical data are not necessary to realize that there is tremendous variance both in job demand levels and in individual learning rates. It is not difficult to imagine some AFSs in which those airmen with the lowest aptitude (the slowest learners) can perform very successfully after only a short training period. On the other hand, there are also AFSs in which the airmen with the highest aptitude (the fastest learners) must undergo extensive on-the-job training even after long periods (30 or more weeks) of formal training. The need to determine the relationship between aptitude and learning time has become more acute as has the necessity of defending empirically the aptitude levels that are set as occupation entry requirements.

Several educational researchers offer support for the use of time-to-learn as a key element in measuring the ability requirements of Air Force jobs. Aptitude can be looked at as something that results in an individual being ready to learn "rapidly" in a specific situation (Cronbach & Snow, 1977). Furthermore, Cronbach and Snow claim that students will likely differ in the time they require to learn, given the same material and instructional procedures. Recent documentation by Gettinger and White (1979) offers additional evidence in support of time-to-learn as a predictor of achievement and aptitude. These authors indicate that the time-to-learn concept makes no assumptions about the intelligence required to perform a task, but deals only with performance under natural conditions. This literature in addition to earlier work by Carroll (in Block & Anderson, 1975; in Cronbach & Snow, 1977; and in Krumboltz, 1965) provides strong support for the integration of the time-to-learn concept into the Air Force classification and assignment systems.

The Air Force Human Resources Laboratory (AFHRL) has been conducting research into this problem for several years. The methodology discussed in this report has greatly benefited and evolved from previous work conducted by Christal (1974) and Fugill (1971, 1972a, 1972b, 1973) in developing the Air Force job inventory methodology and investigating the area of task difficulty and benchmark scale use. The approach was based on task level specifications of learning difficulty provided by two complementary sources of expert ratings: (a) knowledgeable supervisory personnel within each specialty provided relative ratings of task difficulty, and (b) contract job analysts provided benchmark ratings of selected tasks across specialties. Access to the benchmark ratings permitted the development of techniques for calibrating the relative ratings to a standard reference base and for generating aggregate estimates of learning difficulty for every enlisted specialty in the Air Force.

Task Difficulty

The concept of task difficulty was operationally defined in terms of the time it takes to learn to do a task satisfactorily. Fugill (1971) demonstrated that in spite of the complexity of the concept, highly reliable ratings of relative task difficulty, as defined above, could be obtained from supervisory job incumbents from a given career field. Fugill's (1972b) research consistently demonstrated a high relationship ($r = .89$) between time-to-learn (task difficulty) and task aptitude, "the level of aptitude required to insure satisfactory performance of a given task" (p. 1). The aptitude requirements research documented in this report has proceeded on the basis that the aptitude level required to learn a job can be inferred from a measurement of the average difficulty of that job. This assumption is primarily based on Fugill's (1972b) conclusion that relative task aptitude is conceptually inseparable from relative task difficulty when difficulty is measured in terms of the time needed to learn to perform a task satisfactorily.

Occupational Survey Data Base

The basic data used in the identification of tasks for the estimation of task/job difficulty indices came from the occupational survey data routinely collected by the USAF Occupational Measurement Center. Briefly, the job inventories used in the periodic occupational surveys of Air Force jobs are developed by creating a duty outline and a listing of task statements based on job descriptions, course training standards, and other published materials (Christal, 1974). Tasks are then organized within duty categories and the task list revised based on work-site observation of the job and input from technical specialists. When finalized, the job inventory is administered to job incumbents within the specialty to collect information about the relative amount of work-time spent on the tasks which they perform, using a 1-9 point scale ranging from "A Very Small Amount" to "A Very Large Amount." These data are compiled in a computer-generated job description to provide, among other information, an estimation of the percentage of incumbents who perform each task and the average percentage of time spent on each task by those in the specialty who perform it. This same information can be reported for any group of individuals who can be defined by available background variables such as time in service, grade, education, and time in job.

The same duty/task list is administered to supervisors who are asked to rate the tasks on task difficulty, based on how much time is required to learn the task, using a 1-9 point scale ranging from "A Very Small Amount" to "A Very Large Amount." These ratings are compiled to give an estimate of the task difficulty of each task compared with other tasks in the inventory.

Analytic Techniques

The Comprehensive Occupational Data Analysis Programs (CODAP) package developed by AFHRL (Christal, 1974; Morsh, Madden, & Christal, 1961) was the data analytic tool used for this research. The CODAP system was ideally suited for this type of analysis. Computer analysis of all rating data began with the measurement of the degree of interrater agreement among all raters, computed using the intra-class correlation coefficient (R_{11}) described by Haggard (1958) and Lindquist (1953). This reliability coefficient is a measure of the interclass correlation among raters. As discussed in Guilford and Fruchter (1973), each coefficient (R_{11}), taken to be an indication of the reliability of a single rater's ratings, can be used to infer the reliability of a group of raters (R_{kk}) (p. 264). By averaging each set of ratings across the number of raters rating each task, group reliability coefficients (R_{kk}) for all measures can be computed.[1] The interrater reliability coefficient as applied to task factor ratings is described by Goody (1976) and Thomson and Goody (1979). In addition, correlation/regression techniques, the calculation of average task ratings across raters, and the generation of adjusted task difficulty values based on the benchmark equations were used in the specific analyses for task ratings. The analytic techniques are further discussed in the description of procedures to develop task and job difficulty indices.

III. DETERMINATION OF TASK DIFFICULTY

Development of Benchmark Scales

Ratings of task difficulty within specialties, as routinely obtained in conjunction with occupational surveys, are useful in comparing the relative difficulty for tasks and jobs within career ladders. However, a method was needed for comparing difficulty and aptitude levels for tasks across career ladders.

The use of benchmark scales provides very reliable ratings of task difficulty which allow for comparisons of the relative difficulty of tasks not only within a given specialty but also across any number of specialties measured by the same benchmark scale. The benchmark scale is used as a standard reference for calibrating ratings obtained within specialties so as to be comparable across all specialties in an aptitude area. The feasibility of using benchmark scales to measure task difficulty was demonstrated by Fugill (1971, 1972a, 1972b) and further discussed by Fugill (1973) and Christal (1974). Peters and McCormick (1966), in a comparative study, obtained results which demonstrated that task-anchored (benchmark) scales resulted in more reliable ratings of several job factors than did numerically anchored scales.

Considerable thought was given to the number of points to be employed on the benchmark scale. Lissitz and Green (1975) briefly reviewed the literature in this area and found no conclusive evidence to support any specific number of rating points. Research on time-spent scales by Carpenter, Giorgia, and McFarland (1975) suggests that there is little difference in reliability but a potential increase in validity with an increase in the number of rating options from 7 to 9 to 25 and even to 100 points. These results in conjunction with research by Christal and Madden (1960) and Madden (1960, 1961) on the importance of familiarity in evaluative judgments in job evaluation directed this research to a 25-point benchmark scale on which the rater would be carefully trained, on both the tasks anchoring the scale and the tasks to be rated, prior to applying the scale.

Electronics, Mechanical, and General/Administrative Benchmark Scales

Task difficulty benchmark scales were developed separately for the Electronics, Mechanical, and General/Administrative aptitude areas as differentiated by the ASVAB. For a given aptitude area, a set of 15 specialties was selected which best represented aptitude area complexity and provided a variety of tasks from which benchmark tasks could be selected. All specialties used in the development of the benchmark scales are shown in Appendix A.

Table 1 provides a summary of interrater reliability statistics for the relative difficulty ratings collected from specialties used in the benchmark scale development. Using a distribution of these ratings and the criteria outlined in Table 2, 40 tasks were selected from each specialty to develop a set of 600 benchmark tasks in the Mechanical

[1] Guilford and Fr[illegible]ter (197[illegible], p [illegible]) explain how the R_{kk} can be computed from an R_{11} and k raters.

and Electronics aptitude areas. For the general benchmark scale, 60 tasks were selected from each of the 15 specialties to produce a 900-task list. For purposes of discussion, only the 600-task lists will be referenced although essentially the same procedures were followed with the 900 tasks in the General benchmark pool. (See Appendix A for complete interrater reliability statistics.)

Table 1. **Summary of Within-Specialty Interrater Reliability (R_{kk}) Indices for Specialties used in Development Phase**

Aptitude Area	Range of R_{kk}	Median R_{kk}	N AFS	Mean Number of Raters
General/Administrative	.94 - .98	.960	15	63.4
Mechanical	.88 - .97	.942	15	68.9
Electronics	.93 - .99	.955	15	64.7

Note. For all within-specialty ratings, the average number of raters per task (k) ranged from 20 to 100.

Table 2. **Benchmark Task Selection Criteria**

1. Eliminate supervisory tasks
2. Capture range of difficulty
3. Select on high rater agreement (Low SD)
4. Select tasks performed by first-termers
5. Select well known tasks
6. Select easily observed tasks
7. Select on high face validity

A panel of 8 to 14 job analysts was convened for each aptitude area. The panels, which consisted of contract personnel considered expert in the aptitude area, obtained detailed task level information from technical school instructors and job incumbents, and observed task performance at approximately 10 operational locations for each aptitude area. After gaining familiarity with each task in the list, each panel member provided an independent rank-ordering of the 600 tasks, placing the task which required the least learning time at number 1 and the task requiring the greatest learning time at number 600. The final rankings represent the relative ordering of the 600 tasks on the dimension of learning time, without regard to AFS. Interrater reliability estimates for the rank ordering among judges for each aptitude area are given in Table 3. In all, for the three aptitude areas, 2,100 tasks were independently rank-ordered by a team of 8 to 14 raters, resulting in approximately 21,000 rank-order estimates.

Table 3. **Interrater Reliability (R_{kk}) for Rank Ordering of Aptitude Area Benchmark Tasks**

Aptitude Area	R_{kk}	N Tasks	N AFS	N Raters/ Specialty
General/Administrative	.96	900	15	12
Mechanical	.97	600	15	8
Electronics	.96	600	15	8

Note. For all rank ordering, the average number of raters per task (k) was equal to N raters.

The ranking procedure used was one in which the judges made pair-wise comparisons of tasks on which they were considered expert. This procedure resulted in a rank-ordered list of tasks which, it was felt, more accurately captured the variance of the difficulty of the tasks than would a 9-point rating system. However, the resulting distribution was understandably rectangular in shape and thus did not lend itself to the development of a benchmark scale with equal intervals. The solution to this problem was based on the collection of 9-point supervisory ratings of the 600 selected tasks. These relative ratings were collected from approximately 50 supervisors from each of the 15 specialties who rated every task in the list, not just those selected from their specialty. The resulting distribution from these ratings approximated a normal curve. An equal percentile conversion program in the CODAP package was used to convert the task distribution preserving the order from the ranking procedure into the normal distribution obtained from the rating procedure. This converted distribution was used to develop a close approximation of an equal-interval benchmark scale.

Based on the panel rankings and the supervisory ratings of the 600 benchmark tasks, two tasks were selected to represent each of the learning difficulty levels of a 25-point scale. The distribution of the mean ranks of the 600 tasks was divided into 25 equal intervals. Tasks were selected which were close to each interval midpoint value and for which the standard deviations of both the within-specialty ratings and the contractor rankings were relatively low, indicating that both sets of judges agreed on the difficulty level. Tasks were chosen which were widely known or frequently performed, and not unique to a single specialty. The final criterion, face validity, was especially important in the task selection process inasmuch as these tasks were to be used as examples that would anchor the various points on the benchmark scales. (See Appendix B for complete benchmark scales.)

Procedural Guides

Accurate application of the benchmark scales requires detailed knowledge of the benchmark tasks as well as the tasks being rated. A procedural guide was developed for each scale describing the benchmark tasks. This guide was developed for the use of the panel of expert raters who would apply the scales.

There are two parts to the procedural guides: Part I introduces each panel member to the task of assessing learning difficulty and rating the tasks; Part II presents the 25-point scale and provides a one-page description of each of the 50 tasks on the scale. This description includes the scaled task difficulty level, the task title, the specialty from which it was selected, a narrative description of any specific equipment associated with the task, a narrative describing the task performance, and an explanation of the skills and knowledge required to learn the task. Examples from the Mechanical Procedural Guide are included in Appendix C.

Task Rating Using the Benchmark Scales

The benchmark scales and procedural guides were developed to provide task ratings which were comparable both within and across specialties within an aptitude area. In order to obtain such information, it was necessary to apply the same benchmark scale to all specialties in an aptitude area. This was accomplished by comparing a carefully selected subset of tasks from each specialty to be assessed with the tasks on the appropriate benchmark scale and assigning the respective rating to each task in the subset. Regression techniques were then used to estimate the difficulty of the remaining tasks in the job inventory from the data available from the subset of tasks.

Using criteria similar to those used in the selection of the benchmark sets (Table 2), 60 tasks were selected from each remaining specialty in the aptitude area for evaluation by the contract job analysts using the benchmark scales. Specialties used in the application of the benchmark scales are indicated in Appendix A. In the application phase, 102 specialties were evaluated, approximately 34 technical school and 64 operational site visits were made, and approximately 6,100 tasks were rated by 12 to 14 raters, resulting in over 79,000 ratings. Again, each task selected was studied in depth at the appropriate technical school, as well as at two or more operational work sites, by a panel of aptitude area experts. Panels consisted of 12 to 14 members, with two independent teams of six or seven analysts observing the same tasks at separate locations. After accumulating considerable information about each task, the panel members independently provided benchmark difficulty ratings on the 60 selected tasks from each specialty using the appropriate benchmark scale. Interrater reliability statistics for these ratings are summarized in Table 4. Complete rater reliability statistics on the tasks for all specialties studied are given in Appendix A.

Table 4. **Summary of Benchmark Rating Interrater Reliability (R_{kk}) Indices for Specialties Used in Application Phase**

Aptitude Area	Range of R_{kk}	Median R_{kk}	N AFS	Mean Number of Raters
General/Administrative	.87 - .98	.95	55	14.0
Mechanical	.88 - .98	.95	25	13.2
Electronics	.92 - .98	.95	22	12.5

Calibration of Supervisory Estimates to the Benchmark Scale

The benchmark ratings of the sample of 60 tasks within each specialty were used to estimate the relative task difficulty of all tasks in a specialty using standard regression analysis. The use of the benchmark scales allows a task difficulty value to be estimated for every task in the inventory for the AFS under consideration. This value, in turn, provides the means by which tasks and individual jobs can be compared not only in relation to other tasks and jobs within the same specialty, but also relative to tasks in other specialties within the same aptitude area. A separate regression equation was used for each AFS, as the relationship between the expert ratings and relative ratings was unique for each specialty.

The benchmark difficulty ratings and the supervisory difficulty ratings of the same 60 tasks were input as the dependent and independent variables, respectively, in a two-variable linear regression problem for each specialty. The equation took the following form:

$$(Y' = a + bx)$$

where: Y' is adjusted task difficulty
a is a constant
b is a regression coefficient
x is a composite supervisory rating of relative task difficulty

The resulting equations were then applied to the supervisory ratings of all tasks in the specialties and an adjusted difficulty rating was estimated for each task. In all, adjusted difficulty ratings were estimated for approximately 75,000 tasks.

Summary Results of Task Difficulty Assessment

The reliability and validity of the data gathered in this effort were investigated to insure that overall methodology was sound. Single rater reliability coefficients (R_{11}) for all measures ranged from .19 to .71. Group reliability coefficients (R_{kk}) for all measures ranged from .86 to .98. (See Appendix A for complete reliability statistics.) Preliminary investigation has shown that the range of reliability estimates is largely determined by the high variability of task learning difficulty across differences in aircraft, equipment, or commands. Additional research is currently being conducted to determine the reasons for instances of low interrater agreement.

As shown in Table 5, correlations between the benchmark ratings by the two independent teams of raters ranged from .36 to .94 with a median of .79. Investigation of the range of these team 1-team 2 correlations further emphasizes the great deal of variability in the individual task difficulty levels. In the specialties for which the interteam correlations were low, there is evidence that conflicting information was gathered from the operational sites due to differences in equipment, automation of jobs, or mission requirements. The sensitivity of the work area experts to these differences in sites provides additional credibility to the data collection procedures.

Table 5. **Summary of Correlations between Team 1 and Team 2 Ratings**

Aptitude Area	Range of r	Median r	N[a] AFS
General/Administrative	.36 - .91	.75	55
Mechanical	.68 - .94	.82	23
Electronics	.65 - .90	.80	15

[a]Number of AFSs differ from Table 4 because two teams were not used in benchmark rating of all AFSs.

Evidence of concurrent validity of the data collected using the task difficulty benchmark scales is provided by correlations between the average within-specialty ratings collected from incumbent supervisors and the average benchmark ratings collected from aptitude area experts. As shown in Table 6, the correlations between these variables ranged from .54 to .94 with a median of .80 for all specialties studied in the three aptitude areas (N = 147). These relationships offer support for the data collection methodology and the benchmark scaling procedure. The evidence indicates that the difficulty predictions from benchmark data represent a measure of the difficulty of a task which can be compared across as well as within specialties in the same aptitude area. Complete correlational statistics, summarized in Tables 5 and 6, are included in Appendix A.

Table 6. **Summary of Correlations between Within-Specialty Ratings and Benchmark Ratings**

Phase/Aptitude Area	Range of r	Median r	N AFS	N Tasks/AFS
Development Phase				
General/Administrative	.71 - .89	.81	15	60
Mechanical	.57 - .91	.77	15	40
Electronics	.81 - .95	.88	15	40
Application Phase				
General/Admin	.54 - .95	.77	55	60
Mechanical	.58 - .88	.81	25	60
Electronics	.54 - .89	.84	22	60

IV. DETERMINATION OF JOB DIFFICULTY

Conversion of task difficulty into job difficulty was found to be more complicated than a simple average of the difficulties of the tasks comprising the job. A job can be difficult for a variety of reasons such as number of tasks, conditions under which the tasks are performed, variety of tasks, difficulty of tasks, and the amount of time spent on the various tasks performed. The variety of tasks and the environmental conditions of performance did not lend themselves to quantification. The number of tasks performed as a measure of job difficulty was found to be somewhat misleading, especially in comparisons of jobs containing few very difficult tasks with jobs containing many simple tasks. Job difficulty was determined to be best estimated as a function of the difficulty of the tasks comprising the job and the time spent on those tasks.

Average Task Difficulty Per Unit Time - ATDPUT

The collection and analysis of task difficulty data have been described previously. Time-spent data for randomly selected job incumbents in all Air Force specialties has been routinely collected and analyzed by the Air Force Occupational Measurement Center for the past several years. These data are maintained in a computer data bank and were made available for this study. In collecting these data, job incumbents are required to identify those tasks which comprise his or her job and then indicate, using relative time-spent ratings, the relative time spent on each task performed compared to all other tasks performed (Carpenter, Giorgia, & McFarland, 1975). The data from these ratings are analyzed with the CODAP package. The relative time-spent ratings provided by the job incumbents are summed and the rating for each task performed is divided by the sum of all ratings, thus computing a percentage time-spent variable. Previous research has indicated that the relative time-spent format results in highly reliable self-estimates of the percentage of time spent on the various tasks performed in a worker's job (Christal, 1974).

Job difficulty for an individual position was estimated by combining the predicted task difficulty values, determined from the previous analyses, with the percent time-spent estimates to form a new computed variable, Average Task Difficulty Per Unit Time (ATDPUT). ATDPUT is simply the cross-product of percentage time-spent and task difficulty summed across all tasks in the inventory for an individual job.[2] ATDPUT can be computed for any group of individuals (e.g., specialty members with 1 to 48 months of service) by summing each individual's ATDPUT value and dividing by the number of individuals in the group. The CODAP package can be used to compute ATDPUT values for any specified group. Using the ATDPUT value, the difficulty level of individual jobs or job types can be compared to any other within the same aptitude area based on the relative time spent and difficulty of each task.

The relative ranking of specialties from each aptitude area on the ATDPUT value indicates the relative difficulty level of specialties within the Air Force. Figure 1 shows a sample of specialties from the General/Administrative aptitude areas ranked on ATDPUT value for enlisted personnel with 1 to 48 months of military service and their current ASVAB cutoff scores. A comparison of the relative rankings of the ATDPUT values with the ordering of the ASVAB cutoff scores indicates a degree of misalignment of aptitude requirements. Specifically, Figure 1 suggests that some specialties currently assigned a high minimum aptitude requirement may, in fact, have a lower level of difficulty than other specialties assigned a lower minimum aptitude requirement. Other specialties were found to cover a wide range of difficulty levels (indicated by the length of the horizontal lines in Figure 1), suggesting that the specialty might be divided into several different jobs.

[2]ATDPUT values are multiplied by 100 to eliminate decimals and, thus, simplify reporting.

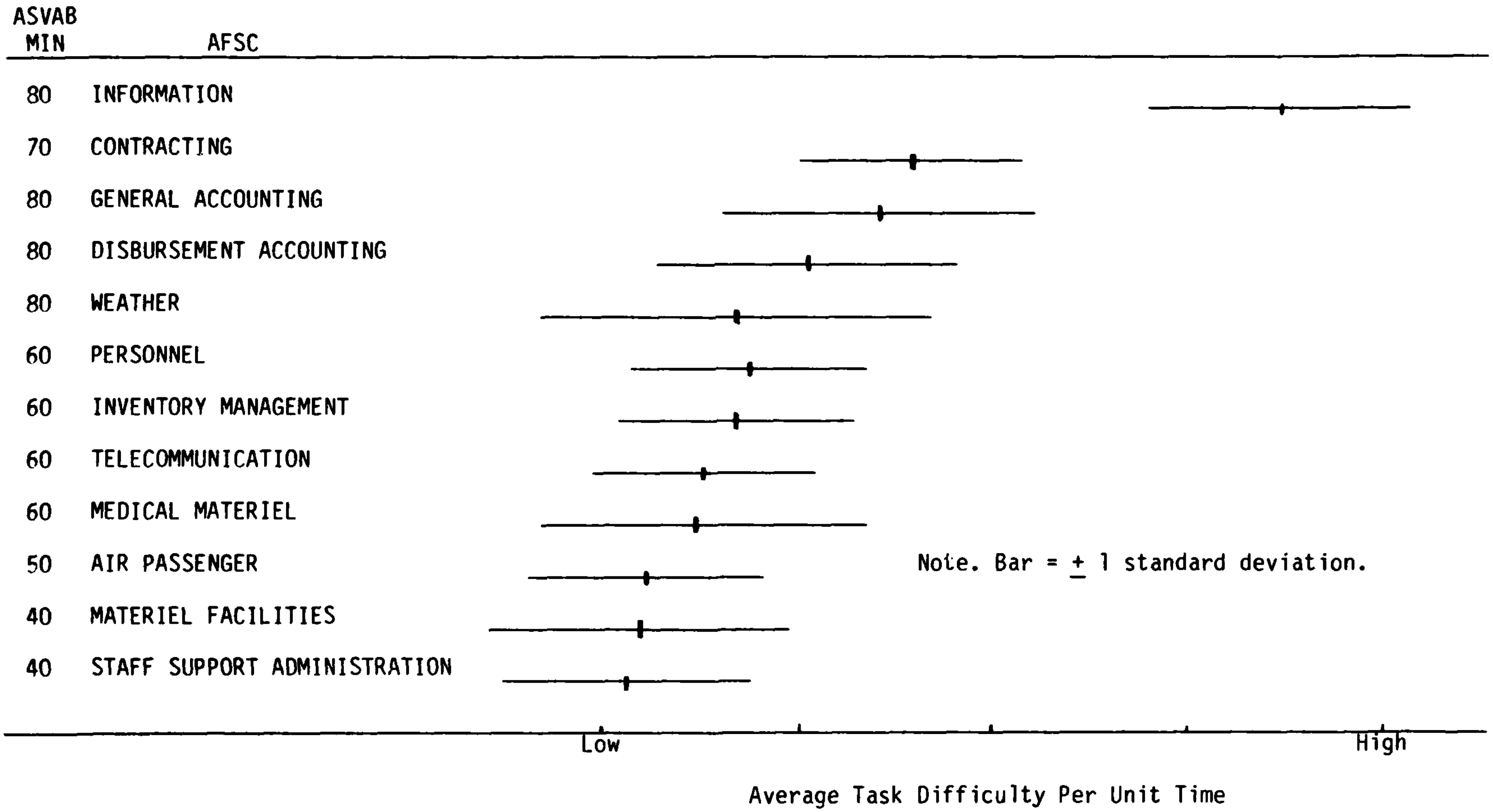

Figure 1. Relative aptitude requirements for entry level jobs.

V. DISCUSSION

The methodology developed and implemented in this research can effectively and objectively be applied to evaluate the relative aptitude requirements of Air Force jobs in a particular aptitude area. Results have been obtained to substantiate both the reliability and the validity of this methodology. The methodology has been applied to Air Force jobs across four aptitude areas. The actual realignment of aptitude requirements is a complex task which will be reported in a forthcoming report; however, in this methodology the Air Force now has a valuable tool for management and classification. For the first time, managers have systematic, empirical data with which to order jobs relative to each other based on the level of talent required. Managers now have the means to determine *empirically* the relative level of difficulty associated with newly developed jobs prior to setting an aptitude score minimum. The availability of the means by which these decisions can be made has far-reaching implications for the Air Force manpower and personnel community.

The implications of the present study for the Air Force classification system are particularly relevant. The Air Force currently classifies a majority of enlistees at the Armed Forces Examining and Entrance Stations via a Person-Job-Match (PJM) algorithm (Hendrix, Ward, Pina, & Haney, 1979). The PJM system determines which specialty to offer each potential applicant. Within this algorithm, there is a job difficulty-aptitude interaction term which increases the likelihood of an offer of a specialty when there is high similarity between job difficulty level and airman aptitude level. In other words, the system will offer the most difficult jobs to the most talented applicants. The algorithm is sensitive to small differences. For example, at the time of this research there were over 30 Electronics AFSs requiring a minimum composite score at the 80th centile. In this instance, the PJM algorithm would likely offer these jobs more evenly to all airmen scoring at or above E-80 on the Electronics composite of the ASVAB. However, should the ATDPUTs from this research be used in place of the ASVAB cutoff score in the job difficulty component of the interaction term, the system would likely offer the more difficult jobs to those airmen scoring near 95 and the least difficult of these E-80 jobs to those scoring near 80, thus providing a more effective distribution of available talent across jobs. Such a system would not override current ASVAB minimums, but it would make more efficient distribution of available talent at or above the minimum.

The implementation of these data into the PJM algorithm could actually result in performing the same function as a change of aptitude minimums. For example, it is likely that some AFSs with current aptitude minimums of 40 are nearly as difficult as other AFSs having minimums at the 60th centile. Without changing the minimums, an augmented PJM algorithm would tend to offer the more demanding job to individuals having a higher level of talent.

The data from this project also provide Air Force planners with valuable information for the development of contingency plans for manning the force in the face of talent and manpower shortages. Since the abolishment of the draft, it has become increasingly difficult for the Air Force to meet personnel procurement objectives. One of the few remaining alternatives for maintaining the force level may be to reduce aptitude levels for some jobs. It is important to determine how this might be accomplished so as to have the smallest impact on mission capabilities. There are at least three ways job and task difficulty information could be used in preparing such contingency plans: (a) determine where aptitude requirement levels could be reduced for existing specialties, (b) identify existing job types within AFSs which could be formed into new management categories and manned by individuals with less talent, and (c) identify low-demand tasks in existing jobs that could be formed into new jobs to be performed by individuals with less talent (Christal, 1974).

Research in this area is continuing. Currently planned efforts include a preliminary study of the extent to which the three benchmark scales overlap and studies of the impact that changes in the aptitude entry requirements would have on the personnel acquisition and training systems. It is anticipated that significant changes in aptitude entry requirements will be required. It is further anticipated that these changes, when implemented, will have profound effects on the numbers of recruits eligible for different career fields, which in turn will have significant impact on the training system. These studies are designed to further explore and refine the technology developed in this effort.

VI. CONCLUSIONS AND RECOMMENDATIONS

It is concluded that the methodology for using job difficulty indices and time-spent data as the basis for determining the relative aptitude level of an Air Force job is technically feasible. This methodology also provides a workable system for altering aptitude minimums in the face of fluctuations in the availability of manpower resources with the least impact on mission capabilities. Since the utility of this methodology, when used in the initial classification process, would insure a more effective distribution of available talent across jobs, it is recommended that this methodology be considered for use in operational realignment of aptitude requirements.

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APPENDIX A: AIR FORCE SPECIALTIES USED IN THE DEVELOPMENT AND APPLICATION OF BENCHMARK SCALES: INTERRATER RELIABILITIES AND CORRELATIONAL STATISTICS

Table A1. Specialties Used in the Development and Application of the Mechanical Benchmark Scale

AFS[a]	Title	Incumbent Ratings R_{11}	Incumbent Ratings R_{kk}	Benchmark Ratings R_{11}	Benchmark Ratings R_{kk}	Incumbent vs. Benchmark Ratings r	Benchmark Ratings Team 1 vs. Team 2 r
113X0	Flight Engineer Spec	40	93	60	95	82	94
114X0	Aircraft Loadmaster	44	97	52	94	81	b
325X1	Avionic Instru Sys Spec	26	93	64	95	74	80
361X0	Cable & Antenna Sys Instal/Maint Spec	29	93	51	94	77	b
361X1	Cable Splicing Instl & Maint Repair Spec	39	94	61	[illegible]	86	81
362X2	Elec Switching Sys Repair Spec	35	94	76	[illegible]	87	82
362X4	Telephone Equip Installer	37	93	66	[illegible]	84	78
391X0A	Maintenance Analysis Spec	25	94	44	90	74	86
423X1	Aircraft Environmental Systems Mechanic	31	95	47	91	86	91
423X2	Aircrew Egress Sys Mechanic	19	94	54	94	77	b
423X3	Aircraft Fuel Sys Mechanic	35	93	63	96	79	b
423X4	Aircraft Pneudraulic Systems Mechanic	31	96	57	95	58	74
423X5	Aerosp Ground Equipment Mechanic	34	97	50	93	87	75
426X1	Recp Propulsion Mechanic	35	95	55	95	64	68
426X2	Jet Engine Mechanic	26	94	69	97	74	b
427X1	Corrosion Control Spec	17	90	59	95	81	b
427X3	Fabrication & Parachute Spec	24	94	54	94	81	b
427X4	Metals Processing Spec	24	93	62	95	61	74
427X5	Airframe Repair Spec	30	95	41	89	80	82
431X0C	Helicopter Mechanic (Articulated Rotor)	31	97	79	98	91	b
431X1C	Tactical Aircraft Maint Spec	39	97	60	95	81	b
461X0	Munitions Systems Spec	32	96	45	92	69	69
462X0	Aircraft Armament Systems Spec	31	94	63	96	85	93
464X0	EOD Spec	28	96	49	93	63	b
472X0	Base Vehicle Equipment Mechanic	40	97	54	94	79	72
472X2	General Purpose Vehicle Maint Mechanic	40	97	53	94	85	77

Table A1 (continued)

AFS[a]	Title	Incumbent Ratings R_{11}	Incumbent Ratings R_{kk}	Benchmark Ratings R_{11}	Benchmark Ratings R_{kk}	Incumbent vs. Benchmark Ratings r	Benchmark Ratings Team 1 vs. Team 2 r
472X3	Vehicle Body Mechanic	40	97	64	96	81	89
542X0	Electrician	39	97	82	95	80	89
542X2	Electrical Power Production Spec	39	96	65	96	87	b
545X0	Refrig & Air Conditioning Spec	28	93	60	95	82	83
546X0	Liquid Fuel Sys Maint Spec	37	96	67	97	85	b
551X0	Pavements Maintenance Spec	34	97	57	95	73	b
551X1	Construction Equipment Operator	34	97	53	94	82	b
552X0	Carpentry Spec	18	93	49	93	76	b
552X1	Masonry Spec	33	95	47	91	74	92
552X4	Protective Coating Spec	41	95	49	92	88	91
552X5	Plumbing Spec	28	97	55	94	57	b
566X1	Environmental Support Spec	33	94	55	94	76	b
603X0	Vehicle Operator/Dispatcher	37	96	36	87	83	86
605X1	Air Cargo Spec	27	86	38	88	71	87

Note. Decimals have been omitted.

[a]For the purpose of this report, not all changes in AFSs as shown in AFR 39-1 since the beginning of this project are reflected in this chart. However, seven AFSs have been deleted from this table due to changes in career field necessitating their reassessment.

[b]Team 1 and Team 2 analyses not conducted on these specialties.

Table A2. Specialties Used in the Development and Application of the Electronic Benchmark Scale

AFS[a]	Title	Incumbent Ratings R_{11}	Incumbent Ratings R_{kk}	Benchmark Ratings R_{11}	Benchmark Ratings R_{kk}	Incumbent vs. Benchmark Ratings r	Benchmark Ratings Team 1 vs. Team 2 r
302X0	Weather Equipment Spec	39	96	72	95	88	b
303X2	AC&W Spec	37	95	79	97	89	b
303X3	Auto Tracking Radar Spec	37	95	77	96	89	b
304X0	Radio Relay Equipment Spec	26	96	70	91	88	b
304X1	Nav Aid Equip Spec	42	97	78	98	90	89
304X4	Ground Radio Comm Equip Repmn	34	97	73	95	78	b
304X5	Television Equipment Repmn	37	96	75	98	87	85
305X4	Electronics Computer Systems Spec	31	96	72	97	89	90
306X2	Telecomm Systems/Equip Maint Spec	40	98	48	93	84	68
316X0F	Missile Systems Analyst Spec	46	94	56	97	89	b
316X1L	Missile Systems Maint Spec	41	95	60	95	82	81
316X2G	Missile Elec Equip Spec	34	88	73	97	88	93
316X3	Instrumentation Mechanic	38	97	69	97	96	81
321X1G	Defensive Fire Control System Spec (B52D/F/G)	41	92	76	98	89	88
321X2Q	Weapon Control Systems Mechanic	32	94	59	95	54	73
322X2B	Avionic Sensor Systems Spec	33	96	56	91	66	b
324X0	Precision Measuring Equip Spec	43	98	62	95	76	b
325X0	Auto Flt Control Systems Spec	41	98	75	97	87	b
325X1	Avionics Instrument Systems Spec	26	93	55	91	71	b
326X0	Avionics Aerosp Ground Equip Spec	37	94	80	97	81	b
326X4	Integrated Avionics Comp Spec	29	85	47	93	70	65
328X0	Avionic Communications Spec	31	93	79	97	82	b
328X3	Electronic Warfare Systems Spec	35	93	70	95	88	b
341X1	Instrument Trainer Spec	39	95	77	96	84	b
341X3	Analog Flight Sim Spec	42	96	66	96	88	b
341X4	Digital Flight Sim Spec	42	96	64	96	86	b
341X5	Analog Nav/Tac Tng Dvs Spec	42	96	66	96	88	b
341X6	Digital Nav/Tac Tng Dvs Spec	42	96	64	96	86	b

Table A2 (continued)

AFS[a]	Title	Incumbent Ratings R_{11}	Incumbent Ratings R_{kk}	Benchmark Ratings R_{11}	Benchmark Ratings R_{kk}	Incumbent vs. Benchmark Ratings r	Benchmark Ratings Team 1 vs. Team 2 r
341X7	Missile Trainer Spec	39	93	59	92	76	b
361X0	Cable & Antenna Sys Instal/Maint Spec	29	93	53	94	81	83
362X2	Electronic Switching Systems Spec	35	94	76	96	83	b

Note. Decimals have been omitted.

[a]For the purpose of this report, not all changes in AFSs as shown in AFR 39-1 since the beginning of this project are reflected in this chart. However, seven AFSs have been deleted from this table due to changes in career field necessitating their reassessment.

[b]Team 1 and Team 2 analyses not conducted on these specialties.

Table A3. Specialties Used in the Development and Application of the General/Administrative Benchmark Scales

AFS[a]	Title	Incumbent Ratings R_{11}	Incumbent Ratings R_{kk}	Benchmark Ratings R_{11}	Benchmark Ratings R_{kk}	Incumbent vs. Benchmark Ratings r	Benchmark Ratings Team 1 vs. Team 2 r
115X0	Pararescue/Recovery Spec	33	94	51	93	76	54
204X0	Intelligence Operations Spec	38	98	65	96	80	75
231X0	Audiovisual Media Spec	53	97	79	98	85	89
231X1	Graphics Spec	42	97	65	96	95	79
231X2	Still Photographic Spec	31	94	40	89	86	b
233X0	Cont Photoprocessing Spec	45	97	70	97	86	83
233X1	Photoprocessing Control Spec	45	97	73	97	89	82
241X0	Safety Spec	29	95	57	94	86	b
291X0	Telecommunications Operator	41	98	71	97	81	81
293X3	Radio Operator	31	93	68	96	66	82
295X0	Auto Digital Switching Spec	42	98	72	97	70	79
392X0	Maintenance Management Spec	26	94	46	91	76	66
511X0	Computer Operator	46	97	70	97	84	75
511X1	Programming Spec	46	97	60	95	83	66
511X2	Computer Systems/Analysis & Design Spec	46	97	52	93	76	53
553X0	Site Development Spec	36	96	48	92	71	b
554X0	Real Estate-Cost Mgt Analysis Spec	30	92	48	92	69	68
555X0	Production Control Spec	33	95	75	97	79	85
566X0	Entomology Spec	33	92	58	94	76	58
571X0	Fire Protection Spec	36	97	68	96	76	75
601X4	Packaging Spec	32	93	56	94	66	71
602X0	Passenger & HHG Spec	32	93	57	94	68	59
602X1	Freight Traffic Spec	29	93	44	90	84	57
605X0	Air Passenger Spec	29	89	36	87	75	36
611X0	Services Spec	36	95	69	96	78	78
611X1	Meatcutter	36	95	74	97	75	84
622X1	Diet Therapy Spec	36	95	67	96	83	82
631X0	Fuel Spec	34	96	45	91	58	52
645X0	Inventory Mgt Spec	27	89	60	95	73	67
645X1	Material Facilities Spec	33	89	61	95	74	79

Table A3 (continued)

AFS[a]	Title	Incumbent Ratings R_{11}	Incumbent Ratings R_{kk}	Benchmark Ratings R_{11}	Benchmark Ratings R_{kk}	Incumbent vs. Benchmark Ratings r	Benchmark Ratings Team 1 vs. Team 2 r
645X2	Supply Systems Spec	33	90	62	95	74	64
651X0	Contracting Spec	33	97	62	95	88	79
672X0	Budget Spec	36	94	58	94	83	70
672X1	General Accounting Spec	36	94	43	90	77	48
672X2	Disbursement Accounting Spec	36	94	52	94	80	74
691X0	Management Analysis Spec	42	97	67	96	84	b
701X0	Chapel Management Spec	46	98	67	96	77	87
705X0	Legal Services Spec	45	98	69	98	86	80
713X0	Printing Binding Spec	41	97	64	96	76	81
713X1	Photolithography Spec	41	97	61	95	54	72
713X2	Duplicating Spec	41	97	58	94	83	76
732X0	Personnel Spec	27	94	58	94	67	60
732X1	Personal Affairs Spec	28	95	60	95	86	76
733X1	Manpower Management Spec	41	96	47	92	75	b
741X1	Recreation Services Spec	32	93	79	98	89	91
742X0	Club Management Spec	34	96	73	97	86	83
751X2	Training Spec	40	97	69	96	83	76
753X0	Small Arms Spec	28	91	66	96	78	84
791X0	Information Spec	34	95	67	96	89	b
791X1	Radio & TV Broadcasting Spec	34	95	71	97	83	b
811X0	Security Spec	25	96	52	93	80	b
811X2	Law Enforcement Spec	25	96	55	94	81	b
901X0	Aeromedical Spec	40	94	69	96	60	84
902X0	Medical Service Spec	41	97	60	95	85	b
902X2	Operating Room Spec	46	96	71	97	76	81
903X0	Radiologic Spec	42	97	68	96	76	86
904X0	Medical Laboratory Spec	34	93	55	94	70	77
905X0	Pharmacy Spec	44	98	57	94	81	76
906X0	Medical Administrative Spec	43	97	93	95	75	b
907X0	Environmental Health Spec	32	95	64	96	81	71

Table A3 (continued)

AFS[a]	Title	Incumbent Ratings R_{11}	Incumbent Ratings R_{kk}	Benchmark Ratings R_{11}	Benchmark Ratings R_{kk}	Incumbent vs. Benchmark Ratings r	Benchmark Ratings Team 1 vs. Team 2 r
908X0	Veterinary	30	94	54	93	84	68
911X0	Aerosp Physiology Spec	35	97	52	93	76	74
914X0	Mental Health Clinic	43	96	74	97	90	83
914X1	Mental Health Unit Spec	43	96	74	97	90	86
921X0	Survival Training Spec	43	97	59	94	79	b
922X0	Aircrew Life Support Spec	33	96	50	92	86	b
981X0	Dental Spec	31	93	67	96	75	74
981X1	Preventive Dentistry Spec	31	93	67	96	70	71
982X0	Dental Laboratory Spec	43	98	47	91	84	b

Note. Decimals have been omitted.

[a]For the purposes of this report, not all changes in AFSs as shown in AFR 39-1 since the beginning of this project are reflected in this chart. However, seven AFSs have been deleted from this table due to changes in career field necessitating their reassessment.

[b]Team 1 and Team 2 analyses not conducted on these specialties.

APPENDIX B: MECHANICAL, GENERAL, AND ELECTRONICS BENCHMARK SCALES

MECHANICAL BENCHMARK SCALE

LEVEL 1
POLICE GROUNDS FOR LITTER
POLICE OPEN STORAGE AREAS

LEVEL 2
CUT WEEDS
DISPOSE OF RAGS

LEVEL 3
LUBRICATE CABLES
RAKE BAR SCREENS

LEVEL 4
LUBRICATE HAND TOOLS
STENCIL DATE OF INSPECTION ON LIFE RAFTS

LEVEL 5
CLEAN LIFE PRESERVERS
DIG DITCHES BY HAND

LEVEL 6
CLEAN PAINT EQUIPMENT SUCH AS BRUSHES OR ROLLERS
APPLY REFLECTIVE TAPE TO EQUIPMENT

LEVEL 7
REMOVE OR REPLACE VENETIAN BLINDS
CLEAN EQUIPMENT OR AREAS AFTER APPLYING PROTECTIVE COATINGS

LEVEL 8
MAINTAIN TOOL CRIBS
MIX CONCRETE BY HAND

LEVEL 9
POSITION NONPOWERED GROUND EQUIPMENT AROUND AIRCRAFT
APPLY ENAMELS TO SURFACES USING ROLLERS

LEVEL 10
CLEAN AND REGRAP SPARK PLUGS
CAULK AREAS AROUND WINDOWS, SINK, OR BATHTUBS

LEVEL 11
PERFORM OPERATOR INSPECTIONS OR MAINTENANCE ON DUMP TRUCKS
DRAIN ENGINE OIL SYSTEMS

LEVEL 12
REMOVE OR REPLACE NOZZLES OR HOSES ON MOTOR GASLINE UNITS
PREPARE ENAMELS FOR APPLICATION

LEVEL 13
INSTALL OR REPLACE WATER FOUNTAINS
DISASSEMBLE OR CLEAN CONVENTIONAL FUEL GATE VALVES

LEVEL 14
PRIME COMPONENTS SUCH AS STARTERS AND HYDRAULIC PUMPS
DISASSEMBLE OR CLEAN CONVENTIONAL FUEL LUBRICATED PLUG VALVES

LEVEL 15
PERFORM PREOPERATIONAL INSPECTIONS OF ENGINE AFTER ENGINE HAS BEEN ON LONG STANDBY
INSTALL OR REPLACE FORMICA ON COUNTER TOPS OR SPLASH BOARDS

LEVEL 16
REMOVE OR INSTALL CANOPY HOSES OR TUBING
PRIME AND BLEED FUEL SYSTEMS

LEVEL 17
REMOVE OR REPLACE TRANSMISSION-DRIVEN GENERATORS
ADJUST AUTOMATIC GOVERNORS AND VOLTAGE REGULATORS

LEVEL 18
TROUBLESHOOT HIGH OR LUBE OIL PRESSURE
INSTALL FUEL MANIFOLDS AND FUEL NOZZLES

LEVEL 19
INSTALL ELECTRICAL COMPONENTS
REMOVE OR INSTALL FUEL CELLS

LEVEL 20
READ AND INTERPRET SCHEMATIC OR WIRING DIAGRAMS
INSTALL TAIL ROTOR ASSEMBLIES ON HELICOPTER AIRCRAFT

LEVEL 21
REMOVE OR INSTALL TAIL DRIVE ASSEMBLY
DIRECT AIRCRAFT EXPLOSIVE HAZARD RENDER SAFE PROCEDURES

LEVEL 22
PERFORM CRITICAL MEASUREMENTS ON JET ENGINES
ADJUST CANOPIES

LEVEL 23
REMOVE OR REPLACE CYCLIC CONTROL SYSTEM COMPONENTS
REMOVE OR INSTALL MAIN ROTOR TRANSMISSION

LEVEL 24
TROUBLESHOOT FULLY ARTICULATED ROTOR SYSEMS AND DETERMINE CORRECTIVE ACTIONS
ASSEMBLE MAIN ENGINE SECTIONS

LEVEL 25
TROUBLESHOOT SYSTEMS FOR BREAKER TRIP-OUTS
TROUBLESHOOT INSTALLED ENGINES

GENERAL/ADMINISTRATIVE BENCHMARK SCALE

LEVEL 1
CLEAN OR WASH MILITARY VEHICLES
STAPLE PUBLICATIONS OR REPORTS

LEVEL 2
PREPARE IDENTIFICATION BANDS FOR PATIENTS
OPERATE FACILITY LOCKS OR DOORS

LEVEL 3
COLLATE PUBLICATIONS
APPLY COLD COMPRESSES

LEVEL 4
PREPARE NEWSPAPER OR OTHER PRINTED MATERIALS FOR MAILING
STENCIL IDENTIFICATION NUMBERS ON LIFE SUPPORT EQUIPMENT

LEVEL 5
TAKE OR RECORD TEMPERATURES
SECURE WEAPONS IN WEAPONS STORAGE LOCKER

LEVEL 6
INSTALL OR REMOVE SINGLE-VISOR ASSEMBLIES ON HELMETS
ADVISE INDIVIDUALS OF THEIR RIGHTS UNDER THE FIFTH AMENDMENT

LEVEL 7
PREPARE REQUESTS FOR MEDICAL/DENTAL RECORDS OR INFORMATION FORMS
PROVIDE GUIDANCE TO INSTALLATION VISITORS

LEVEL 8
PREPARE OR MAIL MEDICAL INFORMATION TO REQUESTING AGENCIES
CHALLENGE OR IDENTIFY UNKNOWN PERSONS

LEVEL 9
CONDUCT TOURS THROUGH FACILITIES
TAKE OR RECORD RADIAL PULSE

LEVEL 10
INSPECT SITE OR FACILITIES FOR SLIPPING HAZARDS
GUARD CLASSIFIED MATERIAL AT ACCIDENT OR INCIDENT SCENES

LEVEL 11
TAKE OR RECORD APICAL PULSE
INSPECT OXYGEN MASKS OR ACCESSORIES

LEVEL 12
COORDINATE COMPLETION OF CLINICAL RECORDS WITH PHYSICIANS OR NURSING STAFFS
CONTROL ENTRY AND TRAFFIC AT DISASTER SCENES

LEVEL 13
INSTRUCT STUDENTS IN METHODS OF PROTECTING FOODS FROM ENVIRONMENT OR ANIMALS
SELECT FILTERS FOR PENETRATING HAZE

LEVEL 14
BRIEF PERSONNEL PRIOR TO APPEARANCE ON RADIO OR TV
ASSEMBLE SURVIVAL KITS FOR SPECIFIC MISSIONS

LEVEL 15
MAINTAIN BASE MASTER PLANS
COMPUTE AIR CREW AVAILABILITY

LEVEL 16
ESTABLISH LOCATION OF EXISTING TOPOGRAPHICAL FEATURES
MANUALLY PROCESS COLOR REVERSAL FILM

LEVEL 17
CONDUCT INTERVIEWS IN CONNECTION WITH STORY ASSIGNMENTS
REVIEW SOURCE MATERIAL TO DETERMINE PORTIONS USABLE FOR PROJECTS

LEVEL 18
DETERMINE REQUIRED GRADES AND AIR FORCE SPECIALTY CODES
WRITE RADIO SCRIPTS

LEVEL 19
DIRECT OPERATION OF AEROMEDICAL EVACUATION FACILITIES
ANALYZE TENANT WORKLOAD DATA TO DETERMINE HOST MANPOWER IMPACT

LEVEL 20
GHOST WRITE EDITORIALS
CONDUCT REHEARSALS OF TV PROGRAMS

LEVEL 21
DETERMINE BENEFITS DERIVED FROM EACH ALTERNATIVE METHOD OF ACCOMPLISHING OBJECTIVES
EVALUATE OR VALIDATE NEED FOR INDIVIDUAL MANPOWER AUGMENTATION POSITIONS

LEVEL 22
BUILD UP LIFE SUPPORT MOBILITY CONTAINERS
ADMINISTER PRIMARY CARE AT SCENE OF ACCIDENTS

LEVEL 23
DIRECT RADIO OR TELEVISION PROGRAMS
PERFORM TRIAGE DURING DISASTER SITUATIONS

LEVEL 24
WRITE STAFF STUDIES, SURVEYS OR SPECIAL REPORTS
ADVISE PERSONNEL ON CIVILIAN HEALTH AND MEDICAL PROGRAM OF THE UNIFORMED SERVICES

LEVEL 25
PREPARE MANAGEMENT ADVISORY REPORT
DESIGN INTERIOR UTILITIES SYSTEMS

ELECTRONICS BENCHMARK SCALE

LEVEL 1
REMOVE AND DISPOSE OF TRASH, WASTE OR MATERIALS
CLEAN OR MAINTAIN AREAS OUTSIDE OF SHOP

LEVEL 2
CLEAN OR VACUUM EQUIPMENT
POLISH OR WAX EQUIPMENT OR FACILITIES

LEVEL 3
CLEAN AND MAINTAIN HAND TOOLS OR TOOL BOXES
MONITOR CLOSED CIRCUIT TELEVISION

LEVEL 4
INSPECT AND CLEAN FOUL WEATHER GEAR
INFLATE OR DEFLATE VEHICLE TIRES

LEVEL 5
STENCIL, DECAL, OR PAINT INSTRUCTIONS OR IDENTIFIERS ON EQUIPMENT
CLEAN OR LUBRICATE MECHANICAL DEVICES SUCH AS GEARS OR HINGES

LEVEL 6
CLEAN AND INSPECT LIGHTING FIXTURES
PERFORM TOOL BOX INVENTORIES

LEVEL 7
VISUALLY INSPECT BATTERIES
READ SERVICE METERS

LEVEL 8
PERFORM VISUAL INSPECTION OF RADOMES
CLEAN AND TIN SOLDERING EQUIPMENT

LEVEL 9
VISUALLY INSPECT ELECTRICAL BONDS AND GROUNDS
INSTALL MOUNTING BRACKETS OR FIXTURES

LEVEL 10
INSTALL CRIMPED WIRING TERMINALS ON COMPONENTS, LINE REPLACEABLE UNITS, OR MODULE WIRING
INSPECT ELECTRICAL OUTLETS FOR GROUNDING

LEVEL 11
REMOVE OR INSTALL CELLS OR STRAPS ON NICKEL CADMIUM OR SILVER ZINC BATTERIES
VISUALLY INSPECT WIRE HARNESSES, CABLES, OR CONNECTOR PLUGS

LEVEL 12
SOLDER WIRES TO CONNECTOR PLUGS, CONTROL BOXES, OR CONTROL PANELS
VISUALLY INSPECT PRESSURE WARNING CIRCUITS

LEVEL 13
INSPECT OR OPERATIONALLY CHECK HYDRAULIC PRESSURE INDICATING SYSTEMS
INSPECT WINDSPEED TRANSMITTING OR MONITORING EQUIPMENT

LEVEL 14
ADJUST TRANSMISSOMETER PROJECTOR LAMP VOLTAGES
REPLACE MECHANICAL COMPONENTS SUCH AS BEARINGS, GEARS, OR PULLEYS

LEVEL 15
INSPECT OR OPERATIONALLY CHECK SURFACE OR FLAP POSITION INDICATING SYSTEMS
REMOVE OR REPLACE SOCKETS FOR COMPONENTS SUCH AS TUBES, RELAYS, AMP, TRANSISTORS OR INTEGRATED CIRCUITS

LEVEL 16
ADJUST AMPLIFIER BALANCES
PERFORM POWER CHECKS OF COMMUNICATIONS SYSTEMS INSTALLED ON AIRCRAFT

LEVEL 17
ALIGN OR ADJUST TRANSMISSOMETER UNITS
PERFORM HIGH-VALUE DESOLDERING

LEVEL 18
ADJUST OR ALIGN RADAR HEIGHT INDICATOR RANGE MARK GENERATING CIRCUITS
TROUBLESHOOT CONVENTIONAL, NON-VERTICAL SCALE INSTRUMENT, FUEL FLOW INDICATING SYSTEMS ON AIRCRAFT

LEVEL 19
ADJUST OR ALIGN VIDEO AMPLIFIERS
TROUBLESHOOT WIND MEASURING SETS

LEVEL 20
TROUBLESHOOT CONSTANT SPEED DRIVE CIRCUITS
ALIGN OR ADJUST AZIMUTH AND ELEVATION ANGLE DETECTION CIRCUITRY

LEVEL 21
TROUBLESHOOT AIRCRAFT FLIGHT CONTROL CIRCUITS
ADJUST OR ALIGN ELECTRONIC COUNTER COUNTERMEASURES CIRCUITS

LEVEL 22
TROUBLESHOOT POWER SUPPLIES AND DISTRIBUTIONS ON DIGITAL COMPUTERS
PERFORM ALIGNMENT OF AIRCRAFT HF RECEIVER

LEVEL 23
TROUBLESHOOT REGULATOR CIRCUITS ON DEVICES WHICH USE AN ANALOG COMPUTER
PERFORM ALIGNMENTS OR ADJUSTMENTS OF AN/APM-335 RADAR RECEIVER TRANSMITTER TEST SETS

LEVEL 24
ISOLATE MALFUNCTIONS IN SYNCHRONIZER CIRCUITRY
PERFORM ALIGNMENTS OF ADJUSTMENTS OF AN/APM-336 RADAR VIDEO/SERVO TEST SET

LEVEL 25
PERFORM FAULT ISOLATION OF AN/APM-336 RADAR VIDEO SERVO TEST SET
PERFORM ALIGNMENTS OR ADJUSTMENTS OF 12A96811 PENETRATION AID TEST STATIONS

APPENDIX C: EXCERPTS FROM THE PROCEDURAL GUIDE FOR USE OF THE MECHANICAL BENCHMARK SCALE

PART I

ASSESSING LEARNING DIFFICULTY AND RATING TASKS

1.0 INTRODUCTION

You are a member of a panel that will assist the USAF Human Resources Laboratory by providing data on the "learning difficulty" of selected Air Force tasks. This Guide describes the procedure by which these tasks are to be rated. You will:

(1) Learn to use a specific research method in judging learning difficulty.

(2) Go to places where work is being performed and study the tasks in their workplace.

(3) Rate each selected task using a 25-level Benchmark Rating Scale.

This guide consists of two parts. Part I explains how to follow the required research procedure and how to use the specific definition of "learning difficulty." That definition is: "time required to learn to perform the task satisfactorily."

2.0 PURPOSE OF DIFFICULTY RATINGS

2.1 Background

Since 1958 the Air Force Human Resources Laboratory has been developing a bank of scientific data. concerning the various kinds of work performed in the Air Force. As a result, most Air Force Specialties (AFSs) can now be described by a list of several hundred specific tasks that are performed by personnel in that specialty. These lists are in the form of task inventories, and they were derived from surveys of workers and supervisors. Each listed task is one which is actually performed by personnel in the AFS, as reported by the survey.

The task inventories include data about each task, such as the frequency with which it is performed, how many people perform it, and its relative difficulty. These data are used both in research and for many practical management decisions. Task inventories are used in designing training, in determining career ladders, and in setting minimum scores on the Armed Services Vocational Aptitude Battery, a battery of tests required for entry into specific career fields.

2.2 Difficulty Data

In an earlier survey NCOs in each AFS were asked to provide task difficulty data. As a result of their input, the task inventories now include a difficulty rating for each task in the list. Those ratings tell only how difficult each task is compared to other tasks in the same AFS. They do not tell how tasks in different AFSs compare with each other. For instance, using those ratings there is no way to compare the work of a medical technician with that of a security policeman.

The procedure this Guide describes will be used to develop difficulty ratings, based on a common rating scale, for Air Force jobs with mechanical aptitude requirements.

3.0 THE PANEL

3.1 General

The panel of which you are a member will rate selected tasks in each of several AFSs. These tasks do not cover all work performed in the AFS concerned, but they are a representative sample of the task inventory for each AFS. The ratings the panel provides will be used, following a statistical method, to evaluate learning difficulty for all tasks in the inventory. Thus, the ratings your panel makes will set difficulty for all tasks in each AFS. It is therefore very important that the ratings you make be performed with care, using the exact definition and criteria this handbook describes. Each rating you make, when averaged with other ratings, will determine the difficulty rating assigned to many other tasks. Final ratings will be an important determiner of how jobs and people are managed in the Air Force.

3.2 Panel Training

You will be required to study the procedure and to undertake at least two training exercises. Before the panel assembles, each panel member must read and understand this part of this Guide, and study the benchmark tasks of Part II in detail. When the panel assembles, there will be a practical exercise. The panel will be briefed on procedures and all questions will be answered. Panel members will then be given several generally familiar tasks. They will have time to discuss those tasks and to ask questions. Then they will rate the familiar tasks using the benchmark scale. Panel members will compare their ratings for each task to determine how well the ratings are in agreement. Panel members will be asked to explain why they made each rating. They will discuss how they interpreted difficulty of the task, and how they interpreted the benchmark scale, in order to clarify any misunderstanding of the method or of the benchmark scale.

3.3 Materials

The materials provided to you will include this Guide, task lists, and rating sheets. The Task List sheets have space for taking notes. It will be useful, however, to have a pad of paper for any additional notes that may be required.

4.0 RATING PROCEDURE

4.1 General

Each task is rated by (1) understanding how the task is performed, (2) analyzing how difficult it is to learn, (3) comparing it to tasks on the Benchmark Rating Scale, and *(4) recording the difficulty level of the most* comparable tasks on the rating scale.

4.2 Task Assessment

It usually will not be clear, just from a task statement, what any given task entails. Therefore, the panel will go to a typical USAF workplace to study how each task is performed and what must be learned to perform it. Ideally, we would like to observe the actual performance of each task. This is rarely practical and would require repeated observations of each task to be meaningful. Therefore, the principal method of study will be to interview workers. The panel will visit workers in their actual workplace in order to examine the equipment, tools, regulations, task orders, and other conditions of the job.

The team should interview at least two holders of the AFS studied. During the interview panelists should take notes, but they should not rate the tasks until later. **Do not hurry.** Be sure all members of the panel fully understand each task before proceeding to the next one. Interviews must be held in a group, with all workers and panel members participating.

4.3 Task Assessment Criteria

Workers should be interviewed to determine exactly what each task is, how it is performed, and what skills or knowledge are required to perform it adequately. Study the following:

(1) Task Definition: What is the task? First, clear up any confusion about what the task statement means. We generally know what a task is when we know what materials the worker begins with and what the task end-product is like. What are the boundaries of the task? Find out what is and is not included in task performance. This is a common area of confusion. If the task is changing spark plugs, must other components (air filter, compressor) be removed first? Or is this a separate task?

(2) The number of steps in a task: Tasks that have many different steps are obviously more difficult to learn than those which have only a few steps. Tasks that contain many repetitions of the same step, however, may be relatively easy to learn.

(3) Tools and equipment *unique* to the task: The learning time required for tools and equipment *unique* to a task adds to learning difficulty.

(4) Regulations, manuals and standard operating procedures: How detailed is the documentation? The more detailed it is, the less has to be learned. Some tasks do not have to be learned, because they can be performed by simply following written instructions.

(5) Memorization: Does the task or any portion of the task have to be memorized in order to be performed? This adds to learning difficulty.

(6) Standards of Performance: Tasks differ in what level of quality or realiability is required for "satisfactory performance." For example, packing a parachute requires a higher standard of product reliability than does changing a faucet washer. In the latter case, if the faucet leaks, you can do it again.

(7) Time Criticality: A task that must be performed within a time limit is more difficult to learn than the same task with no limit for performance.

(8) For many career fields there are required basic skills or knowledge (typing, mathematics). In some cases these are taught in the USAF Technical School. These skills and knowledges add to the learning difficulty of individual tasks only to the extent that they are used in the performance of that task.

Finally, keep in mind during your assessment that you are judging "learning difficulty"—the time required to learn to perform the job satisfactorily. It includes only the learning time unique to the task being rated.

4.4 Rating the Tasks

After having studied the task, each panel member should be confident that he understands the task, ideally to the point at which he could perform it himself. He must know the starting point, the conditions of performance, the task steps, and the criteria for a satisfactory task product. He should have a set of notes from which he can recall the task and remember what skills or knowledge are required in its performance.

Then each panel member will be given time to make an assessment of difficulty, in private, using the Benchmark Rating Scale.

4.4.1 *Isolate Learning Time.* Panel members must carefully consider each task and determine how difficult it is to learn. This means that they must recognize the difference between how hard the task is to *perform* and how hard it is to *learn.* Only learning time should be considered as part of task difficulty. Do not include learning time associated with the basic skills and knowledge personnel should have for entry into the Air Force.

4.2.2 *Task Ratings.* Each task to be rated must now be compared with the tasks on the benchmark scale. Then, for each task to be rated, find a difficulty level on the benchmark scale which most closely corresponds to the difficulty level of the task to be rated. Verify this selection by reviewing those tasks on the benchmark scale which are at the levels above and below your selection, ensuring that the tasks above are more difficult to learn and those below are less difficult to learn. Record your rating.

(1) Remember to consider each task in terms of learning difficulty—not how hard it is to perform.

(2) If one of the tasks at a level appears not to be helpful, consider only the other task at that difficulty level.

(3) If you disagree with the rating of both tasks at any level, use tasks above and below that level for comparison.

4.4.3 *Reassess.* Especially during your first few days using this procedure, you will make judgments that you will want to reconsider later. This is because you are in the process of learning how to use the procedure, and because it takes *time* to become familiar with the rating scale. Most important of all, you will learn a great deal about how to observe and analyze work.

Therefore, panel members are encouraged to reassess their ratings periodically, and are required to rerate those tasks about which they form a new opinion.

PART II

DETAILED DESCRIPTIONS OF BENCHMARK SCALE TASKS[a]

M 1-1

Level 1: POLICE GROUNDS FOR LITTER (Construction Equipment Operator - AFSC 55151)

Task Performance: This task is the routine policing of grounds around a heavy equipment compound or around troop quarters. On direction of a supervisor, litter is picked up by hand, and disposed of in cans or in a dumpster.

Skill/Knowledge Required: No skill or knowledge is required which must be learned in the service. The work is performed using basic skills, learned early in life by everyone.

M 9-1

Level 9: POSITION NON-POWERED GROUND EQUIPMENT AROUND AIRCRAFT (Aircrew Egress Systems Repairman - AFSC 42352)

Equipment: Non-powered ground equipment includes work stands, hoists, slings, seat dollies, canopy stands or dollies, and fire extinguishers. Most have wheel locks. Most work stands have hand rails which are installed at the time they are positioned. Some stands include hydraulic lifts for raising and lowering the stand.

Task Performance: Positioning of this equipment is typically part of another task. T.O. procedures normally spell out the location of this equipment. Safety is a big factor to avoid danger to personnel and damage to the aircraft during positioning. Positioning includes a visual inspection of the area prior to use, locating the equipment, moving it in, locking wheels, installing hand rails, and operating hydraulic hand pumps.

Skill/Knowledge Required: The repairman must have knowledge of each of the types of equipment used and of how they are positioned around aircraft. Operation of the equipment is reasonably simple. The most important factors are the safety of personnel, and the prevention of damage to aircraft.

M 18-2

Level 18: INSTALL FUEL MANIFOLDS AND FUEL NOZZLES (Jet Engine Mechanic - AFSC 42652)

Equipment: Fuel manifolds and nozzles are used to distribute and inject fuel into jet engines. (1) An external manifold consists of sections of flexible and solid tubing, which are connected to form a complex yoke around the engine. It conducts fuel to 10 or 12 nozzles, which are screwed into the body of the engine and which inject the fuel into the combustion chambers. (2) An internal manifold consists of a soft metal circular tube, with 8 nozzle clusters, each containing 6 screw-in nozzles made of similar soft metal. The manifold is mounted around the interior of the engine on brackets and support clamps.

Both types of manifold are very sensitive to physical damage, being either fragile or easily dented and deformed. They are installed by bolts which must be either tab-locked or safety wired in position.

Task Performance: The task is performed with the engine removed and placed on a stand. (1) External manifolds are removed by disconnecting the nozzles and removing manifold bracket bolts, after which the circular manifold is either (a) carefully slid off the end of the engine, or (b) removed by disconnecting the fittings between sections. The nozzles are then screwed out of the engine body. To install manifold and nozzles, the procedure is reversed, nozzles and mounting bolts are torqued and safety wired. Extreme care must be taken to avoid dents or bends in

[a]Due to the length of this section in the Procedural Guide, excerpts only are provided. When used in rating tasks, each benchmark scale task will appear on a separate page and should not exceed one page in length.

manifold lines. Anti-seize compound is required on nozzle threads. (2) To remove internal manifolds, main engine sections must be removed to gain access to the combustion chamber. Then a special jig is inserted to prevent stress or deformation of the manifold during nozzle removal. The 48 nozzles are removed and the manifold is removed by removing 2 sets each of mounting bracket bolts and support bracket bolts. After removal, the manifold is placed in another special jig to relieve any stresses on the tubing. Installation is the reverse of this procedure. Each nozzle is reinstalled by assembling 3 parts in the proper order, using the special jig.

In either case, this task must be performed by following the T.O. procedures to the letter. These procedures are detailed, with illustrations.

Skill/Knowledge Required: This task requires delicate skill, in order not to damage the manifolds. The task is critical because improper installation of the nozzles can cause destruction of an engine. The learning required to perform this task includes learning the general engine structure, the tool and jig skills and the installation procedure, all of these to a higher level of precision and assurance than would be required to install a less fragile assembly.

M 25-2

Level 25: TROUBLESHOOT INSTALLED ENGINES (Jet Engine Mechanic - AFSC 42652)

Equipment: This task is performed on jet engines installed on aircraft. Troubleshooting includes isolation of failure within the engine or confirming that a failure is not in the engine but some related subsystem.

Task Performance: Troubleshooting typically begins with a pilot write-up. Interpretation of these write-ups is often difficult. The isolation process depends upon the failure symptom observed. Oil leaks, which are the most common problems require that all oil be cleaned from the exterior of the engine, the engine and oil systems exercised, and examining for the source of oil leaks. Vibrations are isolated by attaching vibration sensors at different locations around the engine and then running the engine to look for abnormal vibration sources. Other problems such as fuel leaks, throttle rigging, fuel control, and electrical problems require coordination with other subsystem specialties to isolate the problem between the engine and related systems.

Skill/Knowledge Required: Learning troubleshooting is accomplished by exposure and is not formalized. It requires:

(a) A complete knowledge of engine operation and its interface with related aircraft subsystems.

(b) Ability to use and understand the readings of pressure gauges, vibration sensors, and heat gauges.

(c) That the mechanic be cockpit qualified to enable him to run up the engine.

(d) An ability to read and interpret the appropriate Technical Orders.

(e) Coordination with the efforts of other subsystem specialists to isolate problems in the interaction of the engine and related aircraft systems.

DATE
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