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A COMPARATIVE STUDY OF TWO ENTRY LEVEL
FIREFIGHTER SELECTION TESTS

by
Theresa Strand
Dissertation

Submitted to the Office for Graduate Studies, Graduate
Division of Wayne State University, Detroit, Michigan
in partial fulfillment of the requirements for the
degree of

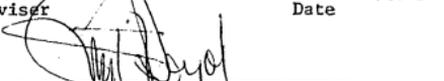
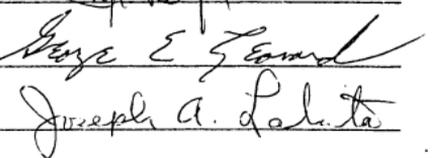
DOCTOR OF PHILOSOPHY

1975

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Chapter I
INTRODUCTION

Background of Study

Merit testing. The merit system of open, competitive testing for employee selection and promotion is steeped in democratic traditions. The use of competitive testing has been traced back to ancient China to the year 2356 B.C. where examinations were first used to allow the humblest individual to enter government service and advance on the basis of individual effort and achievement (Ebel, 1972).

The merit system formally began in the United States when Congress passed the Civil Service Act of 1883, under which the U.S. Civil Service Commission was created. The Act was the outcome of a strong civil service reform movement protesting the prevailing "spoils system" under which political affiliation was the determining factor in the appointment and dismissal of federal employees.

The goal of the merit system has been to assure entry and advancement in the civil service on the basis of ability rather than political patronage. Under provisions of the 1883 Act, ability is determined through individual performance on open, competitive examinations. The names of examinees who pass a specific test are placed on a list in order of the highest scores, with the exception of certain legal modifications, such as bonus points to veterans. Appointment to the position for which the test was held is made in order from the top of the list down, as positions become available. The continuing policy of the U.S. Civil Service Commission, which administers the merit system for the federal government and holds

examinations, has been to assure that "...examining, testing, standards, and employment practices are not affected by discrimination on account of race, color, sex, national origin, partisan political affiliation, or other nonmerit factors (U.S. Civil Service Commission, 1972)."

Since the establishment of the merit system by the federal government, there has been a tremendous increase in the government's use of written employment tests. In particular, the standardized testing procedures developed during World War I and II provided considerable impetus to the use of standardized tests by the government and industry, as well. Goslin (1963) observed that "...standardized, objective ability testing has become the corner-stone of merit systems throughout the country."

State and local civil service agencies have closely followed the merit procedures established by the federal government. The use of standardized employment tests continued to expand along with the rapid growth of government at all levels. Savas and Ginsburg (1973) stated:

Today, the so-called merit system--the name given to the elaborate web of civil service laws, rules, and regulations which embrace the merit principle--covers more than 95 percent of all permanent federal (civilian) employees, all state and county employees paid by federal funds, most state employees, many county employees (particularly in the North-eastern states), most employees in more than three-fourths of America's cities, and almost all full-time policemen and firemen (p. 70).

In considering the expansion of government and the problems related to merit testing encountered by civil service agencies, Goslin (1963) stated:

In view of the size of current staffs and the funds available for validation studies, it is remarkable that government personnel specialists have managed to keep up with the demand for increasing numbers of basic tests and new forms of established instruments...The development and validation of tests which will measure in any detail the abilities necessary for the performance of several thousand different occupations remains an enormous job (p. 112).

Test criticisms. While the intent of open, competitive testing under merit standards was to create fair and unbiased procedures for employee selection and promotion, the fairness of standardized employment tests for minority groups has become a debated issue. Social concern for Negroes and other minority group members whose opportunities for employment have been adversely affected because they have generally scored less well on tests than nonminority groups (Kirkpatrick, 1968; Bray and Moses, 1972) has resulted in a critical reevaluation of employment tests.

It has been hypothesized that the test performance of minority group members, particularly on tests of general mental ability, has been handicapped because of differences in their cultural backgrounds, including unequal educational opportunities (Wallace, Kissinger, and Reynolds, 1966; Cooper and Sobol, 1969). The APA Task Force on Employment Testing of Minority Groups (1969) identified various ways in which employment tests might operate to exclude minority applicants: (1) unfairness of content--the inclusion of vocabulary, concepts, and other types of information unrelated to the backgrounds of minority group members; (2) lack of content relevance--the inclusion of items irrelevant to the requirements of the job; (3) test-induced anxiety and poor motivation resulting from the testing situation; and (4) the unresolved hypothesis that test scores might be differentially valid for different groups (p. 641).

Fair employment legislation. As a result of federal legislation during the past decade, test validity, traditionally the concern of psychometricians, became a legal issue. Title VII of the Civil Rights Act of 1964 represented a major effort of the federal government to assure equal employment opportunities for members of minority groups without regard to race,

color, religion, sex, or national origin.

The Equal Employment Opportunity Commission (EEOC), created as a regulatory agency under provisions of the 1964 Act, formulated guidelines based on the belief that "properly validated and standardized testing procedures could significantly contribute to the implementations of nondiscriminatory personnel practices (*Guidelines on Employment Testing Procedures*, 1966; *Guidelines on Employment Selection Procedures*, 1970)."

Expanded guidelines (*Uniform Guidelines on Employee Selection Procedures*) were published in draft form by the Equal Employment Opportunity Coordinating Council in August, 1973, and in June, 1974. Following a period of open discussion by concerned professional and lay persons, the finalized guidelines are to be published in the Federal Register. The revised Guidelines represented a cooperative effort by representatives of five federal agencies comprising the Council (U.S. Civil Service Commission, Equal Employment Opportunity Commission, U.S. Department of Justice, U.S. Department of Labor, and the U.S. Commission on Civil Rights) to develop a coordinated set of employee selection procedures. The guidelines will be discussed later in this chapter.

The Council was created under provisions of the Equal Employment Opportunity Act of 1972. The Act, passed by Congress as an amendment to the Civil Rights Act of 1964, extended coverage of the 1964 Act to additional employers in private industry, small labor unions, state and local governments, and educational institutions (De Witt, 1973).

Court decisions. A large number of court decisions have directly related to the nondiscriminatory testing provisions of the Civil Rights Act

of 1964, as amended, and the guidelines issued in pursuance of the Act. In evaluating the significance of court decisions and guidelines, Seberhagen, McCollum, and Churchill (1972) stated:

Statutes are considered primary authority and, of course, control any rules promulgated pursuant to them. Court decisions and the decisions and guidelines of regulatory agencies are not laws but interpretations of laws for given situations in which the law was not clear. Nevertheless, these interpretations form a network of legal opinion that must be given great deference by the public (p. 9).

Section 703 (h) of the Civil Rights Act of 1964 dealt directly with the nondiscriminatory use of employment tests. It specifically provided that:

...it shall not be an unlawful employment practice for any employer to...give and to act upon the results of any professionally developed ability test provided that such test, its administration or action upon the results is not designed, intended, or used to discriminate because of race, color, religion, sex, or national origin.

Differences in interpretation regarding Section 703 (h) resulted in numerous court actions brought under the Civil Rights Act of 1964. The principal issues were: (1) the legal definition of a "professionally developed ability test," and (2) whether the lawful use of an employment test depended on employer intent to discriminate or the discriminatory impact of the test (Cooper and Sobel, 1969, p. 1651). Although the published EEOC Guidelines had addressed these issues, it remained for the courts to clarify the legislative intent.

Several landmark cases established legal precedents pertaining to the nondiscriminatory use of employment testing. Foremost among these was the decision of the U.S. Supreme Court (1971) in the case of *Griggs vs. Duke Power Company*.

The case concerned thirteen black employees in the labor department

of the company's power generating plant. The employees instituted a class action in "behalf of present and future black employees" which challenged the company's hiring and promotion procedures. The employees protested the company requirement of a high school diploma and passing scores on a general intelligence test and a mechanical aptitude test for all positions except those in the labor department. The company maintained that the requirements had been instituted for legitimate business needs and contended that Section 703 (h) authorized the use of "any professionally developed ability test" that was not "designed, intended, or used to discriminate."

Both the U.S. District Court (North Carolina) and the U.S. Fourth Circuit Court of Appeals which tried the case, ruled that inasmuch as the tests were required of members of nonminority as well as minority group members, it could not be held that the tests had any discriminatory purpose. However, the U.S. Supreme Court, in reversing the decisions of the two lower courts, held that Congress had directed the thrust of the Act to the "consequences of employment, not simply the motivation." Thus, intent was not the critical issue.

The Supreme Court ruled that a test might unintentionally discriminate against minority groups and where evidence existed that a test was discriminatory in its impact, the burden of proving the job relatedness of the test lay upon the employer. The court further defined a "professionally developed ability test" as one related to job performance, and not a test, such as an intelligence test, that was prepared by a professional test developer. The Court held that it was the responsibility of the test user to "measure man for the job and not man in the abstract."

The Supreme Court emphasized that nothing in the Act precluded the use of testing or measuring procedures. It held that Congress did not intend to guarantee a job to every person regardless of qualifications but rather intended to achieve equality of employment opportunities. The Court further acknowledged the EEOC and the published Guidelines issued pursuant to the Civil Rights Act of 1964 as expressing the will of Congress.

The *Griggs* decision focused attention on the need for reevaluation of written employment tests and other selection procedures to assure that they were fair and valid measures of job performance. Although the *Griggs* decision prohibited the use of general ability tests that had a discriminatory impact and no demonstrable relationship to job performance, it left several issues unresolved: (1) the type of evidence required to establish discriminatory impact; (2) the type of evidence required to determine whether a particular test was job related; and (3) the use of validation guidelines independent of the format established by the EEOC (Roth and Stahl, 1973).

As previously noted, absence of intent to discriminate was not the relevant issue. Plaintiffs were required to submit evidence showing that a test had a discriminatory impact. Courts accepting this evidence would then place upon the employer the burden of proving the job relatedness and validity of the test. However, courts did not always accept claims presented by plaintiffs as adequate evidence for requiring employer proof of validation. Proof of validity was not required in a case where an aptitude test used to evaluate applicants to an apprenticeship program did not function to disproportionately exclude minorities (*U.S. vs. International Brotherhood of Electrical Workers*; U.S. District Court, Ohio 1972). In another case, proof of validity was not required by the court where the plaintiffs

presented only raw figures, made "...no showing of percent of blacks or whites who passed or failed the test," and no showing that the test resulted in the disproportionate exclusion of blacks from employment opportunities (*Russell vs. American Tobacco Company*, U.S. District Court, North Carolina, 1973).

The majority of courts accepted statistical data which showed sparse representation of minority workers within a particular work force and a disproportionate minority pass rate on employment tests favoring nonminority applicants as evidence of discriminatory impact. In *Chance vs. Board of Examiners and Board of Education of the City of New York* (U.S. Court of Appeals, Second Circuit, 1972), the plaintiffs claimed that the competitive examinations given to those seeking permanent appointment as principals in the city schools discriminated against blacks and Puerto Ricans. The Board had argued:

If statistics have any relevancy in determining the claim of discrimination, the only meaningful statistic would be a comparison of the pass-fail ratio of [whites with those of] black and Puerto Rican applicants (p. 1171).

Accordingly, the court ordered a survey to be undertaken to determine the comparative pass ratios of different ethnic groups. The survey, which took several months to complete, was unique in that it covered 50 supervisory examinations given to approximately 6,000 applicants over a period of several years. Results of the survey showed that approximately one and one-half times as many white examinees passed the tests than did black and Puerto Rican examinees.

The court held these findings and additional statistics showing disproportionate employment of minorities in principal and assistant

principal positions within the city, as compared to other large metropolitan school systems not having comparable examination requirements, as sufficient evidence for requiring employer "proof" of test validity. While acknowledging that the EEOC Guidelines held that content validity was appropriate where criterion-related validity was not feasible, the court did not attempt to resolve the controversy on preferred method of validity since it concluded that the Board had failed to establish that the examinations were valid as to content much less to predictiveness.

Similar statistics showing disparate pass rate of minorities and their disproportionate employment in a workforce were accepted by the court in *Bridgeport Guardians, Inc. vs. Commission* (U.S. District Court, Connecticut, 1973). Statistical evidence presented to the courts showed that three and one-half times as many nonminorities passed the tests as did blacks and Puerto Ricans. Also, the employment of minority policemen in the city was shown to be 3.6 percent as compared to their 25 percent representation in the city's population, and the 13 percent and 14 percent employment of minority policemen in neighboring communities.

In the case of *U.S. vs. Georgia Power Company* (U.S. Court of Appeals, Fifth Circuit, 1973), the court addressed itself to the issue of validation procedures which differed from those established in the 1970 EEOC Guidelines. The company requirement that all job applicants pass a battery of aptitude tests before they could be hired resulted in the disproportionate exclusion of blacks from employment and advancement in the company. The tests used were commercially developed tests which had been initiated without any prior study of their ability to predict job performance. In commenting on the use of these tests, the court noted;

For Title VII purposes, a test is not valid or invalid per se but must be evaluated in the setting in which it is used (p. 912).

The company acknowledged its "Griggs burden" and, as evidence of validity, submitted to the court a post-testing study conducted by a consulting psychologist who found a positive relationship between job performance and test scores. The court found the submitted study to be inadequate evidence of test validity because it did not meet the minimum validation of the EEOC Guidelines: (1) results of the statistical validation procedure used in the study differed markedly from results obtained using American Psychological Association validation standards, as suggested by the Guidelines; (2) the study made no separate racial group validation study even though a minority sample was available; and (3) the study did not utilize the test scoring procedures used by the company.

Another contested issue in the courts related to the type of validation procedures required to establish satisfactory evidence of job relatedness. In *Davis vs. Washington* (U.S. District Court, District of Columbia, 1972), the court upheld the city's use of a promotional test of judgment based on critical incidents selected by expert members of the police department and reviewed by another panel of police and testing experts. While acknowledging the three methods of validating the job relatedness of a test (criterion-related, content, and construct), the court noted that each of these recognized processes, if properly used, can establish that an employer's selection device is job related. The court found that the test comprised a suitable sample of the relevant job behaviors and skills required and held the test "validated for content in the present stage of the law and art of testing (p. 6957)."

In *Douglas vs. Hampton* (U.S. District Court, District of Columbia, 1972), eight black college graduates charged that the Federal Service Entrance Examination, used for college graduate entry into the U.S. Civil Service, discriminated against racial and cultural minorities. The district court upheld the use of the test and rejected the plaintiffs' arguments that validation can only be established by an empirical, statistical study. This decision was later reversed by the U.S. Court of Appeals (District of Columbia, 1975), which found that evidence of construct validity "did not conclusively demonstrate the test's job relatedness without a demonstration that proof of empirical validity was not feasible (p. 7057)."

Other courts in their interpretation of the EEOC Guidelines have supported the use of criterion-related validity for establishing job relatedness. A discussion of some of these decisions appears in Chapter II in the review of firefighter court cases.

In attempting to sum up the implications of the court decisions reached here, the following conclusions were reached:

- (1) The court cases reviewed confirm that many employers have heavily relied upon the use of tests for making employment decisions; and that the comparatively poorer performance of minorities on tests has resulted in their disproportionate exclusion from employment opportunities.
- (2) While tests have been relied upon as a more fair and objective method than personal judgments for making employment decisions, evidence of their discriminatory impact makes it legally mandatory to prove their job relatedness and validity.

- (3) In their interpretations of the fair employment provisions of the law, the courts have leaned heavily upon the *Griggs* decision and the EEOC Guidelines issued in pursuance of the Civil Rights Act of 1964, as amended in 1972.
- (4) The type of validation (criterion-related, content or construct) required to establish satisfactory evidence of the job relatedness of an employment test has been a highly contested issue in the courts.

EEOC Guidelines. The Guidelines were developed by the Equal Employment Opportunity Commission in consultation with a panel of psychologists and were based upon professional standards included in the *Standards for Educational Tests and Manuals* and *Standards for Educational and Psychological Tests*, published by the American Psychological Association in 1966 and 1974, respectively. As previously noted, the Guidelines were published first in 1966, expanded in 1970, and then revised and expanded in 1973 and 1974, in draft form, by the Equal Employment Opportunity Coordinating Council. Work on the Guidelines was still underway in September, 1975, at the time this study was being completed.

The Guidelines were designed to serve as a "workable set of standards" with respect to tests and other employee selection procedures under the equal employment opportunity provisions of the federal law. A complete understanding of the many technical details may best be obtained by a thorough review of the Guidelines themselves. However, only a few of the important highlights pertaining to the use of tests are presented here:

- (1) The Guidelines have expanded the definition of test to

include any "standardized, formal, scored or quantified measure or combination of measures used as a basis for any employment decision."

- (2) Where the use of a test has resulted in a significantly higher rejection rate for minority applicants than nonminority applicants, evidence of job relatedness and test validation is required to justify use of the test.
- (3) As stated in the 1974 Guidelines, proof of test validity may be established by either content, construct, or criterion-related validation procedures, as defined by professional scientific standards. Under the 1970 Guidelines, evidence of content or construct validation was considered appropriate only when criterion-related validity studies were not feasible. The type of "preferred validity" became a contested issue that was argued at public hearings (APA Monitor, 1973) and in the courts. The use of content and construct validity has been considered by the U.S. Civil Service System to be more appropriate to the principles of merit testing.
- (4) A systematic and comprehensive job analysis is required as the basis for any type of validation study. A content valid test may only measure those knowledges, skills, or abilities required for immediate job performance, and not those acquired through subsequent work experience or on-the-job training.
- (5) A comparative investigation of the predictive validity of tests for minority subgroups is required wherever tests are

shown to have an adverse impact upon the performance of these subgroups and it is technically feasible to do so. This guideline has become a highly controversial one. A number of research studies which have dealt with this issue of "differential validity" will be reviewed in Chapter II, Literature Review.

Need for Study

Civil service agencies which regularly test large numbers of applicants for many different types of job classifications are faced with special problems relating to their need for large numbers of tests. In addition, they are required to meet both the standards of merit testing and the legal guidelines established for test validation.

Legal guidelines have clearly established that standardized employment tests, including commercially developed ones, be job related and valid for the specific jobs for which applicants are being tested. Concomitantly, there is a need to ascertain that employment tests do not unintentionally disqualify minority as well as nonminority applicants because of reasons unrelated to job performance.

The EEOC Guidelines (1970) stated that the "general reputation of a test, its author, or publisher" could not be accepted in lieu of evidence of test validity. This directive has made evident the need to evaluate commercially prepared tests in the context of the specific job settings for which they are being used. Civil service agencies who frequently use commercially prepared selection tests to augment their own specially developed tests are particularly concerned with the extent to which commercially

prepared tests are job related and valid to their specific work settings.

Research is needed to explore procedures through which commercially prepared tests may be evaluated to assure their specific job relatedness and validity. This requires thorough job analysis through which knowledges, skills, abilities, and other characteristics essential to the performance of a job may be identified. Test review and content analysis of the commercially prepared tests may then be related to the findings of the job analysis. As established by the EEOC Guidelines, validity of employee tests may be ascertained through one of three basic validation procedures--content, criterion-related, or construct. Further, analysis of applicants' test performance may serve to identify test characteristics which tend to disqualify subgroups of applicants on factors unrelated to job performance.

Government employment is looked upon by many minority group members as an opportunity for vocational advancement and economic security. A study by the U.S. Commission on Civil Rights (1969) reported that minorities were disproportionately underrepresented in police and fire departments in many areas of the country. There have been a large number of court cases challenging the use of employment tests on which minorities scored significantly lower than nonminority groups (Cooper and Sobel, 1969). Many of these court cases have focused on civil service tests used to select entry level firefighters. A review of these cases appears in Chapter II.

The Occupational Outlook Handbook (1974) reported that in 1972, about 200,000 men worked as firefighters in city fire departments and that the

number of firefighters employed ranged from 25 in some towns to several thousand in some large cities (p. 181). The *Handbook* forecast that the employment of firefighters is expected to increase rapidly through the mid-1980's to meet the need for fire protection in growing urban communities. Focus on the position of entry level firefighter in terms of its job performance requirements and related employment tests appears particularly relevant at this time to the need for research in the area of testing relating to fair employment practices.

Purpose of Study

This study was intended as an exploratory study of the relationship between commercially developed standardized employment tests and: (1) actual job performance requirements within a specific work setting, as identified through careful job analysis; and (2) the comparative test performance of subgroups of job applicants, by race and educational level. In seeking relevant procedures for establishing the job relatedness and validity of commercially developed standardized tests to a specific job setting, the position of firefighter was selected to serve as a procedural model.

The specific purpose of the study was to evaluate the use of two entry level firefighter selection tests utilized under merit principles by a mid-western municipal agency. The tests were developed by an independent testing company which specializes in designing tests for use by public employers.

Scope of Study

Design. The study was designed as a descriptive, analytic study of the job relatedness and potential social bias of two entry level firefighter

selection tests, as administered to 189 civil service applicants in a mid-western city in June, 1973. The objectives of the study were: (1) to compare the relationship between the two firefighter selection tests used in the test administration and the actual job requirements, as determined through the performance of a careful job analysis; and (2) to explore the potential social bias of the two tests through a comparative statistical analysis of the test performance of subgroups of applicants, by race and educational level. The study was conducted in five major phases as follows:

Phase One: A job analysis of the firefighter position as implemented within the city's fire department was conducted. Findings of the job analysis made it possible to infer the comparative job relatedness and content validity of the two tests.

Phase Two: A comparative analysis of the two selection tests was performed to identify the content areas of the tests, including knowledges, skills, abilities, and other characteristics.

Phase Three: This phase of the study focused on the test performance of the 189 examinees on the two firefighter tests. Normative test data for both tests were obtained through computer analyses of raw test scores. The statistics obtained included means, standard deviations, and reliability. Item analyses were performed to ascertain the indices of item difficulty and discrimination for each test.

Phase Four: The differential test performance of the predominant minority subgroup (blacks) and the majority group (whites)

was analyzed to determine if there was a statistically significant difference in their test performance and their pass/fail rates. The hypotheses that were investigated for each test are stated in null form, as follows:

Hypothesis 1. There will be no statistically significant difference between the mean test scores of applicants, when considered by race.

Hypothesis 2. There will be no statistically significant difference between the mean subtest scores of applicants, when considered by race.

Hypothesis 3. There will be no statistically significant difference between the number of applicants, when considered by race, who pass or fail the test.

Phase Five: Corresponding statistical analyses of the test performance of the 189 applicants by educational level was conducted to determine if the tests were biased in favor of examinees who had attained higher levels of education. The hypotheses that were investigated for each test are stated in null form, as follows:

Hypothesis 4. There will be no statistically significant difference between the mean test scores of applicants, when considered by educational level.

Hypothesis 5. There will be no statistically significant difference between the mean subtest scores of applicants, when considered by educational level.

Hypothesis 6. There will be no statistically significant difference between the number of applicants, when considered by educational level, who pass or fail the test.

Assumptions. This study was based on the assumption that the examinees who took the two entry level tests were representative of the population of applicants who might apply for the civil service position of firefighter.

Statement of controls. The firefighter tests were administered to applicants under standardized testing procedures established for civil service agencies. This included concern for adequacy of physical testing facilities, proctoring, security, scoring, as well as test administration.

Limitations of study. Procedures used in this study for ascertaining the correspondence of job requirements and employment tests were limited to the use of paper and pencil tests.

Definition of Terms

Validity. Questions of validity are questions of what may properly be inferred from a test score; validity refers to the accuracy of such inferences (American Psychological Association, 1974). Different types of validation procedures are used to make different types of judgments about tests. Definitions for the different types of validation are presented below in the context of current EEOC guidelines for personnel selection.

Content validity. Content validity refers to the extent to which a test is a representative sample of the tasks or the specific measurable job knowledges, skills, or abilities deemed to be essential and critical for immediate job performance as identified through job analysis.

Criterion-related validity. This type of validity refers to the extent to which a test correlates with one or more external variables considered to provide a direct measure of job success. Criterion-related validity may be concurrent (indicative of present job success) or predictive (indicative of future job success). EEOC guidelines for establishing criterion-related validity require job analysis and the identification of criterion measures representative of essential work behaviors.

Construct validity. A test with construct validity is used for personnel selection or promotion to infer the degree to which an applicant possesses some hypothetical trait required for satisfactory performance of essential duties identified through job analysis.

Social bias. As used in the context of the present study, social bias refers to the quality of a test whose content is not related to the specific job performance requirements for which applicants are being tested and whose use results in depressed scores for members of a particular subgroup or subgroups.

Job related. A test is job related if it samples knowledges, abilities, skills, or other characteristics shown through careful job analysis to be necessary or important for successful performance of a job.

Procedural model. As used in the context of this study, procedural model refers to the demonstrated application of a systematic set of procedures. It is further used here to refer to the type of information that was sought, the procedures used to obtain the information, and how the information was organized.

Organization of the Report

Chapter I, Introduction, presented background information on the issue of the fairness of competitive employment testing--from its early democratic traditions of civil service merit testing to the nondiscriminatory testing provisions of the Civil Rights Act of 1964, as amended, and the numerous court challenges relating to employment testing. In addition, this first introductory chapter included a discussion of the descriptive, analytic study that was conducted and reported here of the use of two entry level firefighter tests.

Chapter II, Literature Review, overviews some of the literature on test fairness, reviews court cases involving testing challenges in firefighter selection, and reviews research literature pertaining to firefighters and firefighter selection. The procedures used in this study are discussed in Chapter III, Methodology. This included a job analysis of the firefighter position in a midwestern city, the analysis of two firefighter selection tests used by the city in a civil service test administration, and the statistical procedures used to analyze the results of the test administration.

Chapter IV, Results, presents the results of the job analysis and the two firefighter tests analyses, as well as statistical results of the test performance of a group of 189 firefighter applicants, and the comparative test performance of subgroups of the 189 applicants, when considered by race and educational level. A summary of the study, conclusions, and recommendations are presented in Chapter V.

Chapter II
LITERATURE REVIEW

Introduction

An important part of the literature search that was conducted provided background information for this study and was discussed in the first chapter. Chapter II provides additional perspective on the issue of test fairness particularly as it related to the legal challenges involving firefighter selection tests. Also, results of the literature search reported in this chapter include a review of firefighter studies concerned with identifying predictor variables of firefighter success.

Issue of Test Fairness

In response to findings that tests were being used for employee selection purposes with insufficient evidence that they were job related and valid, and that the use of these tests frequently served as arbitrary barriers to minority group employment (Roth and Stahl, 1973), renewed attention was focused on the issue of test fairness.

While it was readily acknowledged that employment tests were designed to discriminate, a careful distinction was made between fair and unfair test discrimination. Kirkpatrick, Ewen, Barrett, and Katzell (1968) stated that a test may be considered unfair where minority group members obtain significantly lower test scores than nonminority group members but would, in fact, be as successful on the job (p. 6).

Ways in which employment tests might unfairly discriminate against

minority group members were examined from both a rational and empirical basis. Possible sources of test bias (or unfairness) were seen to fall in three general categories: test content, test environment, and test misuse (Flaugher, 1974). Attention was directed to ways of minimizing factors that might serve to unfairly handicap the test performance of minority group members.

One major challenge to the fairness of employment tests was their emphasis on verbal skills demanding knowledge differentially available in various ethnic groups (APA Task Force in Employment Testing of Minority Groups, 1969, p. 641). While some efforts were made to minimize racial differences in test performance through use of culture-fair or nonverbal tests, this was not found to be a solution to the problem (Byham and Spitzer, 1971; Bray and Moses, 1972).

Another approach to improving test fairness was through the use of item analysis. This statistical technique was utilized to determine whether particular test content was more difficult for members of different racial groups and also to provide clues for modifying test items for low scoring groups (Bianchini, 1966; Kishner, 1973). Direct examination of the test items could also serve as a means for improving the verbal components of a test.

Another major challenge to fairness of test content was in the lack of relevance to job performance. Intelligence and aptitude tests were not viewed as adequate predictions of job success because they were believed to reflect the disparate educational opportunities of minority group members (Cooper and Sobel, 1969; Wallace, 1972). In considering problems relating to the use of employment tests, the APA Task Force (1969) stated:

Tests of specialized job-relevant knowledges and skills or of samples of job performance are, in themselves, free of bias...The crucial question is whether the test activities accurately reflect the job behaviors (p. 640).

Another issue relating to test fairness has been that of differential validity--that is, whether test scores might differentially predict job performance for different racial ethnic groups. There have been many studies dealing with this issue and, in considering some of their findings, Guion (1972) stated:

...Early writings on the subject seemed to indicate that determining validities independently for blacks and whites would result in fair selection systems (Guion, 1966; Kirkpatrick, Ewen, Barrett and Katzell, 1968; Krug, 1966; Lopez, 1966). Sober second thought and data suggest that differential validity is either hard to find or works to the further disadvantage of blacks (Boehm, 1972; Campbell, 1972, Grant and Bray, 1970)...(p. 73).

A major six-year study conducted by Campbell, Crooks, Mahoney, and Rock (1973) related test scores to job performance for 1,400 workers in three skilled occupations--medical technician, cartographer, and inventory manager. The study found that the employment tests based on job analyses predicted tests fairly for members of different racial ethnic groups.

Differential validity has nevertheless continued to be a controversial issue. Bray and Moses (1972) stated:

...In general, the results...tended to be inconclusive. Interestingly enough, it seems that as a general rule, most studies showing a lack of differential validity have used better than average criterion measures, while most of the studies supporting differential validity rely on subjective, poorly defined rating criteria...It does appear, however, that the closer the study design comes to the ideal, the less likelihood there is of finding differential validity (p. 554).

Firefighter Court Cases

Of particular interest to this study were court cases which involved

testing challenges in the area of firefighter selection. Review of these cases provided useful guidelines for the study of the two firefighter selection tests used in the civil service test administration.

Griggs burden. As established in *Griggs*, where evidence is presented that may support an inference of the existence of discriminatory testing practices, even if not intentional, the employer has the lawful burden of showing that such tests are job related and valid. However, before employers are required to present such proof, plaintiffs must first submit to the courts statistical evidence indicative of the discriminatory impact of the test. In the cases reviewed, evidence accepted by the courts included: (1) disproportionate minority employment in the city's fire department as compared with minority representation in the age eligible group of the city's population; (2) a high minority failure rate on the test; and (3) low ranking of minorities on the list of passing examinees.

In the case of *Western Addition Community Organization vs. Alioto*, (U.S. District Court, N.D., California, 1973), the court, while admitting such evidence, affirmed:

...the law does not require that all employment must proportionately reflect racial population components; it only requires that no minority job applicant (and for that matter no white job applicant), otherwise sufficiently qualified or readily qualifiable to perform a job, shall be...disqualified on the basis of an examination that goes *beyond* the requirements of the job (p. 739).

In *Carter vs. Gallagher* (U.S. Court of Appeals, Eighth Circuit, 1971), the court accepted evidence which showed that although the city had a minority population of 6.4 percent, there were no minorities employed in the city's 535-person fire department; and that use of the written examination had resulted in an all-white fire department. In *Western Addition Community*

vs. *Alioto* (U.S. District Court, N.D., California, 1973), the statistical evidence accepted was disproportionate representation of blacks and Mexican-Americans in the fire department. Although blacks constituted 14 percent of the city's adult population, only 4 were employed in the city and county's 1800-man fire department. Also, none of the blacks and only four Mexican-Americans ranked high enough on the eligible list to stand a chance for selection to the fire service during the life of the list. The evidence accepted in *Fowler vs. Schwarzwalder* (U.S. District Court, Minnesota, 1972) included the fact that none of the minority applicants were successful in being one of the top 20 applicants; and that while the city had a minority population of approximately 6 percent, only 1.4 percent were firefighters. In *Harper vs. Mayor and City Council*, (U.S. District Court, Maryland, 1973) the evidence accepted by the court included the fact that the failure rate for whites was 4-1/2 percent and for blacks 20 percent. Other cities in which legal challenges were made of disproportionate hiring of minorities in the fire department included Boston, Chicago, and New York City.

Firefighter tests. Specific criticisms levelled in courts against the use of firefighter employment tests included allegations that the tests were not job related or properly validated. One of the principal issues in *Fowler vs. Schwarzwalder* was the validity of the written selection test. The plaintiff's expert witness stated that the examination "...tested specific mechanical and scientific knowledge which assumed an educational and socioeconomic background derived principally from physics and mechanics" and "...that background is most prevalent among nonminority persons." The court held that a proper job analysis had not been conducted and that the test could not be assumed to have content validity. While the job analysis had

only consisted of a list of job duties, it had not included the knowledges, skills, and abilities that were based upon a "systematic, empirical review of the elements that made up job performance."

Similarly, in *Harper vs. Mayor and City Council*, the court reviewed the various entry level firefighter tests that had been used by the city over a period of years and found that the tests had been prepared without benefit of a sound job analysis. The court commented that this "...fact seriously hampers, if it does not destroy, the tests ability to 'measure the person for the job and not the person in the abstract'." The city's 1971 test had consisted of multiple-choice questions prepared by a personnel technician and was based on a commercially prepared firefighter selection test used in previous years. The city offered testimony of a firefighting job expert who described the test as a general mental ability and mechanical aptitude type test, and concluded that the test was definitely job related. However, the court considered this expert advice an untested assumption and stated:

The crucial issue is whether the same type of psychological processes are involved in answering general aptitude questions of the type found in the test and in performing the duties of a firefighter (p. 7995).

In *Western Addition Community Organization vs. Alioto*, the court evaluated three firefighter tests used in the city. Plaintiffs contended that about 52 percent of the questions on the 1968 examination were not job related and bore no relevance to firefighting. They also claimed that the primary emphasis of the test was on math, verbal skills, and reading comprehension, and that the test items were those commonly found in group intelligence tests and scholastic achievement tests. Although the city's

1971 written test had been developed to correct the deficiencies of the previous test, the court held it invalid because of the absence of the proper job analysis required by the federal guidelines. The test had consisted of 40 multiple choice questions excerpted from firefighter department training manuals designed to test understanding and 90 questions on mechanical comprehension, practical choice, nonverbal reasoning, spatial visualization, and arithmetic, which had been purchased in the belief that "the questions had been used successfully by another public agency." In refusing to accept proof of validity of the test, the court cited the EEOC Guidelines that "under no circumstances will the general reputation of a test, its author or its publisher, or casual reports of test validity, be accepted in lieu of evidence of validity." Statistical evidence submitted to the courts by the plaintiffs showed that the test discriminated 3 to 1 in favor of nonminority applicants.

Eventually, the court accepted evidence that the job analysis conducted for the 1973 examination prepared by the city was substantially in accordance with the Guidelines. The job analysis had succeeded in identifying 10 traits and skills essential to the firefighter job as implemented within the city. Two of these traits--mechanical aptitude and written communication were selected to be included on the test. The court did not consider the content validation acceptable because the test was not limited to samples of knowledges and skills composing the job; it included questions designed to test skill in general, "such as mechanical aptitude questions concerning ability to note elementary principles of physics--pressures, balances, etc.;" it called for knowledges or skills which could be acquired in a brief orientation on the job; and it measured only two of

ten important skills which constituted an obvious overemphasis on these skills.

In *Vulcan vs. Civil Service Commission of City of New York* (U.S. District Court, New York, 1973), the court declared the firefighter selection test invalid because 20 percent of the questions were devoted to government and current events and were completely unrelated to the position of firefighter. Accordingly, the court ordered the preparation of a valid examination which measured up to the professionally accepted standards of content validity. The court held that even if the examination were valid for success in training school, further demonstration was needed that training was a valid test of performance on the actual job. The court also acknowledged the importance of physical skills in the firefighter job performance.

Establishing validity of firefighter tests. While the proof of job relatedness and content validation was a basic issue in the court cases reviewed above, some courts focused on the need for criterion-related validation studies. The court in *Vulcan* noted:

Chance explicitly left open the question of whether the State is required to establish predictive validity as well as content validity for its job testing procedures.* Some courts have taken the position that predictive or concurrent validation of employment examinations is absolutely required, at least in the absence of a showing that studies employing these methods have been attempted and found impractical to implement. The strong preference for these types of validation is based upon the fact that empirical comparison between test and job performance is the only means of conclusively establishing that an examination actually accomplishes its goal (p. 5839).

**Chance vs. Board of Examinees and Board of Education of the City of New York* (U.S. Court of Appeals, Second Circuit, 1972).

The defendants in *Vulcan* contended that neither method of criterion-related validity was feasible or practical because of the "truncation of sample problem"--the diminished sample resulting from the fact that failing or low scoring applicants would never be appointed. The court did not attempt to evaluate the validity of these objections because of prior failure to establish content validity. In *Harper*, the court questioned a predictive validity study which correlated the test scores on the firefighter entrance test with that of test scores on the fire school final examination rather than criteria of actual job performance.

Implication for study. After reviewing the firefighter court cases, several conclusions were made that have direct implications for this study:

- (1) The courts have emphasized the importance of a proper job analysis which included identification of important worker characteristics such as required knowledges, skills, and abilities as a basic requirement for proving job relatedness and validity.
- (2) The validity of firefighter selection tests was challenged in the courts where the tests included items irrelevant to the knowledges and abilities required of a firefighter, emphasized general abilities such as those found on group intelligence tests, included knowledge or skills which could be provided in training, required specialized mechanical or scientific knowledge, and which measured only a limited number of firefighter skills identified.
- (3) Particular emphasis has been placed upon the importance of using appropriate validation strategies. The courts reaffirmed that

proof of validity could not be established by expert opinion or by virtue of the fact that a test was professionally prepared. Legal preference was often expressed for predictive or concurrent validation studies despite identified problems of truncation of sample (in predictive studies) and effects of experience, and lack of motivation in concurrent validation studies. Also, under question in the courts was the use of predictive validation studies which correlated test scores with success in training rather than job success.

- (4) While some courts emphasized legal preference for criterion-related validation studies as proof of job relatedness, many found that the tests under consideration lacked content validity. It appears that the use of appropriate validation procedures are importantly related to the context of the individual employment situation and that evidence of more than one type of validity can strengthen support for the use of tests.

Firefighter Studies

In relation to the job analysis conducted for this study, a literature search was conducted to identify predictor variables indicative of firefighter success. Relatively few empirical studies relating to firefighters and firefighter selection could be identified that were pertinent to this study.

Literature reviews by Wolff and North (1952) and Jarrett (1957) disclosed that since 1920 increasing emphasis had been placed upon the mental as well as physical qualifications of firefighters. The development of

more sophisticated employment tests appeared to focus increasing attention on other characteristics predictive of firefighter success including various aptitudes and personal characteristics.

A predictive validity study by Wolff and North (1951) disclosed a significant relationship between firefighter proficiency and both a written civil service test of general knowledge and a test of mechanical comprehension. In a concurrent validation study conducted by the U.S. Training and Employment Service (1958), minimum test scores were set for four aptitudes predictive of firefighter job performance as measured by the General Aptitude Test Battery (GATB). They were: intelligence (general learning ability); spatial aptitude (ability to comprehend forms in space and understand relationships of plane and solid objects); form perception (ability to perceive pertinent detail in objects or in pictorial or graphic material); and manual dexterity (ability to move hands easily and skillfully). Three of these aptitudes (spatial aptitude, form perception, and manual dexterity) were considered to be related to mechanical aptitude or ability (Albright, Glennon, and Smith, 1963, p. 113).

Ghiselli (1966) conducted a comprehensive review of employment test validity studies conducted from 1919-1964. Based on his review of firefighter studies, he concluded that firefighter trainability was best measured by tests of spatial and mechanical abilities; that tests of intellectual ability were nearly as good; and that tests of perceptual accuracy also had some merit. He also found that the tests were more efficient predictors of firefighter trainability than of job proficiency (p. 82).

In a study of variables that correlated with firefighter success, Marks (1970) found that early assumption of family responsibility and

parental family adjustment differentiated between high and low vocational success. Physical abilities and personal attributes were rated most highly important of six performance dimensions identified in a job analysis of entry level firefighters (Waibel and others, 1974). The other dimensions included mechanical and trades knowledge, problem solving, mechanical and spatial aptitude, and communication skills.

Other characteristics indicative of firefighter proficiency were identified through observational techniques. These included the ability to understand and follow written and oral directions (Public Administration Service, 1940) and the ability to reason, draw conclusions, and form judgments (International Fire Service Training Association, 1968).

On the basis of the firefighter studies reviewed in this chapter, it was concluded that the characteristics relating to firefighter success were multi-dimensional and included physical and personal qualities as well as various mental characteristics. It was also concluded that in conducting a job analysis, more specific information relating to actual firefighter job responsibilities and duties was needed to establish their logical correspondence to firefighter characteristics required to perform the job.

Introduction

This study was designed as a descriptive, analytic study of the job relatedness and potential social bias of two entry level firefighter selection tests. In discussing the functions of different kinds of descriptive research, Best (1959) stated:

The process of descriptive research goes beyond mere gathering and tabulation of data. It involves an element of interpretation of the meaning or significance of what is described. Thus, description is often combined with comparison or contrast, involving measurement, interpretation, and evaluation (p. 102).

Some of the questions this study was concerned with were as follows:

- (1) What degree of job relatedness and content validity could be inferred from the findings of a job analysis to the two firefighter selection tests?
- (2) What important differences in test content could be observed from an analysis of the two firefighter selection tests?
- (3) How did the test performance of the total group of applicants compare on the two tests?
- (4) Were there any significant differences between the mean scores of applicants on the two firefighter tests and their subparts, when considered by race?

(5) Were there any significant differences between the mean scores of applicants on the two firefighter tests and their subparts, when considered by educational level?

(6) Were the test items on the two firefighter tests comparatively more difficult for subgroups of applicants, when considered by race?

(7) Were the test items on the two firefighter tests comparatively more difficult for subgroups of applicants, when considered by educational level?

This study was designed to be conducted in five major phases, as reviewed previously in Chapter I. Following the presentation of background information relevant to this study, Chapter III includes a detailed discussion of the procedures used in each of the five phases of the study. Briefly stated, the phases of the study were as follows:

Phase One: job analysis of firefighter position;

Phase Two: comparative content analysis of two firefighter tests;

Phase Three: comparative statistical analysis of test performance of applicants on both firefighter tests;

Phase Four: comparative statistical analysis of test performance of subgroups of applicants, by race, on both firefighter tests; and

Phase Five: comparative statistical analysis of test performance of subgroups of applicants, by educational level, on both firefighter tests.

Background Information

Locale. The locale of the study was a midwestern city with a

population of more than one-half million in 1970, ranking in population among the top 30 cities in the nation. While the city's population is predominantly white, during the last decade from 1960 to 1970, the black population increased over one third. In 1970, the ratio was almost 3 blacks to every 10 whites and others living in the city.

The city has a modern and well-equipped fire department. Personnel Department statistics indicated that, at the time of the study, there were 55 fire companies located throughout the city and 857 fire department employees organized at seven levels:

- Fire Department Director (Administrative Head)
- Fire Chief
- Deputy Chief
- Battalion Chief
- Fire Captain
- Fire Apparatus Operator
- Firefighter

Personnel Department statistics also indicated that there were 444 assigned firefighters at the time of the study who comprised 51.8 percent of fire department personnel. Personnel turnover in the fire department was reported to be relatively low with an average of two to three vacancies occurring each month. The average number of annual vacancies occurring in the fire department over a five year period was reported to be 336.

Firefighter Job. The average work week of the firefighter at the time of the study was 51.5 hours. Firefighters were assigned to one of three rotating shifts. Each shift was on duty for 24 hours and then had 48 hours off. The major tasks performed by the firefighters in the city were included in the job description prepared as part of the job analysis conducted for this study. A description of the 24 hour daily routine of the firefighter appears in Appendix A.

A capsule description of the general work duties of firefighters appeared in the *Occupational Outlook Handbook* (1974):

During duty hours firefighters must be prepared to rush to a fire and handle any emergency that occurs... At every fire, firefighters perform specific jobs assigned to them by their commanding officer. They may connect hose lines to hydrants, operate a pressure pump, or position ladders. Because their duties may change several times while the company is in action they must be skilled in many firefighting activities. In addition, they help people to safety and administer first aid (p. 181).

Merit testing for firefighter applicants. The position of firefighter is the entry level position in the department. As part of the merit selection system used by the city's Personnel Department, job applicants are required to take a written examination. The selection process also requires an oral interview, a physical examination, and verification of applicant requirements, as established by the fire department. Those passing all phases of the selection process are placed on a list in order of those who scored highest on the written examination. Appointments are made from the top of the list as job openings for firefighters occur. Successful applicants are assigned to an intensive six to eight week training program at the Fire Academy prior to their assignment at one of the city's fire stations. Firefighters are required to serve two years to become eligible to take the promotional examination for fire apparatus operator.

Subjects of study. The subjects of the study were 189 males who applied for the municipal civil service position of entry level firefighter and were tested in June, 1973. Information concerning the characteristics of the applicants (sex, age, educational attainment, racial ethnic group membership, and employment status) was available from firefighter job application records. The information recorded on the forms was hand tallied and is summarized in Table 1, which appears on the following page.

TABLE 1
 CHARACTERISTICS OF FIREFIGHTER
 EXAMINEES BY TOTAL GROUP
 (N=189)

Characteristics	Number	Percent of total
<i>Sex</i>		
Male	189	100 %
<i>Age</i>		
21 or less years	46	24.3
22-25 years	100	52.9
26-35 years	43	22.8
<i>Educational Level</i>		
High school only	95	50.3
Post high school	94	49.7
<i>Racial/Ethnic Origin</i>		
American Indian	1	.5
Black	36	19.1
Spanish surnamed	1	.5
White	151	79.9
<i>Employment Status at Application</i>		
Employed	139	73.5
Unemployed	50	26.5

As can be observed, the majority of the applicants were white (79.9 percent) and the largest minority group was black (19.1 percent). The percent of black applicants who took the firefighter selection tests approximated the city's black population.

Somewhat more than half of the examinees were in the 22-25 year age range, and almost three-fourths were employed at the time they filed their applications. Examinees were rather evenly divided by educational level. Approximately half the group had a high school diploma or Certificate of High School Equivalence and the other half (49.7 percent) had additional post high school education.

Table 2 presents characteristics of examinees when considered by race. Ten percent more of the white examinees than black examinees had post high school education and 15.1 percent more of the whites than blacks were employed.

Test administration. To accommodate the large number of applicants, the written test administration was held in five separate testing sessions from June 18 through June 21, 1973. The two firefighter tests were administered to applicants in a special testing room and were conducted under standardized testing conditions. The 1973 Firefighter Test was administered first. It had a total of 139 test items and two and one-half hours were allowed to complete it. The 1966 test had 120 items and one and three-quarter hours were allowed for its completion.

Test instruments. As part of the selection procedures, applicants were administered two firefighter tests: Firefighter Test (Form 20-C) copyrighted in 1966 by the Public Personnel Association and Firefighter Test

TABLE 2
 CHARACTERISTICS OF FIREFIGHTER APPLICANTS BY RACE
 (Black = 36; White = 151)

Characteristics	Black		White	
	Number	Percent of total	Number	Percent of total
<i>Sex</i>				
Male	36	100 %	151	100 %
<i>Age</i>				
21 or less years	6	16.7	40	26.5
22-25 years	21	58.3	78	51.7
26-35 years	9	25.0	33	21.9
<i>Educational Level</i>				
High school only	21	58.3	73	48.3
Post high school	15	41.7	78	51.7
<i>Employment Status at Application</i>				
Employed	22	61.1	115	76.2
Unemployed	14	38.9	36	23.8

B-1 (P) copyrighted in 1973 by the International Personnel Management Association, which later incorporated the former organization.

The 1973 Firefighter Test was developed as a replacement for the former. However, because the test was new and had not yet been used for personnel selection by the Personnel Department, both tests were administered to applicants. The earlier 1966 test included items designed to measure general as well as other abilities for learning the job. The 1973 Firefighter Test, which was developed on the basis of a general job analysis conducted for the position, focused on the specific abilities required to absorb training. Both tests were paper and pencil examinations with multiple choice test items.

Procedures

Phase One: Job analysis. A job analysis consists of a systematic study of a job to obtain information for making various types of occupational decisions. Super and Crites (1962) recognized that a job analysis is a basic requirement for the selection and construction of tests that are valid indicators of job performance. Through the identification of worker characteristics directly related to job success, the job analysis can help assure that tests do not measure factors unrelated to on-the-job performance. As observed by Albright, Glennon, and Smith (1963), unless a test has a proven relationship to job success, hiring the highest scorers may amount only to hiring those who are good test performers.

For personnel selection purposes, a job analysis consists of defining the job and discovering what it calls for in employee behaviors (Dunnette, 1966). The two major aspects involved in selection-oriented job analysis

involve study of the tasks performed on the job and the identification of worker characteristics required to perform these tasks.

The KSAP job analysis model, developed by the Educational Testing Service, was used to conduct the job analysis of the firefighter position. This model was a variation of the job element approach which seeks to directly identify and evaluate the component elements (worker knowledges, skills, abilities, and personal characteristics) required for successful job performance through ratings made by job experts.

In order to identify the job-related elements, a preliminary study was made of the duties and primary tasks performed by job incumbents. This study, whose outcome was a detailed job description, helped assure that there was basic agreement about what constituted the primary tasks of the job. In addition, the job description provided a current up-to-date record of the job tasks as they existed at the time of the study.

Various job analysis techniques used to study the job included a literature review of firefighter studies, examination of occupational literature on firefighters, a site visit to the Fire Academy where new recruits were being trained, an interview with the Supervisor of Training, examination of training materials, and a review of the job specification for the firefighter position retained by the Personnel Department.

A job description was developed based on information obtained from the procedures described above. The job description which is included in Appendix B consisted of two basic parts: (a) a job summary describing the overall scope and purpose of the job; and (b) a logical grouping of the major tasks performed on the job. Following a review by selected Fire

Academy personnel, the job description was finalized.

Based on the job description and other relevant information obtained during the occupational study, a rating scale was developed which included a listing of firefighter job-related knowledges, skills, abilities, and personal characteristics (KSAPs). The rating scale provided for the comparative evaluation of the identified job elements on four variables: (a) entry requirement--to what extent was the element necessary at entry into the job; (b) frequency--how often was the element used on the job; (c) importance--how important was the element to successful job performance; and (d) KSAP differences--to what extent did the element relate to differences in employee effectiveness.

An instruction sheet for completing the ratings and the rating form are included in Appendix C and D, respectively. Altogether the ratings were completed by 18 battalion fire chiefs stationed throughout the city and two fire training captains.

Each of the elements was rated on a four point scale. The obtained ratings were tallied by hand and then averaged to obtain a mean rating for each job element. Tables were then prepared indicating the comparative mean ratings of the job elements.

Phase Two: Content analysis. The purpose of the content analysis was to gain understanding of the various test items included in the firefighter selection tests and to relate their content to the findings of the job analysis. In examining test items, a special effort was made to classify them into separate categories based on type of item content.

Tinkelman (1971) observed that the term "test content" had been broadly used to describe different types of content areas such as subject matter or types of abilities. Study of the two tests disclosed that because of differences in test emphasis, the content areas included such diverse categories as subject areas, general abilities, specific abilities, and aptitudes.

A method for classifying the items in a test outline was sought that could provide a basis for direct comparison of the content with the findings of the job analysis. In considering various methods for classifying test content, Tinkelman (1971) stated:

There is no single scheme of classification that can serve all situations. For each test, it is necessary to develop a unique classification that is appropriate for the special purposes of that test, that describes the achievement of the examinee in a meaningful manner... (p. 55).

In the present study, a format for classifying test content was adapted from a procedure described by Ebel (1972, p. 365). In constructing a test outline to examine content relevance and balance, Ebel focused on content (subject area), tasks presented by items, and the relative proportion of items included in each of these categories.

The format adapted for this study attempted to provide a means for classifying the diverse categories of items included in the two tests as well as a description of the types of tasks presented by the items. Overall, the content outline was constructed to provide the following: descriptive information concerning the publisher and purpose of the test, copyright date, and the type and total number of items; the test categories into which items were classified; the total number and percent of the

items in each category, and a description of the tasks presented by the items. The completed content outlines for both tests appear in Chapter IV, Results.

Phase Three: Comparative test statistics for both firefighter tests. The administration of the two firefighter selection tests to the same group of 189 applicants made it possible to statistically describe and compare their test performance on both tests. The statistical analyses of the tests focused on four factors considered important in judging the effectiveness of a test: difficulty, discrimination, reliability, and speededness (Ebel, 1972).

Applicants recorded their responses to test items on the two multiple-choice tests on standardized answer sheets. In preparation for data processing and analyses, the recorded responses were keypunched on computer cards and then verified for accuracy. Computer analyses of test data were performed at the Vogelback Computing Center at Northwestern University in Evanston, Illinois.

The two tests were rescored and descriptive measures of test statistics were obtained through computer analyses. The statistics obtained for each firefighter test and the test subparts included the mean, standard deviation, and a coefficient of reliability based on the Kuder-Richardson formula 20. Test reliability has been defined as "the consistency with which a test yields the same results in measuring whatever it does measure (Remmers, Gage, and Rummel, 1965)." The Kuder-Richardson formula 20 is a widely accepted formula which provides an estimate of test reliability based on the internal consistency of test items.

Item analyses were also performed to ascertain the index of difficulty and index of discrimination for each of the test items, as administered to the group of 189 applicants. Ebel's (1972) definition of index of difficulty as "the proportion of the group who do not answer the item correctly" is the definition that was used in this study.

The index of discrimination is a coefficient ranging from -1.00 to +1.00 which indicates the extent to which a particular test item was answered correctly by those applicants who scored high on the test and those who scored low. The index of discrimination used in this study was the biserial correlation coefficient (r_{bis}). Henrysson (1971) identified the use of biserial correlation coefficient as an index of item discrimination that is independent of the index of item difficulty (p. 142).

In addition, an analysis was made of the speededness of the two tests to determine whether the test was appropriate in length to the time available.

Phase Four: Comparative test performance by race. The hypotheses that were investigated in comparing the test performance of applicants, by race, on each test are stated below in null form. It should be observed that these are descriptive hypotheses relating to ex post facto data.

Hypothesis 1. There will be no statistically significant difference between the mean test scores of applicants, when considered by race.

Hypothesis 2. There will be no statistically significant difference between the mean subtest scores of applicants, when considered by race.

Hypothesis 3. There will be no statistically significant difference between the number of applicants, when considered by race, who pass or fail the test.

Computer analyses of test data were performed for subgroups of applicants, by race, corresponding to the analyses performed for the entire group. Statistics available for black and white subgroups of applicants included means, standard deviations, and reliability coefficients, in addition to indices of item difficulty for each test item. A comparative frequency distribution of test scores was prepared by race. Also a tally was made of those who passed or failed the two tests.

Various statistical procedures were used to test the stated hypotheses. The critical ratio test of mean differences for large groups was used to determine statistically significant differences between the mean test performance of black and white applicants on the two firefighter tests and the tests' subparts.* The chi square test was used to determine whether there was a statistically significant difference between the number of blacks and whites who passed or failed the two tests. Finally, the statistical significance of the difference of percents of blacks and whites who failed each test item was determined through the t-test of proportions.

Phase Five: Comparative test performance by educational level.

The hypotheses that were investigated in comparing the test performance of applicants, when considered by educational level, are stated below in null form. These hypotheses which correspond to those previously stated for applicants, by race, are descriptive hypotheses relating to ex post facto data.

*The critical ratio test used to test the significance between the two means was the ratio between the differences of the two statistics and the standard error of their difference.

Hypothesis 4. There will be no statistically significant difference between the mean test scores of applicants, when considered by educational level.

Hypothesis 5. There will be no statistically significant difference between the mean subtest scores of applicants, when considered by educational level.

Hypothesis 6. There will be no statistically significant difference between the number of applicants, when considered by educational level, who pass or fail the tests.

The computer analyses of test data and statistical procedures used to test the hypotheses stated above were the same as those used to analyze the comparative test performance of applicants, by race. A comparative frequency distribution of test scores of applicants by educational level was prepared and a tally made of those who passed or failed the two firefighter selection tests.

Chapter IV

RESULTS

Phase One: Job Analysis

Introduction. The objectives of the job analysis conducted for this study were to gain a thorough understanding of the firefighter job duties and primary tasks performed by job incumbents; to ascertain the scope and relative significance of the job elements required for successful on-the-job performance; and to relate the findings of the job analysis to the two firefighter selection tests used for civil service merit testing.

Basically, the job analysis consisted of the following procedures:

- (a) occupational study of the job using various job analysis techniques;
- (b) preparation of a factual job description identifying the major tasks performed by job incumbents;
- (c) identification of relevant job elements (knowledges, skills, abilities, and personal characteristics) required for job performance plus the preparation of a rating scale on which the assembled job elements might be evaluated by selected job experts;
- (d) distribution of the rating scale for completion by selected fire department personnel members;
- (e) statistical processing of the obtained ratings;
- (f) preparation of tables indicating the comparative mean ratings of the job elements on four factors--importance to successful job performance, frequency of utilization on the job, relationship to differences in employee effectiveness, and necessity at entry into the job, prior to on-the-job training; and
- (g) analysis of the obtained ratings and identification of job elements that might serve as the basis for the construction or identification of appropriate employment tests.

Job description. A job description was prepared to document the content of the firefighter position as implemented within the city's fire department. The job description included a summary of the overall scope and purpose of the firefighter position, and identified the job responsibilities and major tasks performed on the job. The job description, which appears in Appendix B, indicated the wide range of activities that firefighters engaged in during the performance of their duties. These were defined in six major areas of responsibility: firefighter training, firefighting activities, emergency rescue operations, emergency medical treatment, fire prevention activities, and general operational activities.

The preparation of the job analysis followed rules identified in the *Handbook for Analyzing Jobs* (1972): use of a terse, direct style; use of the present tense throughout; use of an action verb to begin each sentence; and omission of any words that do not impart direct information (p. 31).

Ratings of job elements. From the occupational study of the job and the task information provided in the job description, a comprehensive list of knowledges, skills, abilities, and personal characteristics required for task performance was assembled in a rating scale (see Appendix C). Each of the job elements was rated by experts on a four-point scale on four factors: essentiality at entry level, importance to job performance, frequency with which the job element was utilized on the job, and extent to which the job element differentiated between high and low job performers.

Tables 3-6, on pages 52-63, present the mean ratings for each of the job elements as evaluated by the experts. The mean ratings were interpreted in intervals as follows:

- .0 - 1.4 lowest rating
- 1.5 - 2.4 second lowest rating
- 2.5 - 3.4 second highest rating
- 3.5 - 4.0 highest rating

The overall ratings of the job elements indicated that the identified elements were highly relevant to the job situation and that they could provide useful information concerning the job relatedness and validity of the employment tests.

Discussion:

Firefighter knowledges. The 34 job knowledge elements included in the rating scale related to understanding of specific facts or principles of job related subjects or subject areas.

The job knowledge elements were rated desirable but not essential at entry level into the position; none received a mean rating higher than 2.3. Inasmuch as firefighters in the municipality participated in an intensive six to eight week training program before assignment to a firefighter company, this rating was one that might be anticipated.

Also, the mean ratings for job knowledge elements indicated that many were considered to be critically important and very frequently used on the job. These included knowledge of: principal duties of a firefighter; firefighter apparatus, tools and equipment; responding to an alarm; extinguishment practices; and construction, care and use of fire service ladders and fire hose and hose appliances. Other highly rated job knowledge elements related to rescue operations, first aid procedures, and various aspects of pre-fire planning and fire prevention.

TABLE 3

MEAN RATINGS FOR FIREFIGHTER KSAP_s (KNOWLEDGES, SKILLS, ABILITIES, AND PERSONAL CHARACTERISTICS) CONSIDERED NECESSARY AT ENTRY LEVEL INTO POSITION, PRIOR TO ON-THE-JOB TRAINING

- RATINGS: 1. Not important--is learned on the job.
 2. Desirable but not essential.
 3. Some degree is essential.
 4. Full competence is essential.

\bar{X}	Job Elements: Knowledges
	<i>Departmental Operations:</i>
	1.2 Municipal fire codes.
	1.5 Fire department rules and regulations.
	1.7 Fire department organization and line of authority.
	2.0 Principal duties of a firefighter.
	<i>Firefighting:</i>
	1.2 Ventilation practices.
	1.3 Construction, care, and use of fire hose and hose appliances.
	1.3 Construction, care, and use of fire service ladders.
	1.3 Salvage and overhaul procedures.
	1.4 Firefighting apparatus, tools, and equipment (recognition, proper use, and location of tools and equipment on apparatus.)
	1.4 Forcible entry procedures.
	1.4 Extinguishment practices.
	1.5 Fire alarm system.
	1.5 Breathing apparatus and tests.
	1.5 Portable extinguishers.
	1.7 Responding to an alarm.
	1.7 Use of ropes and knots.
	<i>Rescue Operations:</i>
	1.6 Procedures for removing persons from dangerous situations.
	<i>First aid Procedures:</i>
	1.7 Fractures, slings.
	1.9 Treatment of burns.
	1.9 Artificial respiration.

(Continued)

TABLE 3

(Continued)

\bar{X}	Job Elements: Knowledges (Continued)
1.9	Care of wounds (head, face, internal injuries).
1.9	Shock, poisoning.
2.0	Hemorrhage (types and control of bleeding).
	<i>Pre-fire Planning and Fire Prevention:</i>
1.3	Water supply.
1.3	Inspection practices.
1.4	Elementary principles of hydraulics.
1.6	Properties of chemicals, chemical changes.
1.7	Explosives, explosions.
1.8	Hazardous conditions.
1.9	Elementary principles of mechanics.
2.2	Safety practices.
2.3	Street system, physical layout, and principal buildings of Kansas City, Missouri.
	<i>General Operational Duties:</i>
1.2	Procedures for maintenance of facilities.
1.5	Maintenance and repair of apparatus equipment, and tools.
\bar{X}	Job Elements: Skills
1.9	Connecting hoses using proper couplings and nozzles.
2.0	Performing standard first aid procedures.
2.2	Assembling, operating, and disassembling equipment.
2.7	Climbing ladders.
\bar{X}	Job Elements: Abilities
1.7	Solve elementary hydraulics problems relating to firefighter responsibilities.
1.7	Operate complicated equipment such as pumping apparatus, aerial ladders, pulmotors, and oxygen units.
1.9	Visualize an object when rotated in space.
1.9	Visualize spatial relationships in positioning equipment.
2.0	Solve elementary geometry problems.

(Continued)

TABLE 3

(Continued)

\bar{X}	Job Elements: Abilities (Continued)
2.1	Solve elementary algebra problems.
2.1	Visualize the operations of a machine in motion.
2.2	Solve computational problems involving units of measurement.
2.3	See the relationships between different parts of a machine.
2.5	Make job related decisions based on knowledge of facts, scientific principles, and reasoning abilities.
2.7	Understand and interpret maps, charts, tables, and sketches.
2.7	Perform arithmetic calculations involving fractions, decimals, and percentages.
2.7	Analyze situations and reason proper course of action.
3.0	Read, comprehend, and correctly interpret texts, manuals, and other instructional materials.
3.1	Recall and explain written information.
3.1	Add, subtract, multiply, and divide whole numbers.
3.2	Respond to rapid changes in instruction.
3.4	Understand and follow oral and written directions.
<hr/>	
\bar{X}	Job Elements: Personal Characteristics
2.7	Ability to establish effective public relations.
3.4	Physical strength for lifting, carrying.
3.4	Agility for climbing, making rapid changes in movements.
3.4	Willingness to accept assignments and orders without question.
3.5	Ability to remain calm in emergency situation.
3.6	Physical coordination.
3.6	Physical stamina.
3.6	Ability to work cooperatively as part of a team.
3.7	Alertness.

Note: *Knowledges* were defined as understanding of facts or principles relating to a particular subject or subject area. *Skills* were defined as ability to perform psychomotor acts with ease and precision. *Abilities* were defined as present power to perform a function, verbal or mental. *Personal characteristics* were defined as physical and personality qualities.

TABLE 4

MEAN RATINGS FOR FREQUENCY OF ON-THE-JOB USE
OF FIREFIGHTER KSAP_s (KNOWLEDGES, SKILLS,
ABILITIES, AND PERSONAL CHARACTERISTICS)

- RATINGS: 1. Rarely used.
2. Sometimes used.
3. Often used.
4. Very frequently used.

\bar{X}	Job Elements: Knowledges
	<i>Departmental operations:</i>
2.4	Municipal fire codes.
3.6	Fire department organization and line of authority.
3.6	Fire department rules and regulations.
3.9	Principal duties of a firefighter.
	<i>Firefighting:</i>
2.7	Use of ropes and knots.
2.9	Portable extinguishers.
3.1	Fire alarm system.
3.2	Forcible entry procedures.
3.3	Breathing apparatus and tests.
3.4	Salvage and overhaul procedures.
3.5	Construction, care, and use of fire hose and hose appliances.
3.5	Ventilation practices.
3.6	Construction, care, and use of fire service ladders.
3.8	Responding to an alarm.
3.8	Extinguishment practices.
3.9	Firefighting apparatus, tools, and equipment (recognition, proper use, and location of tools and equipment on apparatus).
	<i>Rescue Operations:</i>
3.0	Procedures for removing persons from dangerous situations.
	<i>First Aid Procedures:</i>
2.2	Fractures, slings.
2.4	Shock, poisoning.
2.6	Hemorrhage (types and control of bleeding).

(Continued)

TABLE 4
(Continued)

\bar{X}	Job Elements: Knowledges (Continued)
2.7	Care of wounds (head, face, internal injuries).
2.8	Treatment of burns.
2.9	Artificial respiration.
	<i>Pre-fire Planning and Fire Prevention:</i>
2.3	Properties of chemicals, chemical changes.
2.4	Explosives, explosions.
2.9	Inspection practices.
2.9	Elementary principles of mechanics.
3.0	Elementary principles of hydraulics.
3.2	Hazardous conditions.
3.4	Water supply.
3.6	Street system, physical layout, and principal buildings of Kansas City, Missouri.
3.7	Safety practices.
	<i>General Operational Duties:</i>
3.1	Maintenance and repair of apparatus equipment, and tools.
3.3	Procedures for maintenance of facilities.
\bar{X}	Job Elements: Skills
3.1	Performing standard first aid procedures.
3.3	Assembling, operating, and disassembling equipment.
3.6	Climbing ladders.
3.7	Connecting hoses using proper couplings and nozzles.
\bar{X}	Job Elements: Abilities
1.5	Visualize an object when rotated in space.
1.6	Solve elementary geometry problems.
1.8	Solve elementary algebra problems.
1.9	Visualize the operations of a machine in motion.
2.1	Perform arithmetic calculations involving fractions, decimals, and percentages.
2.1	See the relationships between different parts of a machine.

(Continued)

TABLE 4

(Continued)

\bar{X} Job Elements: Abilities (Continued)	
2.2	Solve computational problems involving units of measurement.
2.3	Visualize spatial relationships in positioning equipment.
2.6	Add, subtract, multiply and divide whole numbers.
2.9	Understand and interpret maps, charts, tables, and sketches.
2.9	Solve elementary hydraulics problems relating to firefighter responsibilities.
3.1	Recall and explain written information.
3.2	Read, comprehend, and correctly interpret texts, manuals, and other instructional materials.
3.3	Make job related decisions based on knowledge of facts, scientific principles, and reasoning abilities.
3.5	Operate complicated equipment such as pumping apparatus, aerial ladders, pulmotors, and oxygen units.
3.5	Respond to rapid changes in instruction.
3.6	Analyze situations and reason proper course of action.
3.9	Understand and follow oral and written directions.
\bar{X} Job Elements: Personal Characteristics	
3.1	Ability to establish effective public relations.
3.5	Physical strength for lifting, carrying.
3.5	Willingness to accept assignments and orders without question.
3.6	Agility for climbing, making rapid changes in movements.
3.8	Physical coordination.
3.8	Physical stamina.
3.8	Ability to remain calm in emergency situation.
3.9	Alertness.
3.9	Ability to work cooperatively as part of a team.

Note: *Knowledges* were defined as understanding of facts or principles relating to a particular subject or subject area. *Skills* were defined as ability to perform psychomotor acts with ease and precision. *Abilities* were defined as present power to perform a function, verbal or mental. *Personal characteristics* were defined as physical and personality qualities.

TABLE 5

MEAN RATINGS FOR FIREFIGHTER KSAP_S (KNOWLEDGES,
SKILLS, ABILITIES, AND PERSONAL CHARACTERISTICS)
CONSIDERED IMPORTANT TO SUCCESSFUL JOB
PERFORMANCE

- RATINGS: 1. Slightly important.
2. Moderately important.
3. Very important.
4. Critically important.

\bar{X}	Job Elements: Knowledges
	<i>Departmental operations:</i>
2.4	Municipal fire codes.
3.2	Fire department organization and line of authority.
3.4	Fire department rules and regulations.
3.7	Principal duties of a firefighter.
	<i>Firefighting:</i>
3.1	Use of ropes and knots.
3.2	Portable extinguishers.
3.2	Salvage and overhaul procedures.
3.3	Fire alarm system.
3.3	Forcible entry procedures.
3.4	Ventilation practices.
3.5	Construction, care, and use of fire hose and hose appliances.
3.5	Construction, care, and use of fire service ladders.
3.6	Extinguishment practices.
3.7	Responding to an alarm.
3.8	Firefighting apparatus, tools, and equipment (recognition, proper use, and location of tools and equipment on apparatus).
3.8	Breathing apparatus and tests.
	<i>Rescue Operations:</i>
3.9	Procedures for removing persons from dangerous situations.
	<i>First Aid Procedures:</i>
3.3	Fractures, slings.
3.6	Treatment of burns.
3.6	Care of wounds (head, face, internal injuries).

(Continued)

TABLE 5

(Continued)

\bar{X}	Job Elements: Knowledges (Continued)
3.7	Shock, poisoning.
3.9	Artificial respiration.
3.9	Hemorrhage (types and control of bleeding).
	<i>Pre-fire Planning and Fire Prevention:</i>
2.6	Elementary principles of mechanics.
2.9	Inspection practices.
3.0	Elementary principles of hydraulics.
3.2	Properties of chemicals, chemical changes.
3.3	Water supply.
3.3	Street system, physical layout, and principal buildings of Kansas City, Missouri.
3.5	Explosives, explosions.
3.6	Hazardous conditions.
3.6	Safety practices.
	<i>General Operational Duties:</i>
2.7	Procedures for maintenance of facilities.
3.0	Maintenance and repair of apparatus equipment, and tools.
\bar{X}	Job Elements: Skills
3.5	Assembling, operating, and disassembling equipment.
3.5	Connecting hoses using proper couplings and nozzles.
3.6	Climbing ladders.
3.7	Performing standard first aid procedures.
\bar{X}	Job Elements: Abilities
1.8	Solve elementary geometry problems.
1.9	Visualize an object when rotated in space.
2.0	Solve elementary algebra problems.
2.1	Visualize the operations of a machine in motion.
2.2	Solve computational problems involving units of measurement.
2.5	See the relationships between different parts of a machine.
	(Continued)

TABLE 5

(Continued)

\bar{X}	Job Elements: Abilities (Continued)
2.6	Perform arithmetic calculations involving fractions, decimals, and percentages.
2.6	Visualize spatial relationships in positioning equipment.
2.8	Add, subtract, multiply, and divide whole numbers.
2.9	Understand and interpret maps, charts, tables and sketches.
3.1	Solve elementary hydraulics problems relating to firefighter responsibilities.
3.2	Recall and explain written information.
3.3	Read, comprehend, and correctly interpret texts, manuals, and other instructional materials.
3.5	Analyze situations and reason proper course of action.
3.5	Make job related decisions based on knowledge of facts, scientific principles, and reasoning abilities.
3.6	Understand and follow oral and written directions.
3.7	Operate complicated equipment such as pumping apparatus, aerial ladders, pulmotors, and oxygen units.
3.7	Respond to rapid changes in instruction.
\bar{X}	Job Elements: Personal Characteristics
3.2	Ability to establish effective public relations.
3.3	Physical strength for lifting, carrying.
3.6	Agility for climbing, making rapid changes in movements.
3.7	Physical coordination.
3.7	Physical stamina.
3.8	Alertness.
3.8	Willingness to accept assignments and orders without question.
3.8	Ability to remain calm in emergency situation.
3.9	Ability to work cooperatively as part of a team.

Note: *Knowledges* were defined as understanding of facts or principles relating to a particular subject or subject area. *Skills* were defined as ability to perform psychomotor acts with ease and precision. *Abilities* were defined as present power to perform a function, verbal or mental. *Personal characteristics* were defined as physical and personality qualities.

TABLE 6

MEAN RATINGS FOR EXTENT TO WHICH FIREFIGHTER KSAP_s
 (KNOWLEDGES, SKILLS, ABILITIES, AND PERSONAL
 CHARACTERISTICS) RELATE TO DIFFERENCES
 IN EMPLOYEE EFFECTIVENESS

- RATINGS: 1. High and low performers have about the same level
 of this KSAP.
 2. There are differences in this KSAP among employees,
 but they do not seem to affect performance.
 3. High performers seem to have more of this KSAP.
 4. High performers are clearly superior to low per-
 formers in this KSAP.

\bar{X} Job Elements: Knowledges

Departmental Operations:

- 2.8 Municipal fire codes.
 3.3 Fire department organization and line of
 authority.
 3.4 Fire department rules and regulations.
 3.8 Principal duties of a firefighter.

Firefighting:

- 2.9 Fire alarm system.
 3.0 Use of ropes and knots.
 3.1 Portable extinguishers.
 3.1 Salvage and overhaul procedures.
 3.2 Forcible entry procedures.
 3.4 Construction, care, and use of fire hose
 and hose appliances.
 3.4 Ventilation practices.
 3.5 Construction, care, and use of fire
 service ladders.
 3.6 Responding to an alarm.
 3.6 Extinguishment practices.
 3.7 Breathing apparatus and tests.
 3.8 Firefighting apparatus, tools, and
 equipment (recognition, proper use,
 and location of tools and equipment
 on apparatus).

Rescue Operations:

- 3.6 Procedures for removing persons from
 dangerous situations.

First Aid Procedures:

- 3.2 Shock, poisoning.
-

(Continued)

TABLE 6

(Continued)

\bar{X}	Job Elements: Knowledges (Continued)
3.3	Fractures, slings.
3.4	Treatment of burns.
3.4	Care of wounds (head, face, internal injuries).
3.4	Hemorrhage (types and control of bleeding).
3.5	Artificial respiration.
	<i>Pre-fire Planning and Fire Prevention:</i>
3.0	Explosives, explosions.
3.0	Elementary principles of hydraulics.
3.0	Elementary principles of mechanics.
3.1	Inspection practices.
3.2	Water supply.
3.2	Safety practices.
3.3	Properties of chemicals, chemical changes.
3.3	Street system, physical layout, and principal buildings of Kansas City, Missouri.
3.4	Hazardous conditions.
	<i>General Operational Duties:</i>
2.6	Procedures for maintenance of facilities.
3.1	Maintenance and repair of apparatus equipment, and tools.
\bar{X}	Job Elements: Skills
3.2	Assembling, operating, and disassembling equipment.
3.2	Connecting hoses using proper couplings and nozzles.
3.3	Climbing ladders.
3.6	Performing standard first aid procedures.
\bar{X}	Job Elements: Abilities
2.3	Visualize an object when rotated in space.
2.4	Solve elementary geometry problems.
2.6	Visualize the operations of a machine in motion.
2.8	Solve elementary algebra problems.
2.8	Visualize spatial relationships in positioning equipment.

(Continued)

TABLE 6

(Continued)

\bar{X}	Job Elements: Abilities (Continued)
2.9	Solve computational problems involving units of measurement.
2.9	See the relationships between different parts of a machine.
3.0	Perform arithmetic calculations involving fractions, decimals, and percentages.
3.2	Add, subtract, multiply, and divide whole numbers.
3.3	Understand and interpret maps, charts, tables, and sketches.
3.4	Solve elementary hydraulics problems relating to firefighter responsibilities.
3.5	Recall and explain written information.
3.6	Read, comprehend, and correctly interpret texts, manuals, and other instructional materials.
3.6	Operate complicated equipment such as pumping apparatus, aerial ladders, pulmotors, and oxygen units.
3.6	Analyze situations and reason proper course of action.
3.7	Respond to rapid changes in instruction.
3.7	Make job related decisions based on knowledge of facts, scientific principles, and reasoning abilities.
3.8	Understand and follow oral and written directions.
<hr/>	
\bar{X}	Job Elements: Personal Characteristics
3.0	Physical strength for lifting, carrying.
3.1	Ability to establish effective public relations.
3.3	Agility for climbing, making rapid changes in movements.
3.5	Physical coordination.
3.6	Physical stamina.
3.6	Willingness to accept assignments and orders without question.
3.7	Alertness.
3.7	Ability to remain calm in emergency situation.
3.7	Ability to work cooperatively as part of a team.

Note: *Knowledges* were defined as understanding of facts or principles relating to a particular subject or subject area. *Skills* were defined as ability to perform psychomotor acts with ease and precision. *Abilities* were defined as present power to perform a function, verbal or mental. *Personal characteristics* were defined as physical and personality qualities.

Job knowledge seemed to be importantly related to those who performed well on the job. The mean ratings for all knowledge elements was 2.6 or higher, indicating that high job performers were considered to know more or to be clearly superior to low job performers in all listed knowledges.

Firefighter skills. On-the-job firefighter skills related to ability to perform psychomotor acts with ease and precision. All the listed skills received mean ratings of 3.5 or over, indicating that they were considered critically important to successful job performance; all were rated often or very frequently used. Ratings also indicated that successful job performers seemed to have more of all job skills and were clearly superior to low job performers in performing standard first aid procedures. At entry level, some degree of skill in climbing ladders was considered essential.

Firefighter personal characteristics. These job elements referred to physical and personality qualities required for successful job performance. All the listed personal characteristics received comparatively high mean ratings for entry level and on-the-job performance. Alertness, ability to work cooperatively as part of a team, physical stamina, physical coordination, and ability to remain calm in emergency situations, were all rated "full competence is required at entry level." Almost all of the elements listed under this category received ratings indicating that they were critically important, very frequently used, and that high job performers seemed to have more or were clearly superior to low job performers in the listed personal characteristics.

Firefighter abilities. These job elements referred to ability

to perform various verbal or mental functions. On the basis of the ratings of these elements by the job experts, abilities played an important role at entry into the job and on-the-job performance as well. A number of abilities were rated from 2.5 to 3.4 which indicated that some degree was essential at entry into the job. These included ability to:

Understand and follow directions (also rated critically important, and very frequently used).

Respond to rapid changes in instructions (also rated critically important and very frequently used).

Add, subtract, multiply, and divide whole numbers (also rated very important and often used).

Recall and explain written information (also rated very important and often used).

Read and comprehend written instructional materials (also rated very important and often used).

Analyze situations and reason proper course of action (also rated critically important and very frequently used).

Perform arithmetic calculations involving fractions, decimals, and percentages (also rated very important and sometimes used).

Understand and interpret maps, charts, tables, and sketches (also rated very important and often used).

Make job-related decisions based on knowledges of facts, scientific principles, and reasoning abilities).

Discussion. Of the many elements originally identified, an evaluation was made to determine whether they should be included in a written selection test for the position of entry level firefighter. The factors determining their inclusion on the final list of job requirements were: how important they were to successful job performance; how frequently they were utilized on the job; how well they distinguished between high and low job performers; whether special training eliminated the need for the element as an entry

requirement; and whether the element could be tested quantifiably on a written test.

The mean ratings for the job related knowledges, skills, abilities, and personal characteristics, by the firefighter experts had direct implications for the preparation of general test specifications for the position of entry level firefighter. While mean ratings indicated that physical and personal characteristics as well as job related skills were highly important, these job elements were not considered appropriate for measurement by a written test. Also, the intensive training provided to new firefighters and the comparatively low ratings for knowledge elements precluded their use on firefighter selection tests for the municipality.

Of nine ability elements which received significant ratings for importance, frequency, and necessity at entry level, seven were considered appropriate for measurement on a written test. The two job elements that were deleted included "ability to respond to rapid changes in instructions" and "recall and explain written information."

The remaining job elements were condensed into related categories and general test specifications were prepared for the firefighter entry level position. These specifications, which are listed below, were based on the averaged ratings for the various firefighter job elements, and comprise a framework for the construction or selection of written tests for entry into the position, prior to training.

FIREFIGHTER TEST SPECIFICATIONS

I. Understanding and Following Directions

II. Reasoning and Judgment

Ability to analyze situations and reason proper course of action;

Ability to make job related decisions based on knowledge of facts, scientific principles, and reasoning abilities

III. Reading Comprehension

IV. Arithmetic Calculations

Basic arithmetic operations

Fractions, decimals, and percentages

V. Understanding and Interpreting Maps, Charts, Tables and Sketches

Phase Two: Content Analysis

Introduction. The purpose of the test analysis was to ascertain the job relevance and content validity of the two firefighter selection tests as they related to the findings of the job analysis. In analyzing the tests, attention was focussed on the following: major content areas or subtests, the relative proportion of items in these areas, the types of knowledges and abilities the items appeared to tap, the tasks represented by the items, and the relationship of the tests' content to findings of the job analysis.

Tables 7 and 8, on the following pages, present the results of the content analysis of the two tests. Both tests were multiple-choice tests: the 1966 firefighter test had 120 items, each with five options, and the 1973 firefighter test had 139 items, each with four options. The items in the 1966 firefighter test were arranged in spiral format, with categories of items which alternated frequently. The 1973 firefighter test items were arranged in block form, with all items in the same category adjacent to each other.

TABLE 7

ANALYSIS OF FIREFIGHTER TEST 20-C

Publishers: Public Personnel Association
 Copyright: 1961, 1966
 Number of Items: 120
 Types of Items: Multiple choice; four options

Purpose: "...to measure many of the general and mechanical abilities required to learn firefighting methods and techniques and to understand fire regulations and instructions (Publisher)."

<u>Content Areas or Subtests:</u>	<u>Item Numbers</u>	<u>Total Number of Items</u>	<u>Percent</u>
Vocabulary Knowledge These items tested knowledge of synonyms of words included in a sentence. Many were general vocabulary items set in a Firefighter context.	1-3, 23, 24, 26, 51, 52, 54, 81- 83, 105-107	15	12.5
Verbal Reasoning These items tested ability to distinguish which one of five words did not belong.	14-16, 31-33, 62-64	9	7.5
Reading Comprehension These test items, most of which were related to Firefighting, tested ability to understand reading passages.	40-42, 71-73, 95-97, 118-120	12	10.0
Mechanical Knowledge The items in this category were essentially those of factual knowledge: tool recognition (pictorial), users of tools, and several miscellaneous questions relating to an automotive part, diesel engine, and mechanical insight (prediction) pertaining to pulleys and pumps.	10-13, 20-22, 38, 47-50, 68-70, 78- 92, 80, 102-104, 115-117	26	21.7

(Continued)

TABLE 7

(Continued)

<u>Content Areas or Subtests:</u>	<u>Item Numbers</u>	<u>Total Number of Items</u>	<u>Percent</u>
Mathematical Computations Many of these items were elementary algebra questions involving various types of problem solving.	7-9, 17-19, 28, 43-46, 59, 74- 76, 98-101, 111	20	16.7
Spatial Visualization These items were in pictorial format and involved counting touching blocks.	34-36, 65-67, 89- 91, 112-114	12	10.0
Physical Sciences Included items from fire chemistry and fire physics, most of which required knowledge of facts or terminology.	4, 37, 39, 53, 58, 60, 61, 88, 93, 108, 109, 110	12	10.0
Miscellaneous Items in this category included four first aid questions; five questions related to structural information; and five fire-fighter related questions.	5, 6, 25, 27, 29, 30, 55-57, 77, 84, 85-87	14	11.7

TABLE 8

ANALYSIS OF FIREFIGHTER TEST B-1 (P)

Publisher: International Personnel Management Association

Copyright: 1973

Number of Items: 139

Type of Items: Multiple choice; four options

Purpose: "The test is intended to be used with other selection procedures to select the most qualified person for the position of firefighter. It is designed to measure those skills, abilities, knowledges, and aptitudes which would enable a person to successfully absorb training and make him a better firefighter (Publisher)."

<u>Content Areas of Subtests:</u>	<u>Item Numbers</u>	<u>Total Number of Items</u>	<u>Percent</u>
Judgment and Reasoning	1-27	27	19.4
Job-related questions pertaining to fire chemistry, firefighting, rescue, first aid, etc.; items tested reasoning ability.			
Mechanical Aptitude	28-52	25	17.9
Majority of items in this category were pictorial items showing gear systems, pump systems, pulley and weight systems testing ability to predict mechanical movements based on knowledge of scientific principles; several pictorial items tested ability in assembly of parts.			
Understanding and Following Directions	53-82	30	21.6
Test items related to understanding training schedules, tables, following directions, and use of maps.			
Arithmetic Calculations	83-114	31	22.3
Test items related to ability to substitute in various types of equations including friction loss, engine pressure, nozzle pressure, and hose factors.			

(Continued)

TABLE 8
(Continued)

<u>Content Areas of Subtests:</u>	<u>Item Numbers</u>	<u>Total Number of Items</u>	<u>Percent</u>
Reading Comprehension	115-140	26	18.7
Items tested comprehension of reading passages pertaining to various aspects of fire- fighting, fire prevention, rescue operations, etc.			

Note: The total number of test items was 139; one item number (113) was not used.

Items in the 1966 firefighter test presented a challenge in classification because of the spiral arrangement of item categories, the greater variability of content areas, and because items could logically be placed in more than one category. While most items were classified on the basis of their content similarity, the classification of other items depended on subjective judgment.

The major test categories that were identified in the 1966 test included: vocabulary knowledge, verbal reasoning, reading comprehension, mechanical knowledge, mathematical computations, spatial visualization, and physical sciences. In addition, a "miscellaneous" category was used to classify small subsets of items that did not appear to belong under any major heading.

Test items in the 1973 firefighter test were classified in five major content areas, as identified by the test publisher. These areas included: judgment and reasoning, mechanical aptitude, understanding and following directions, arithmetic calculations, and reading comprehension.

Findings. Tables 7 and 8 present the results of the analysis of the two firefighter selection tests. The 1966 firefighter test was comprised of eight content areas or subtests whose weighting of items varied from 7.5 percent for verbal reasoning to 21.7 percent for mechanical knowledge. The 1973 firefighter test was comprised of five content areas whose weightings of items were almost equal--from 18.7 percent for reading comprehension to 22.3 percent for arithmetic calculations.

Both tests included content areas of reading comprehension, mathematical computations, and mechanical aptitude. Two major content areas of the 1973

test that were not included in the 1966 test were "judgment and reasoning" and "understanding and following directions." These two content areas comprised approximately two-fifths of the 1973 firefighter test.

Review of the 1966 test indicated that the major emphasis of the test was on general verbal and mathematical abilities. Thirty percent of the items included the combined categories of vocabulary knowledge, verbal reasoning, and reading comprehension. Twenty percent of the 1966 test items included mathematical computations; the combined categories of mechanical knowledge and spatial visualization comprised another 31.7 percent of the test items. These two subtests were combined on the basis of studies showing mechanical comprehension to be a combination of mechanical information, ability to judge spatial relations, and perception (Super and Crites, 1962, p. 254).

In addition to differences in their content areas, the two firefighter tests differed in the emphasis they placed on knowledge and abilities. Table 7 indicates that a relatively large proportion of the items on the 1966 firefighter test tapped factual knowledge such as vocabulary, mechanical information, and physical sciences. In contrast, the principal emphasis of the 1973 firefighter was on comprehension and reasoning. Table 8 indicates that ability to comprehend was required for at least three major content areas: understanding and following directions, reading comprehension, and judgment and reasoning. In addition, the test items in arithmetic calculations were not only concerned with computational abilities but also with comprehension; test items in this content area tested ability to understand and substitute in various types of algebraic equations relating to firefighter job performance.

Other differences between the two firefighter tests were also observed. Many of the test items in mechanical ability on the 1966 test were composed of factual items of mechanical knowledge. Most of the items in mechanical aptitude on the 1973 test tested understanding and ability to predict movements in mechanical systems. Also, reading comprehension items in the 1973 firefighter test had greater clarity and job relevance than did the 1966 test.

Discussion. The 1973 firefighter selection test was developed by the publisher through an analysis of the average firefighter's job. Its five content areas included: understanding and following directions, judgment and reasoning, reading comprehension, arithmetic calculations, and mechanical aptitude.

These content areas closely corresponded to the firefighter written test specifications developed on the basis of the job analysis conducted for this study. The test specification categories included: understanding and following directions, reasoning and judgment, reading comprehension, arithmetic calculations, and understanding and interpreting maps, charts, tables, and sketches.

In considering the relationship of aptitude tests to job skills, Beach (1973) noted:

Mechanical aptitude tests...measure the capacities of spatial visualization, perceptual speed, and knowledge of mechanical matter. They do not measure manual dexterity and manipulative skill. (p. 263).

The job analysis ratings indicated that various aspects of mechanical ability, such as ability to operate complicated equipment like pumping apparatus, aerial ladders, pulmotors, and oxygen units were rated

"critically important" and "frequently used," and "desirable but not essential" at entry level. Similarly, ability to see relationships between different parts of a machine was rated "very important" and "desirable but not essential" at entry level.

Some possibility exists that mechanical abilities may be acquired through on-the-job training and that items on written tests relating to mechanical systems may tend to be more predictive of knowledge of scientific principles rather than mechanical abilities displayed in on-the-job tasks. However, results of the literature search reported in Chapter II indicated that mechanical aptitudes or abilities had been found to be significantly related to firefighter performance in other studies.

Phase Three: Comparative Test Statistics for Total Group

Introduction. Phase Two of the study focused on qualities of the two firefighter tests relating to content relevance and balance of items. Phase Three focused on statistical qualities of the two firefighter tests, as administered to the 189 firefighter applicants: comparative test score statistics, reliability, speededness, difficulty, and discrimination.

On each of the two tests, examinees received one point for each test item answered correctly. The maximum number of raw score points possible was 120 on the 1966 firefighter test and 139 on the 1973 firefighter test. A score of 63 on either test constituted a passing score, as determined by the city's personnel department.

Findings. The total group statistics for the two firefighter tests are presented in Table 9, which follows:

TABLE 9
TOTAL GROUP STATISTICS FOR 189 FIREFIGHTER APPLICANTS

Test	Number of Items	Range of Scores	Mean	Standard Deviation	Reliability KR-20	Percent Passed	Percent Failed
1966	120	23-107	68.86	14.84	90.2	68.3	31.7
1973	139	20-109	63.81	17.69	91.6	48.7	51.3

Results of the administration of the two tests indicated that, on the average, firefighter applicants received higher test scores on the 1966 test and that 1.4 times as many applicants passed the 1966 test as did the 1973 test. Although the 1973 test included 19 more items than the 1966 test, the mean score was 5.05 points lower than the 1966 test.

In identifying the appropriate level of difficulty for a test, Ebel (1972) considered that the ideal mean score should be about midway between the maximum possible score and the expected chance score. The ideal mean scores for the two tests were 72 for the 1966 test and 86.88 for the 1973 test. The score difference of 23.07 from the ideal mean for the 1973 test indicated that its difficulty level was overly high for the applicants. The actual mean score for the 1966 test was considerably closer to its ideal mean.

Another important quality of an employment test is its ability to discriminate between applicants at different levels of ability. The variability of the scores on a test is a measure of its ability to discriminate between applicants. Ebel (1972) observed that the larger the standard deviation is, under ordinary circumstances, the better the test. He

considered that the ideal standard deviation of a test was one-sixth the range between the highest possible score and the expected chance score. The ideal standard deviations for the two tests was 16 for the 1966 test and 17.38 for the 1973 test. The actual standard deviations of the two tests indicated that the 1973 test, had greater ability to discriminate than did the 1966 test.

In considering the importance of reliability, Ebel (1972) emphasizes that while reliability is a necessary but not sufficient condition for quality in a test, only to the degree that test scores are reliable can they be useful for any purpose whatsoever (p. 408). Application of the Kuder-Richardson Formula 20 to the test results yielded a coefficient of 90.2 for the 1966 test and 91.6 for the 1973 test. Estimates of reliability coefficients in the vicinity of .90 indicate a relatively high level of test reliability.

Another measure of test quality is its speededness, that is the appropriateness of its length for the testing time available. Results of an analysis of the comparative test speededness of the two firefighter tests for the total group are presented in Table 10.

TABLE 10
COMPARATIVE SPEEDEDNESS OF FIREFIGHTER TESTS FOR TOTAL GROUP

Speededness Variables	1966 Test	1973 Test
Percent of total group completing test	97.9	57.1
Percent of total group completing 75% of test	100	85.2
Number of items reached by 80% of examinees	120	108
Total number of items	120	139

The testing time allowed for completion of the two firefighter tests was one and three-quarter hours for the 1966 firefighter test and two and one-half hours for the 1973 firefighter test. Data presented in Table 10 indicated that although all but a small percent of the total group completed the 1966 test, 42.9 percent did not complete the 1973 firefighter test and only 80 percent of the group reached item 108. Despite the longer period of time allowed to complete the 1973 firefighter test, its comparative higher level of difficulty than the 1966 test, suggested that the test could be improved by eliminating some of the items. This was considered particularly important inasmuch as 26 blocked items included at the end of the test were reading comprehension items.

The difficulty and discrimination indices for items on the 1966 and 1973 firefighter tests were obtained through computer analyses and appear in Appendix E. The level of difficulty represents the percent of applicants who did not respond correctly to the item and the index of discrimination was the biserial coefficient.

Table 11 and 12 indicate the percent of test items on each of the two firefighter tests as classified by level of difficulty (Ebel, 1972, p. 390) and discrimination (Ebel, 1972, p. 399). The obtained indices represent the results of the tests administration to the total group of 189 firefighter applicants and might vary with different groups.

TABLE 11

PERCENT OF FIREFIGHTER TEST ITEMS CLASSIFIED BY LEVEL OF DIFFICULTY

Index of Difficulty	1966 Test		1973 Test	
	N of Items	Percent	N of Items	Percent
Difficult (76% to 100%)	10	8.3	19	13.7
Optimum Level (25% to 75%)	76	63.3	103	74.1
Easy (0-24%)	34	28.3	17	12.2
Total	120	100.0	139	100.0

TABLE 12

PERCENT OF FIREFIGHTER TEST ITEMS CLASSIFIED BY LEVEL OF DISCRIMINATION

Index of Discrimination	1966 Test		1973 Test	
	N of Items	Percent	N of Items	Percent
High (.40 and up)	62	51.7	57	41.0
Satisfactory (.30 to .39)	28	23.3	40	28.8
Marginal (.20 to .29)	13	10.8	23	16.5
Low (.01 to .19)	14	11.7	11	7.9
Zero or Negative	3	2.5	8	5.8
Total	120	100.0	139	100.0

Data presented in Tables 11 and 12 indicated that the major portion of test items in both firefighter tests were at the optimum level of difficulty. Results indicated that the 1973 test had a relatively higher percent of items at the "difficult" level and a lower percent of items at the "easy" level. Also, the 1973 test had several more items at the high and "satisfactory" levels of discrimination, combined, than did the 1966 test.

Discussion. Total group statistics for the two firefighter tests presented in this section included comparative test statistics, and measures of reliability, speededness, difficulty, and discrimination. Discussion of these aspects of test quality were included with the presentation of statistical results.

Phase Four: Comparative Test Results by Race

Introduction. The test scores of the 189 firefighter applicants were statistically analyzed separately by race and then tables were prepared which presented the comparative results. Frequency distributions of the test scores of black and white applicants on the two firefighter tests are presented in Appendix F.

Statistical tests of significance were conducted to investigate the three hypotheses formulated in Chapter 3. These hypotheses, stated in null form, related to the statistical significance of the difference between black and white subgroups of applicants on the firefighter selection tests-- their mean scores on the two tests and the subtests, and the number who passed or failed the tests. Also, through the use of item analyses, a study was made of the statistical significance of the difference in index of item

difficulty for each test item for black and white subgroups of applicants.

Findings. Tables 13 and 14 present comparative test statistics for the subgroups of black and white applicants. Test statistics indicated a high level of test reliability for both subgroups. A comparison of the test results of the white applicants with those of the black applicants revealed a difference of 16.41 between their mean scores on the 1966 firefighter test and 17.44 on the 1973 test. The critical ratio test indicated that these differences were highly significant at the .001 level of significance.

TABLE 13
TEST STATISTICS ON FIREFIGHTER TEST 20-C (1966)
(Number of Test Items: 120)

Group	Number	Mean	Standard Deviation	Reliability KR-20	Range
Black	36	55.61	14.19	89.1	23-85
White	151	72.03	13.29	88.1	38-107
Other	2	--	--	--	--
Total	189	68.86	14.84	90.2	23-107

Critical Ratio = 6.31, .001 level of significance.

TABLE 14
TEST STATISTICS ON FIREFIGHTER TEST B-1 (1973)
(Number of Test Items: 139)

Group	Number	Mean	Standard Deviation	Reliability KR-20	Range
Black	36	49.78	14.24	87.8	20-82
White	151	67.22	16.82	90.6	42-109
Other	2	--	--	--	--
Total	189	63.81	17.69	91.6	20-109

Critical Ratio = 6.36 .001 level of significance.

TABLE 15

COMPARATIVE TEST STATISTICS OF APPLICANTS, BY RACE, FOR
FIREFIGHTER TEST 20-3 (1966) FOR TEST SUBPARTS

Subtests	Number of Test Items	Black (N=36)		White (N=151)		Critical Ratio
		Mean	S.D.	Mean	S.D.	
Vocabulary Knowledge	15	8.22	2.93	10.56	2.81	4.34***
Verbal Reasoning	8	5.92	1.79	6.83	1.54	2.81**
Reading Comprehension	12	5.58	2.59	7.58	2.46	4.20***
Mechanical Knowledge	27	11.06	4.09	13.12	3.21	2.82**
Mathematical Computations	20	6.86	2.94	10.86	3.99	6.80***
Spatial Visualization	12	6.75	2.50	7.97	2.01	2.73**
Physical Sciences	12	4.28	1.83	6.07	2.18	5.07***
Miscellaneous	14	6.94	2.32	9.03	1.86	5.03***
Total Test	120	55.61	14.19	72.03	13.29	6.31***

*.05 level of significance; **.01 level of significance; ***.001 level of significance

TABLE 16

COMPARATIVE TEST STATISTICS OF APPLICANTS, BY RACE,
FOR FIREFIGHTER TEST B-1 (1973) FOR TEST SUBPARTS

Subtests	Number of Test Items	Black (N=36)		White (N=151)		Critical Ratio
		Mean	S.D.	Mean	S.D.	
Judgment and Reasoning	27	14.83	3.77	16.72	3.45	2.75**
Mechanical Aptitude	25	9.42	3.66	12.05	3.72	3.86***
Understanding and Following Directions	30	13.06	5.48	16.46	5.06	3.39**
Calculations	31	7.03	6.38	13.91	7.77	5.56***
Reading Comprehension	26	5.44	5.81	8.09	5.78	2.46*
Total Test	139	49.78	14.24	67.22	16.82	6.36***

*.05 level of significance; **.01 level of significance; ***.001 level of significance

The comparative test statistics for the subgroups of black and white applicants on the subtests of the two firefighter tests are presented in Tables 15 and 16. A comparison of test results revealed that the mean scores for black applicants on the eight subtests of the 1966 test and the five subtests of the 1973 test were significantly lower as indicated by the critical ratio test. (Tables 15 and 16 appeared on pages 82 and 83.)

The pass/fail status of applicants, by race, is presented in Table 17 for the 1966 firefighter test and Table 18 for the 1973 firefighter test. Data showed that the white applicants passed the two tests at higher rates than did black applicants: proportionately 2.5 times as many whites passed the 1966 test, and 2.9 times passed the 1973 test as did blacks. Application of the chi square test of significance indicated that these differences were statistically significant at the .001 level of significance.

TABLE 17

PASS/FAIL STATUS OF APPLICANTS BY RACE
ON FIREFIGHTER TEST 20-C (1966)

Pass/Fail Status	Black		White		Total	
	Number	Percent	Number	Percent	Number	Percent
Passed	11	30.6	117	77.5	128	68.4
Failed	25	69.4	34	22.5	59	31.6
Total	36	100.0	151	100.0	187	100.0

Chi square = 29.64, .001 level of significance.

Note: A minimum score of 63 constituted a passing score.

TABLE 18

PASS/FAIL STATUS OF APPLICANTS BY RACE
ON FIREFIGHTER TEST B-1 (1973)

Pass/Fail Status	Black		White		Total	
	Number	Percent	Number	Percent	Number	Percent
Passed	7	19.4	84	55.6	91	48.7
Failed	29	80.6	67	44.4	96	51.3
Total	36	100.0	161	100.0	187	100.0

Chi square = 15.19; .001 level of significance.

Note: A minimum score of 63 constituted a passing score.

The t-test for proportions was conducted for each item on the two firefighter tests and results are reported in Table 19 for the 1966 firefighter test, and Table 20 for the 1973 firefighter test, on the following pages. Of the 120 items in the 1966 test, 52 (43.4 percent) were found to vary significantly between the subgroups of applicants by race. On all but two of these items, the percent of blacks who did not answer the test items correctly was higher than for whites. The two items on which the percent of whites who did not answer the test items correctly was higher than for blacks may be attributed to a chance occurrence. Altogether, there were 13 items on the 1966 test in which the index of difficulty for blacks was equal to or lower than that for whites. These items were dispersed throughout the test.

On the 1973 firefighter test, 39 test items (28.1 percent) were found to vary significantly between subgroups of applicants, by race. On all of these items, the index of difficulty was higher for blacks than for whites. However, the index of difficulty for blacks was equal to or lower than that

TABLE 19

 INDEX OF DIFFICULTY FOR TEST ITEMS ON FIREFIGHTER TEST 20-C (1966)
 FOR BLACK (N=36) AND WHITE (N=151) APPLICANTS

Item	Index of Difficulty				Item	Index of Difficulty			
	Black	White	t	p<		Black	White	t	p<
1	30.6	12.7	1.7009		31	30.6	21.9	1.1051	
2	30.6	23.8	.8454		32	13.9	4.6	2.0501	.05
3	69.4	83.4	-1.9128		33	44.4	28.5	1.8448	
4	58.3	53.6	.5089		34	63.9	58.9	.5500	
5	19.4	19.9	-.0676		35	16.7	8.6	1.4456	
6	77.8	53.6	2.6459	.01	36	30.6	7.3	3.8961	.001
7	55.6	19.9	4.3472	.001	37	75.0	76.8	.2287	.05
8	33.3	22.5	1.3524		38	16.7	4.6	2.5689	.02
9	69.4	51.7	1.9186		39	30.6	15.2	2.1536	.05
10	55.6	77.5	-2.6685	.01	40	27.8	23.8	.5010	
11	83.3	83.4	-.0145		41	61.1	38.4	2.4738	.02
12	77.8	70.2	.9093		42	77.8	52.3	2.7788	.01
13	47.2	61.6	-1.5776		43	58.3	45.0	1.4359	
14	58.3	37.1	2.3225	.05	44	80.6	66.9	1.6049	
15	11.1	7.3	.7534		45	63.9	32.5	3.4785	.001
16	36.1	24.5	1.4132		46	75.0	60.3	1.6428	
17	66.7	37.1	3.2255	.01	47	27.8	9.3	2.9794	.01
18	27.8	12.6	2.2629	.05	48	25.0	12.6	1.8730	
19	22.2	11.9	1.6061		49	80.6	72.8	.9624	
20	61.1	41.1	2.1677	.05	50	30.3	23.8	1.1732	
21	72.2	74.2	-.0245		51	38.9	16.6	3.5061	.001
22	63.9	63.6	.0336		52	50.0	30.5	2.2155	.05
23	38.9	29.8	1.0558		53	30.6	15.2	2.1536	.05
24	69.4	68.2	.1392		54	50.0	19.9	3.7141	.001
25	11.1	7.9	.6181		55	75.0	48.3	2.8860	.01
26	27.8	14.6	1.8884		56	36.1	15.9	2.7337	.01
27	16.7	27.8	-1.3702		57	16.7	20.5	.5144	
28	77.8	42.4	3.8178	.01	58	86.1	57.6	3.1842	.01
29	72.2	32.5	4.3667	.01	59	66.7	30.5	4.0322	.001
30	80.6	80.8	-.0274		60	52.8	45.0	.8431	

Note: Index of Difficulty represents the percent of group who did not answer item correctly; p values are for two tailed t-test, df = 185.

TABLE 19
(continued)

Item	Index of Difficulty			p<	Item	Index of Difficulty			p<
	Black	White	t			Black	White	t	
61	66.7	40.4	4.1033	.001	91	50.0	38.4	1.2734	
62	22.2	5.3	3.2580	.01	92	30.6	34.4	-.4335	
63	11.1	34.4	-2.7436	.01	93	75.0	60.9	1.5801	
64	80.6	53.0	3.0182	.01	94	88.9	66.2	2.6856	.01
65	30.6	11.9	2.7859	.01	95	52.8	36.4	1.8083	
66	8.3	4.0	1.0816		96	22.2	14.6	1.1159	
67	72.2	65.5	.7560		97	38.9	29.8	1.0558	
68	86.1	84.8	.1966		98	86.1	58.9	3.0578	.01
69	13.9	7.9	1.1273		99	83.3	59.6	2.6648	.01
70	69.4	47.7	2.3416	.05	100	83.3	68.2	1.7977	
71	52.8	27.2	2.9558	.01	101	69.4	41.1	3.0589	.01
72	44.4	11.9	4.4757	.001	102	55.6	43.7	1.2874	
73	61.1	53.0	.8771		103	58.3	37.1	2.3225	.05
74	63.9	49.0	1.6078		104	8.3	2.0	1.9262	
75	72.2	53.0	2.0892	.05	105	38.9	11.3	3.9980	.001
76	72.2	64.2	.9087		106	61.1	44.4	1.8029	
77	86.1	58.3	3.1161	.01	107	33.3	17.9	2.0434	.05
78	86.1	77.5	1.1415		108	88.9	66.2	2.6856	.01
79	88.9	82.8	.8965		109	80.6	76.8	.4909	
80	69.4	51.7	1.9187		110	72.2	37.7	3.7443	.001
81	61.1	35.1	2.8602	.01	111	86.1	86.8	-.1110	
82	33.3	7.3	4.2674	.001	112	52.8	46.4	.6909	
83	44.4	23.2	2.5663	.02	113	33.3	17.9	2.0434	.05
84	27.8	1.3	5.8370	.001	114	91.7	80.8	1.5608	
85	61.1	13.9	6.0484	.001	115	52.8	36.4	1.8083	
86	52.8	66.2	-1.5017		116	75.0	63.6	1.2956	
87	72.2	51.0	2.2979	.02	117	66.7	57.6	.9989	
88	55.6	47.0	.9277		118	66.7	60.3	.7092	
89	36.1	33.8	.2625		119	69.4	41.7	2.9922	.01
90	38.9	29.1	1.1426		120	66.7	52.3	1.5608	

TABLE 20

INDEX OF DIFFICULTY FOR TEST ITEMS ON FIREFIGHTER TEST
B-1 (1973) FOR BLACK (N=36) AND WHITE
(N=151) APPLICANTS

Item	Index of Difficulty				Item	Index of Difficulty			
	Black	White	t	p<		Black	White	t	p<
1	58.3	49.0	1.0030		36	94.4	82.1	1.8309	
2	50.0	47.0	.3239		37	63.9	64.2	-.3373	
3	55.6	65.6	-1.1211		38	83.3	72.2	1.3702	
4	16.7	11.9	.7740		39	27.8	19.2	1.1413	
5	5.6	9.3	-.7120		40	50.0	37.1	1.4222	
6	14.7	21.2	-.8783		41	83.3	82.1	.1696	
7	36.1	28.5	.8945		42	75.0	67.5	.8739	
8	50.0	53.0	-.3239		43	66.7	58.9	.8599	
9	86.1	87.4	-.2094		44	58.3	38.4	2.1722	.05
10	50.0	45.7	.4648		45	91.7	94.0	-.5051	
11	30.6	22.5	1.0217		46	27.8	24.5	.4102	
12	72.2	73.5	-.1583		47	36.1	25.8	1.2398	
13	47.2	31.1	1.8299		48	63.9	47.0	1.8224	
14	19.4	11.9	1.1892		49	63.9	54.3	1.0431	
15	22.2	10.6	1.8861		50	33.3	13.2	2.8804	.01
16	13.9	8.6	.9691		51	52.8	49.7	.3343	
17	41.7	23.8	2.1677	.05	52	75.0	48.3	2.8860	.01
18	50.0	43.0	.7597		53	55.6	42.4	1.4307	
19	30.6	23.2	.9261		54	19.4	15.9	.5075	
20	77.8	55.0	2.5031	.02	55	63.9	41.7	2.4017	.02
21	63.9	43.0	2.2577	.05	56	75.0	39.7	3.8159	.001
22	52.8	31.1	2.4485	.02	57	22.2	13.9	1.2366	
23	38.9	32.5	.7298		58	50.0	33.1	1.8943	
24	47.2	33.1	1.5856		59	55.6	37.7	1.9612	
25	58.3	61.6	-.3647		60	30.6	23.2	.9261	
26	77.8	80.8	-.4042		61	75.0	51.0	2.6045	.01
27	22.2	23.8	-.2035		62	38.9	22.5	2.0246	.05
28	61.1	35.1	2.8602	.01	63	22.2	5.3	3.2580	.01
29	38.9	29.8	1.0442		64	38.9	12.6	3.7183	.001
30	91.7	94.0	-.5051		65	30.6	11.3	2.9130	.01
31	75.0	72.2	.3390		66	69.4	43.0	2.8489	.01
32	38.9	31.8	.8131		67	52.8	68.2	-1.7435	
33	77.8	66.9	1.2707		68	55.6	49.0	.7117	
34	72.2	37.7	3.7443	.001	69	75.0	58.9	1.7884	
35	55.6	49.0	.7117		70	63.9	55.6	.9044	

Note: Index of Difficulty=percent of group who did not answer item correctly;
p values are for two tailed t-test, df = 185.

TABLE 20
(continued)

Item	Index of Difficulty				Item	Index of Difficulty				
	Black	White	t	p <		Black	White	t	p <	
71	55.6	47.0	.9277		106	72.2	39.1	3.5840	.001	
72	58.3	60.9	-.2536		107	77.8	63.6	1.6201		
73	88.9	94.0	-1.0790		108	88.9	61.6	3.1269	.01	
74	63.9	41.1	2.4686	.02	109	86.1	57.6	3.1842	.01	
75	25.0	19.2	.7772		110	83.3	82.1	.1696		
76	55.6	51.7	.4211		111	69.4	43.0	2.8489	.01	
77	75.0	61.6	1.5068		112	88.9	56.3	3.6321	.001	
78	72.2	56.3	1.7454		113	---	---	---	---	
79	97.2	93.4	.8717		114	66.7	36.4	3.3075	.01	
80	66.7	72.8	-.7295		115	80.6	80.6	---	---	
81	80.6	70.2	1.2516		116	77.8	64.9	1.4836		
82	61.1	60.9	.0221		117	94.4	96.0	-.4249		
83	66.7	41.7	2.7024	.01	118	75.0	66.9	.9398		
84	52.8	35.1	1.9611		119	61.1	44.4	1.8029		
85	75.0	61.6	1.5068		120	66.7	41.1	2.7693	.01	
86	77.8	60.9	1.9001		121	80.6	62.3	2.0802	.05	
87	77.8	44.4	3.6021	.001	122	75.0	61.6	1.5068		
88	63.9	39.7	2.6263	.01	123	77.8	68.9	1.0534		
89	72.2	47.7	2.6450	.01	124	80.6	68.2	1.4673		
90	86.1	64.9	2.4710	.02	125	86.1	72.2	1.7279		
91	72.2	58.9	1.4734		126	63.9	47.7	1.7471		
92	80.6	41.1	4.2608	.001	127	86.1	76.8	1.2224		
93	83.3	58.3	2.7936	.01	128	80.6	80.1	.0676		
94	80.6	64.2	1.8857		129	72.2	65.6	.7560		
95	66.7	47.0	2.1246	.05	130	80.6	74.8	.7313		
96	75.0	62.9	1.3699		131	80.6	82.1	-.2097		
97	77.8	56.3	2.3706	.02	132	88.9	73.5	2.0844	.05	
98	91.7	65.6	3.0896	.01	133	83.3	73.5	1.2266		
99	80.6	71.5	1.1084		134	77.8	74.2	.4476		
100	75.0	60.3	1.6428		135	72.2	66.9	.6122		
101	83.3	68.9	1.7231		136	75.0	59.6	1.7157		
102	86.1	72.2	1.7279		137	69.4	58.9	1.1603		
103	66.7	41.7	2.7024	.01	138	86.1	66.9	2.2721	.05	
104	86.1	54.3	3.5061		139	88.9	79.5	1.3001		
105	86.1	50.3	3.9010		140	94.4	84.1	1.6044		

for whites on 16 items (11.5 percent) of the test: 8 items in "judgment and reasoning;" 3 items in "mechanical aptitude;" 4 items in "understanding and following directions," and 1 item in "reading comprehension."

The comparatively high levels of index of difficulty for both black and white applicants indicated that many of the entire group of 189 applicants did not complete the test. The analysis of the speededness of the test reported in Table 10 showed that only 80 percent of the applicants reached test item 108.

Discussion. Three hypotheses were formulated in the investigation of the differential test performance of black and white applicants for each of the two firefighter tests. They were as follows.

Hypothesis 1. There will be no statistically significant difference between the mean test score of applicants, when considered by race.

Hypothesis 2. There will be no statistically significant difference between the mean subtest scores of applicants, when considered by race.

Hypothesis 3. There will be no statistically significant difference between the number of applicants, when considered by race, who pass or fail the test.

Results of the statistical analyses conducted in the investigation of each of the above hypotheses showed statistically significant differences between the test performance of black and white subgroups of applicants on both firefighter tests on: (1) mean scores for the total test, (2) mean

scores for each of the subtests, and (3) percent of those who passed or failed the tests. On the average, white applicants performed significantly better on the two tests than did black applicants, and significantly more white applicants passed the two tests than did black applicants. On the basis of the results of the statistical analyses each of the three such hypotheses stated above was rejected.

In comparing the level of item difficulty for blacks and whites on both tests, the number and proportion of test items showing significant differences in difficulty between black and white applicants was lower on the 1973 test. Analyses of the comparative difficulty level of items for black and white applicants showed a statistically significant difference for 52 items (43.3 percent) of the 1966 firefighter test and 39 items (28.1 percent) on the 1973 firefighter test. On all but two of the items on the 1966 firefighter test, the percent of black applicants who did not answer the items correctly was higher than for white applicants.

Phase Five: Comparative Test Results by Educational Level

Introduction. This phase of the study focused on the comparative test performance of the 189 firefighter applicants, when considered by educational level. The two subgroups were those who had only a high school education or its equivalent and those who had some additional type of post high school education.

Similar to the procedures in Phase Four, the test scores of the 189 firefighter applicants were analyzed separately by educational level. Tables were prepared presenting the comparative results; and statistical tests of

significance of differences in test performance were conducted. Three hypotheses, stated in null form, were formulated which related to the differential test performance of the two subgroups: their mean scores on the two tests and the different subtests, and the number who passed or failed the tests. In addition, a study was made of the statistical significance of the difference in index of item difficulty for each test item for the two subgroups of applicants.

Findings. The test statistics for the two subgroups of applicants by educational level are presented in Tables 21 and 22, which follow. Application of the Kuder-Richardson Formula 20 to test results disclosed a high level of test reliability for both subgroups.

TABLE 21
TEST STATISTICS ON FIREFIGHTER TEST 20-C (1966)
(Number of Test Items = 120)

Group	Number	Mean	Standard Deviation	Reliability KR-20	Range
H.S. Only	95	64.36	14.55	89.6	23-107
Post H.S.	94	73.41	13.76	89.2	24-101
Total	189	68.86	14.84	90.2	23-107

Critical Ratio = 4.39, .001 level of significance.

TABLE 22
 TEST STATISTICS ON FIREFIGHTER TEST B-1 (1973)
 (Number of Test Items = 139)

Group	Number	Mean	Standard Deviation	Reliability KR-20	Range
H.S. Only	95	58.23	15.37	88.9	23-98
Post H.S.	94	69.45	18.16	92.1	20-109
Total	189	63.81	17.69	91.6	20-109

Critical ratio = 4.58, .001 level of significance.

The mean score of applicants with post high school education was higher on both firefighter tests than the mean score of those with high school education only. Application of the critical ratio test disclosed that the mean difference of 9.05 on the 1966 firefighter test and 12.22 on the 1973 firefighter test was highly significant at the .001 level of significance.

Tables 23 and 24 present the comparative test statistics of the two subgroups of applicants on the subtests of the 1966 test and the 1973 test, respectively. Use of the critical ratio test showed that the mean score of applicants with post high school education was significantly higher on six of the eight subtests of the 1966 firefighter test and four of the five subtests of the 1973 firefighter test than the mean score of applicants with high school education only. No significant difference between mean scores was revealed between the two subgroups of applicants on two of the subtests of the 1966 firefighter test (mechanical knowledge and spatial visualization) and one of the subtests on the 1973 firefighter test (understanding and following directions).

TABLE 23

COMPARATIVE TEST STATISTICS OF APPLICANTS BY
EDUCATIONAL LEVEL, FOR FIREFIGHTER TEST
20-C (1966) FOR TEST SUBPARTS

Subtests	Number of Test Items	H.S. or GED (N=95)		Post H.S. (N=94)		Critical Ratio
		Mean	S.D.	Mean	S.D.	
Vocabulary Knowledge	15	9.13	3.18	11.12	2.33	4.91***
Verbal Reasoning	8	6.23	1.65	7.07	1.48	3.69***
Reading Comprehension	12	6.42	2.65	7.98	2.28	4.34***
Mechanical Knowledge	27	12.80	3.30	12.63	3.65	-.34 (NS)
Mathematical Computations	20	8.95	3.78	11.23	4.10	3.96***
Spatial Visualization	12	7.57	2.07	7.90	2.24	1.05 (NS)
Physical Sciences	12	5.07	1.91	6.38	2.33	4.22***
Miscellaneous	14	8.18	2.11	9.10	2.02	3.06**
Total Test	120	64.36	14.55	73.41	13.76	4.39***

*.05 level of significance; **.01 level of significance; ***.001 level of significance

TABLE 24

COMPARATIVE TEST STATISTICS OF APPLICANTS,
 BY EDUCATIONAL LEVEL, FOR FIREFIGHTER
 TEST B-1 (1973) FOR TEST SUBPARTS

Subtests	Number of Test Items	H.S. or GED (N=95)		Post H.S. (N=94)		Critical Ratio
		Mean	S.D.	Mean	S.D.	
Judgment and Reasoning	27	15.36	3.60	17.35	3.29	3.97***
Mechanical Aptitude	25	10.95	3.66	12.16	3.94	2.19*
Understanding and Following Directions	30	15.15	5.35	16.49	5.18	1.75 (NS)
Calculations	31	10.12	6.42	14.95	8.65	4.36***
Reading Comprehension	25	6.66	5.73	8.50	5.83	2.19*
TOTAL TEST	139	58.23	15.37	69.45	18.16	4.58***

*.05 level of significance; ** .01 level of significance; *** .001 level of significance.

Tables 25 and 26 present the pass/fail status of the two subgroups of applicants, by educational level. Data showed that a larger proportion of the subgroup of applicants with post high school education passed the two tests than did the subgroup with high school education only. On the 1966 firefighter test, 1.4 times as many applicants with post high school education passed as did those with high school education; on the 1973 firefighter test, 1.9 times as many applicants with post high school education passed as did those in the other subgroup.

TABLE 25
PASS/FAIL STATUS OF APPLICANTS BY EDUCATIONAL
LEVEL ON FIREFIGHTER TEST 20-C (1966)

Pass/Fail Status	H.S. or GED		Post H.S.		Total	
	Number	Percent	Number	Percent	Number	Percent
Passed	54	56.8	75	79.8	129	68.3
Failed	41	43.2	19	20.2	60	31.7
Total	95	100.0	94	100.0	189	100.0

Chi square = 11.48, .001 level of significance.

TABLE 26
PASS/FAIL STATUS OF APPLICANTS BY EDUCATIONAL
LEVEL ON FIREFIGHTER TEST B-1 (P) 1973

Pass/Fail Status	H.S. or GED		Post H.S.		Total	
	Number	Percent	Number	Percent	Number	Percent
Passed	32	33.7	60	63.8	92	48.7
Failed	63	66.3	34	36.2	97	51.3
Total	95	100.0	94	100.0	189	100.0

Chi square = 16.18, .001 level of significance.

The index of difficulty was obtained for each of the two subgroups of applicants for each item on the two firefighter tests. The t-test for proportions was conducted for each item on the two firefighter tests. Results for the 1966 test and the 1973 test are reported in Tables 27 and 28, respectively.

Of the 120 items in the 1966 test, 45 items (37.5 percent) were found to vary significantly between those who had post high school education and those who did not. On all but four of these test items, the percent of those with high school education only who did not answer the test items correctly was higher than for the other subgroup. However, on 26 test items (21.7 percent) of the 1966 test, the index of difficulty for those with high school education only was equal to or less than that of those with post high school education. Most of these items were on two of the 1966 firefighter subtests--spatial visualization and mechanical knowledge.

On the 1973 test, 33 test items (23.7 percent) were found to vary significantly between subgroups of applicants by educational level. The index of difficulty was significantly lower for the subgroup of applicants with post high school education on 32 of these test items. The one item for which the index of item difficulty was lower for those with high school education may be attributed to a chance occurrence.

Statistics also indicated that the index of item difficulty for the subgroup with high school education was equal to or lower than that of the subgroup with post high school education on 20 items (10.6 percent) of the 1973 test. These items were distributed across all of the five subtests of the 1973 firefighter test.

TABLE 27

INDEX OF DIFFICULTY FOR TEST ITEMS ON FIREFIGHTER TEST 20-C (1966)
FOR APPLICANTS WITH HIGH SCHOOL EDUCATION AND GED ONLY
(N=95) AND THOSE WITH POST HIGH SCHOOL EDUCATION (N=94)

Item	Index of Difficulty				Item	Index of Difficulty			
	H.S. only	Post H.S.	t	p<		H.S. only	Post H.S.	t	p<
1	29.5	11.7	3.0148	.01	31	31.6	14.9	2.7085	.01
2	34.7	14.9	3.1410	.01	32	8.4	4.3	1.1517	
3	88.4	73.4	2.6182	.01	33	38.9	24.5	2.1210	.05
4	58.9	50.0	1.2252		34	57.9	61.7	-.5313	
5	24.2	14.9	1.6070		35	8.4	11.7	-.7527	
6	60.0	56.4	.5004		36	10.5	13.8	-.6927	
7	27.4	25.5	.2953		37	82.1	71.3	1.7522	
8	32.6	16.0	2.6518	.01	38	6.3	7.4	-.2986	
9	60.0	50.0	1.3781		39	21.1	16.0	.8993	
10	73.7	72.3	.2162		40	21.1	27.7	-1.0538	
11	81.1	85.1	-.7307		41	47.4	37.2	1.4153	
12	75.8	68.1	1.1753		42	67.4	46.8	2.8539	.01
13	55.8	60.6	-.6671		43	50.5	45.7	.6586	
14	49.5	34.0	2.1545	.05	44	72.6	67.0	.8363	
15	9.5	7.4	.5175		45	46.3	29.8	2.3294	.05
16	30.5	22.3	1.2750		46	72.6	54.3	2.6059	.01
17	51.6	33.0	2.5807	.02	47	11.6	13.8	-.4531	
18	24.2	6.4	3.3856	.001	48	18.9	10.6	1.6037	
19	17.9	9.6	1.6512		49	69.5	79.8	-1.6227	
20	43.2	47.9	-.6470		50	27.4	23.4	.6299	
21	74.7	72.3	.3728		51	22.1	19.1	.5085	
22	55.8	72.3	-2.3567	.02	52	43.2	25.5	2.5545	.02
23	41.1	22.3	2.7688	.01	53	29.5	6.4	4.1211	.001
24	76.8	60.6	2.3959	.02	54	35.8	14.9	3.2914	.01
25	10.5	5.3	1.3206		55	64.2	41.5	3.0628	.01
26	26.3	7.4	3.4575	.001	56	22.1	17.0	.8814	
27	30.5	21.3	1.4393		57	20.0	19.1	.1556	
28	60.0	38.3	2.9757	.01	58	69.5	57.4	1.7229	
29	43.2	37.2	.8389		59	41.1	35.1	.8470	
30	83.2	77.7	.9510		60	46.3	45.7	.0825	

Note: Index of Difficulty = percent of group who did not answer item correctly; p values are for two tailed t-test, df = 187.

TABLE 27
(continued)

Item	Index of Difficulty			p<	Item	Index of Difficulty			p<
	H.S. only	Post H.S.	t			H.S. only	Post H.S.	t	
61	50.5	40.4	1.3905		91	41.1	39.4	.2377	
62	15.8	1.1	3.6158	.001	92	40.0	27.7	1.7816	
63	23.2	36.2	-1.9511		93	63.2	62.8	.0568	
64	69.5	47.9	3.0081	.01	94	73.7	67.0	1.0060	
65	14.7	16.0	-.2473		95	50.5	29.8	2.8943	.01
66	4.2	5.3	-.3546		96	23.2	9.6	2.5158	.02
67	71.6	62.8	1.2853		97	41.1	21.3	2.9285	.01
68	90.5	79.8	2.0645	.05	98	70.5	58.5	1.7196	
69	3.2	14.9	-2.8001	.01	99	71.6	56.4	2.1715	.05
70	44.2	59.6	-2.1130	.05	100	73.7	68.1	.8453	
71	35.8	28.7	1.0442		101	55.8	36.2	2.6958	.01
72	24.2	11.7	2.2314	.05	102	47.4	44.7	.3714	
73	57.9	52.1	.7993		103	34.7	48.9	-1.9740	.05
74	57.9	44.7	1.8105		104	3.2	3.2	--	
75	62.1	52.1	1.3853		105	23.7	9.6	2.5158	.02
76	69.5	62.8	.9708		106	44.2	51.1	-.9471	
77	66.3	61.7	.6571		107	28.4	12.8	2.6425	.01
78	77.9	80.9	-.5085		108	76.8	64.9	1.7957	.05
79	82.1	86.2	-.7694		109	78.9	75.5	.5557	
80	54.7	56.4	-.2345		110	57.9	31.9	3.5831	.001
81	42.1	38.3	.5313		111	86.3	87.2	-.1820	
82	16.8	7.4	1.9743	.05	112	51.6	43.6	1.0982	
83	34.7	19.1	2.4106	.02	113	25.3	16.0	1.5744	
84	10.5	2.1	2.3663	.02	114	87.4	78.7	1.5906	
85	31.6	14.9	2.7085	.01	115	36.8	41.5	-.6602	
86	61.1	66.0	-.6979		116	73.7	58.5	2.2020	.05
87	54.7	55.3	-.0827		117	64.2	54.3	1.3814	
88	57.9	39.4	2.5375	.02	118	70.5	52.1	2.5905	.02
89	35.8	33.0	.4041		119	60.0	35.1	3.4180	.001
90	34.7	27.7	1.0356		120	58.9	50.0	1.2252	

TABLE 28

INDEX OF DIFFICULTY FOR TEST ITEMS ON FIREFIGHTER TEST B-1 (1973)
FOR APPLICANTS WITH HIGH SCHOOL EDUCATION AND GED ONLY
(N=95) AND THOSE WITH POST HIGH SCHOOL EDUCATION (N=94)

Item	Index of Difficulty		t	p<	Item	Index of Difficulty		t	p<
	H.S. only	Post H.S.				H.S. only	Post H.S.		
1	63.2	38.3	3.4146	.001	36	82.1	87.2	-.9696	
2	54.7	41.5	1.8112		37	70.5	57.4	1.8709	
3	70.5	56.4	2.0078	.05	38	85.3	62.8	3.5215	.001
4	13.7	11.7	.4117		39	24.2	18.1	1.4611	
5	12.6	4.3	2.0434	.05	40	42.1	36.2	.8287	
6	25.3	24.5	.1268		41	77.9	87.2	-1.6789	
7	32.6	27.7	.7319		42	68.4	70.2	-.2675	
8	58.9	45.7	1.8119		43	62.1	58.5	.5044	
9	84.2	90.4	-1.2758		44	45.3	38.3	.9729	
10	53.7	39.4	1.9653		45	93.7	93.6	.0231	
11	31.6	17.0	2.3325	.05	46	27.4	22.3	.8089	
12	77.9	69.1	1.3674		47	30.5	24.5	.9211	
13	40.0	28.7	1.6310		48	52.6	47.9	.6444	
14	21.1	5.3	3.1958	.01	49	63.2	48.9	1.9754	.05
15	16.3	8.5	1.6213		50	22.1	12.8	1.6789	
16	12.6	6.4	1.4485		51	55.3	44.7	1.5220	
17	32.6	22.3	1.5818		52	53.7	53.2	.0687	
18	46.3	42.6	.5105		53	48.4	41.5	.9509	
19	28.4	21.3	1.1261		54	17.9	16.0	.3471	
20	58.9	59.6	.0977		55	49.5	42.6	.9490	
21	50.5	44.7	.7962		56	51.6	40.4	1.5405	
22	45.3	25.5	2.8376	.01	57	18.9	13.8	.9451	
23	38.9	27.7	1.6289		58	41.1	31.9	1.3099	
24	41.1	30.9	1.4566		59	49.5	31.9	2.4556	.02
25	58.9	62.8	-.5478		60	30.5	18.1	1.9812	.05
26	69.5	90.4	-3.5750	.001	61	56.8	53.2	.4961	
27	24.2	22.3	.3083		62	31.6	19.1	1.9691	
28	40.0	39.4	.0841		63	8.4	8.5	.0246	
29	38.9	24.5	2.1210	.05	64	18.9	16.0	.5237	
30	94.7	92.6	.5906		65	18.9	10.6	1.6037	
31	72.6	73.4	-.1139		66	51.6	44.7	.9467	
32	32.6	33.0	-.0584		67	62.1	69.1	-1.0101	
33	72.6	64.9	1.1391		68	50.5	51.1	-.0823	
34	45.3	43.6	.2345		69	64.2	59.6	.6494	
35	51.6	48.9	.3702		70	60.0	54.3	.7897	

Note: Index of Difficulty = percent of group who did not answer item correctly; p values are for two tailed t-test, df = 187.

TABLE 28
(continued)

Item	Index of Difficulty			P<	Item	Index of Difficulty			P<
	H.S. only	Post H.S.	t			H.S. only	Post H.S.	t	
71	50.5	47.9	.3565		106	52.6	39.4	1.8156	
72	58.9	62.8	-.5478		107	72.6	60.6	1.7447	
73	92.6	92.6	0		108	75.8	58.5	2.5262	.02
74	47.4	43.6	.5231		109	81.1	45.7	5.0409	.001
75	17.9	22.3	-.7529		110	81.1	84.0	-.5237	
76	55.8	48.9	.9471		111	55.8	40.4	2.1130	.05
77	66.3	61.7	.6571		112	68.4	57.4	1.5614	
78	61.1	57.4	.5162		113	--	--	--	--
79	93.7	94.7	-.2932		114	52.6	31.9	2.8725	.01
80	74.7	69.1	.8543		115	77.9	84.0	-1.0646	
81	75.8	67.0	1.3354		116	66.3	69.1	-.4105	
82	60.0	60.6	-.0842		117	97.9	93.6	1.4390	
83	60.0	34.0	3.5692	.001	118	73.7	62.8	1.6057	
84	42.1	36.2	.8287		119	54.7	39.4	2.1014	.05
85	76.8	51.1	3.6710	.001	120	54.7	36.2	2.5469	.02
86	75.8	53.2	3.2391	.01	121	68.4	62.8	.8083	
87	55.8	44.7	1.5220		122	68.4	60.6	1.1177	
88	53.7	36.2	2.4116	.02	123	73.7	67.0	1.0059	
89	63.2	42.6	2.8295	.01	124	74.7	67.0	1.1618	
90	78.9	58.5	3.0174	.01	125	81.1	68.1	2.0483	.05
91	67.4	56.4	1.5531		126	54.7	46.8	1.0833	
92	61.1	36.2	3.4153	.001	127	81.1	76.6	.7556	
93	76.8	50.0	3.8158	.001	128	81.1	79.8	.2247	
94	77.9	57.4	2.9995	.01	129	73.7	60.6	1.9127	
95	55.8	45.7	1.3850		130	78.9	72.3	1.0538	
96	72.6	57.4	2.1853	.05	131	85.3	78.7	1.1782	
97	61.1	60.6	.0702		132	73.7	78.7	-.8048	
98	74.7	67.0	1.1606		133	81.1	70.2	1.7418	
99	78.9	67.0	1.8372		134	81.1	69.1	1.9033	
100	68.4	56.4	1.6987		135	67.4	69.1	-.2504	
101	78.9	63.8	2.2906	.05	136	66.3	58.5	1.1041	
102	78.9	71.3	1.2052		137	64.2	56.4	1.0930	
103	50.5	43.6	.9477		138	75.8	66.0	1.4795	
104	69.5	52.1	2.4440	.02	139	87.4	74.5	2.2536	.02
105	69.5	45.7	3.3023	.01	140	90.5	81.9	1.7106	

Discussion. In the investigation of the differential test performance of subgroups of applicants, considered by educational level, three hypotheses were formulated for each of the two firefighter tests. They were stated in null form as follows:

Hypothesis 4. There will be no statistically significant difference between the mean test score of applicants, when considered by educational level.

Hypothesis 5. There will be no statistically significant difference between the mean test subtest scores of applicants, when considered by educational level.

Hypothesis 6. There will be no statistically significant difference between the number of applicants, when considered by educational level, who pass or fail the test.

On the basis of the results of the statistical analyses reported in this section, hypotheses 4 and 6, as stated above, were rejected for both firefighter tests. However, hypothesis 5 was only partially rejected for both firefighter tests. It was not rejected for two of the subtests on the 1966 firefighter test (mechanical knowledge and spatial visualization) and one of the subtests on the 1973 firefighter test (understanding and following directions). Hypothesis 5 was rejected for all other subtests of the two firefighter tests.

In comparing the level of item difficulty for the two subgroups of applicants, by educational level, the number and proportion of test items showing significant differences in difficulty was lower on the 1973 test.

On the 1966 test, the indices of difficulty for 26 items (21.7 percent) were found to vary significantly, and on the 1973 test, 33 items (23.7 percent) were found to vary significantly.

CHAPTER V
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

Background information on the various problems and issues concerning the fairness of employment testing, particularly as it related to civil service testing under merit standards, was presented in the first two chapters of this study. The need for establishing job relatedness and validity of employment tests which have been shown to have a discriminatory impact upon minority group applicants has been mandated by civil rights legislation and ensuing employment test guidelines, as well as by court decisions. An overview of some of these was presented in Chapter I.

Considerable attention has been focused on methods for establishing the job relatedness and validity of employment tests. The study conducted and reported here presents one approach that was attempted to ascertain the correspondence between commercially prepared employment tests and actual job requirements, as determined by the results of a careful job analysis. Another concern of the study was the potential social bias of commercially prepared tests as related to the comparative test performance of examinees, when considered by race and level of educational background.

The administration of two entry level firefighter tests to a group of 189 firefighter applicants in a midwestern city made it possible to evaluate the comparative job relatedness and content validity of the two tests, as well as to compare the comparative test performance of applicants, by race and educational level. The position of firefighter was particularly relevant to the context of this study inasmuch as statistics have shown that

minority group members have been disproportionately underrepresented in municipal fire departments, where entry into the position has been based on merit testing.

As part of the literature search conducted for this study, a study was made of various court cases in which the valid use of entry level firefighter tests was challenged. These court cases were discussed in Chapter II. In addition, a review was made of available firefighter studies to identify variables which were shown to be related to firefighter job success.

The study reported here was conducted in five phases and the methodology used in each phase of the study was discussed in Chapter III. The purpose of this final chapter is to report the conclusions that were reached based on an analysis of the findings reported in Chapter IV and to explore some of the implications of these conclusions.

Conclusions

(1) The findings of the study emphasized the importance of a job analysis in the selection and development of employment tests that were job related and valid for their specific use. The job analysis conducted for this study served to identify the firefighter job elements on the basis of their importance, frequency of use, ability to distinguish between high and low job performers, and entry level requirement. In particular, the results of the job analysis helped provide a sharper definition of worker requirements before specialized training such as that provided to firefighters.

The content of the 1973 firefighter test which was based on a general job analysis of the firefighter position was found to closely correspond to the results of the job analysis conducted for this study.

(2) The use of content validation may not be completely appropriate where an employment test includes diverse types of content such as aptitudes as well as abilities or knowledge. The 1973 firefighter test included a block of test items relating to mechanical aptitude, which has been shown in other studies to be related to firefighter success. The American Psychological Association (1974) emphasized that the study of a test may involve information about all types of validity and require many investigations (p. 26).

(3) On the average, applicants who were nonminority group members and who had some additional education beyond high school performed significantly better on both tests than the other applicants. It was concluded that although a test may be more job related and valid for a specific employment situation, the test may not be any easier for minority group applicants or for that matter, nonminority group members with lesser education.

(4) It was also concluded that direct efforts could be made to assure that tests did not unfairly exclude minority group members and others with less education. The 1973 firefighter test appeared easier to read--the vocabulary seemed simpler, there were fewer words with long syllables, and sentences were shorter. Analysis of the comparative index of item difficulty for subgroups of applicants by race and educational level revealed that there were fewer significant differences in the 1973 test than in the 1966 test.

(5) While it is critically important that an employment test be job related and valid for the situation in which it is being used, it is also

important that attention be focused on other aspects of test quality as identified by Ebel (1972). These qualities include test reliability, appropriate level of difficulty, ability, and the speededness of tests for applicants. An analysis of the speededness of the 1973 firefighter test indicated that the test was too long or that an insufficient amount of testing time has been allowed.

(6) Results of the job analysis indicated that many important characteristics relevant to firefighter success were not measurable by written employment tests. These characteristics included physical and personal characteristics identified through the job analysis.

Recommendations

It is recommended that adjustments be made in the use of the 1973 firefighter test. The testing time for applicants may be increased or the test may be shortened by eliminating items low in difficulty and discrimination. The present length of the test allows it to be shortened and still maintain satisfactory reliability.

It is further recommended that a criterion-related study (predictive or concurrent) be conducted to strengthen support of the job-relatedness and content validity of the 1973 test as ascertained in this study. Use of concurrent validation techniques may achieve more timely results.

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APPENDICES

Appendix A

FIREFIGHTER DAILY ROUTINE

0630 to 0700 Arrive at station
 Change to department clothing
 Place fire clothes on apparatus
 Check equipment
 Confer with relief

0700 Roll Call & Radio Test
 Company together for orders of day
 Work assignment and detail men
 Department communication, department directives/changes
 in procedures
 Timesheet, Day's activities
 Arrange for noon meal

0730 Begin house duties and work schedule

Monday	Motor & underneath	Clean & inspection
Tuesday	Yard day	Grass & shrubs
Wednesday	Polish day	Brightwork
Thursday	Basket day	Clean, inspect and repair tools, ladders, etc.
Friday	Window clean & air out day	
Saturday	Scrub out day	Kitchen clean

Clean all rooms, mop floors, dust, make beds, clean all
 apparatus and premises each day and other necessary work.

Wash, shave, clean up, personal hygiene

1100 Prepare noon meal
 Eat meal and clean kitchen

1230 to 1300 Break time

1300 Fire safety home and building inspection program

1500 Return from inspections
 Change clothes and personal habits
 Complete inspection reports paper work

1530 Break time

1600 Clean apparatus and floor - necessary at return of any outing

1630 Prepare evening meal

1730 Wash dishes, clean kitchen and secure the kitchen area

Appendix A
(continued)

Firefighter Daily Routine
Page 2

1830	Engage in 1 hour Company drill period on various fire control procedures i.e. response district, hose lay outs, ladder raises, first aid, EMT, fire pre-plan tool uses, procedures, hydraulics
1930	Clean up and personal habits Recap daily activity - fire reports, drill reports, daily log
2000	Silent watch activated Station Roll Call
2100	Secure station and prepare for bed rest
0630	Arise, personal habits Prepare for relief crew
0700	Dismissed

If the Company is involved in fire safety inspection in the morning, the morning and afternoon activities are reversed.

Fire and emergency activities are not included in the schedule above. Figure for each hour spent at fire and emergency duty, 2 hours work back at the fire station caring for and restoring equipment to the readiness state.

Each Company will report to the Training Academy 4 to 6 times a year for 4 hour refresher drills and maintenance requirements. 60 Companies X 3 shifts X 4 visits per year = 720 periods.

Some of the daily care and service to fire equipment and apparatus becomes necessary after each emergency run, and may be repeated as often as the Company responds or several times in one day.

Appendix B

FIREFIGHTER JOB DESCRIPTION

Job Summary: Under supervision, controls and extinguishes fires, protects life and property, and maintains equipment and facilities as employee of city.

Tasks Performed:

Participates in training activities

1. Prior to formal assignment as firefighter, participates in concentrated training course in basic firefighting theory and practice, emergency rescue operations, fire prevention, standard first aid, and other related subjects.
2. While on assigned duty at a fire station, participates in practice drills, attends classroom lectures to learn new techniques for firefighting, and observes equipment demonstrations, and reviews and studies fire manuals and textbook.
3. Receives special training at hospital and/or area college in treating persons requiring emergency medical assistance in cases of accidents or natural causes.
4. When assigned to airport duty, receives specialized training in fire prevention, firefighting, and rescue operations applicable to aircraft fires, crashes, and other airport emergency situations.

Participates in fire fighting activities

1. While on duty, remains alert to alarm bell signal to rush to a fire or other emergency situations on immediate notice; when alarm sounds, puts on protective clothing and rides on fire apparatus to scene of fire.
2. As a member of a pumper or ladder company, performs specific tasks as assigned by commanding officer; responds to rapid changes in assigned tasks while company is in action.
3. Carries, lays, and connects fire hose lines to hydrants and pumps using proper couplings and nozzles; holds nozzle and directs water stream at fire; climbs ladder to enter upper portion of burning building with hose line; uses appropriate water, fog, or chemical stream to combat

Appendix B
FIREFIGHTER JOB DESCRIPTION
(continued)

- and extinguish fires caused by electricity, explosives, gasoline, oil, or other types of inflammable materials; uses portable fire extinguisher in places not easily accessible with a hose.
4. Removes wall ladders from apparatus, carries, raises and positions ladder; climbs conventional or aerial ladder as directed; ties ropes in specially prescribed knots and hitches to rope off areas, secure equipment, and to hoist tools, extinguishers, and other equipment.
 5. Forces way through barriers to gain access to fire area, to free persons trapped in structures, or to provide ventilation in structure for escape of smoke and poisonous gases; uses forcible entry tools such as axes, hatchets, sledge hammers, battering rams, prying tools, poles, and hooks, hand and power saws, cutting torches, and others to break open windows and doors and when necessary to chop open roofs, ceilings, walls, partitions, and floors.
 6. Participates in salvage and overhaul operations as directed; searches for and extinguishes any remaining fire, channels and sweeps water, removes debris from building, spreads canvas tarpaulins over exposed areas to prevent further damage by wind, rain, or possible rekindling of fire; lowers ladders and replaces on truck; removes firefighting tools and equipment for return to fire station.
 7. When assigned to airport duty as a member of the fire and rescue squad, responds to all aircraft emergencies such as potential hazardous landings, aircraft fires, crashes, and airport structural fires.

Performs emergency rescue operations

1. As part of a team, responds to emergency calls in cases of fire, explosions, drowning accidents, and natural or other catastrophes; rescues persons from burning buildings, demolished structures, gaseous areas, electrical contact, earth openings, under water, storms and floods, transportation accidents, and forest and brush fires.
2. Removes persons from danger in burning structures or other entrapments; climbs ladder to perform rescue when entrance into or exit from the structure cannot be made by normal means; rescues persons overcome by smoke, dragging or carrying them when necessary; uses special rescue knots to lower victim in horizontal or vertical position; assists persons to walk and to climb down a ladder; holds net as part of a team at a ground station.

Appendix B
FIREFIGHTER JOB DESCRIPTION
(continued)

3. Operates special rescue equipment such as saws, pneumatic tools, cutting torch, and hydraulically operated rescue equipment.

Provides emergency medical treatment

1. Renders emergency medical treatment to a victim of an accident or sudden illness until a doctor is obtained; provides treatment to persons overcome by fire or smoke, in cases of heart attack, drowning, burns, asphyxiation, employing mechanical devices such as resuscitation and oxygen equipment or using various emergency medical materials and/or techniques.

Participates in fire prevention activities

1. Participates in pre-fire planning activities including familiarization with major buildings, schools, and hospitals, and their fire protection for facilities; practices map and grid map reading, locating buildings and street intersections; rehearses plans for combating fire in buildings and in areas having high fire potential; rehearses response to various types of disasters including those caused by nature.
2. When assigned, participates in special details for tracing dangerous gas leaks or smoke, pumping flooded basements, and detecting radiation.
3. When requested, accompanies superior officer in making personal visits to dwellings, stores, and other business establishments; assists in identifying potential fire hazards and inspecting for compliance with local fire control ordinances relating to safety exits, sprinkler systems, storage of flammable materials, and other safety factors.

Participates in general operational activities

1. Takes turn standing watch at communications center in fire station; receives and records alarms of fire and other emergency situations; relays information to appropriate personnel within the fire station; and dispatches appropriate apparatus and personnel.
2. Cleans, inspects, and lubricates equipment and apparatus to maintain them in good running order, making minor repairs when necessary; washes and stretches hoses to dry before storing; when required, recharges portable fire

Appendix B

FIREFIGHTER JOB DESCRIPTION
(continued)

extinguishers; tests breathing apparatus; inspects and repairs ladders, hoses, ropes, tools, and other equipment, including emergency medical equipment.

3. Performs routine "housekeeping" duties relating to maintenance of departmental quarters, buildings, and grounds, including cleaning and washing walls, windows and floors, cutting grass, and polishing brass.

Appendix C

Instructions for Rating Knowledges, Skills, Abilities and Personal Characteristics (KSAPs)

On the following pages, are listed the specific knowledges, skills, abilities, and personal characteristics (KSAPs) required of employees in the specified job category. Please review the list and make any additions or deletions you feel appropriate. Space has been provided so that you may include any additional KSAP you feel is important.

The next step is to rate each of the listed KSAPs (including those that you added) on all four characteristics which appear below: *A. Entry Requirement, B. Frequency, C. Importance, and D. KSAP Differences.*

In rating the KSAPs, consider each one separately before proceeding to the next one. For example, for the first listed KSAP, select the most accurate of the four alternatives to *Characteristic A* and place its identifying number in *Column A* on the appropriate line (see next page); do the same with *Characteristic B, C, and D, in turn.* Rate each KSAP on all four characteristics and then proceed to the next one.

CHARACTERISTIC:

- A. ENTRY REQUIREMENT: *To what extent is this KSAP necessary at entry into the position, that is, prior to on-the-job training?*
1. Not important--is learned on the job.
 2. Desirable but not essential.
 3. Some degree is essential.
 4. Full competence is essential.
- B. FREQUENCY: *How often is this KSAP utilized on the job?*
1. Rarely used.
 2. Sometimes used.
 3. Often used.
 4. Very frequently used.
- C. IMPORTANCE: *How important is the use of this KSAP to successful job performance?*
1. Slightly important.
 2. Moderate important.
 3. Very important.
 4. Critically important.
- D. KSAP DIFFERENCES: *To what extent do differences in this KSAP relate to differences in employee effectiveness?*
1. High and low performers have about the same level of this KSAP.
 2. There are differences in this KSAP among employees, but they do not seem to affect performance.
 3. High performers seem to have more of this KSAP.
 4. High performers are clearly superior to low performers in this KSAP.

Appendix D

FIREFIGHTER JOB PERFORMANCE REQUIREMENTS
KSAP Rating Scale

KNOWLEDGE OF:

(Understanding of facts or principles relating to a particular subject or subject area.)

Departmental operations:

1. Fire department organization and line of authority. _____
2. Fire department rules and regulations. _____
3. Principal duties of a firefighter. _____
4. Municipal fire codes. _____
5. _____
6. _____
7. _____

Firefighting:

8. Fire alarm system. _____
9. Responding to an alarm. _____
10. Firefighting apparatus, tools, and equipment (recognition, proper use, and location of tools and equipment on apparatus.) _____
11. Breathing apparatus and tests. _____
12. Portable extinguishers. _____
13. Use of ropes and knots. _____
14. Construction, care, and use of fire _____
15. Constructions, care, and use of fire service ladders. _____
16. Forcible entry procedures. _____
17. Ventilation practices. _____

	Entry Requirement	Frequency	Importance	KSAP Differences
	A	B	C	D
1.	—	—	—	—
2.	—	—	—	—
3.	—	—	—	—
4.	—	—	—	—
5.	—	—	—	—
6.	—	—	—	—
7.	—	—	—	—
8.	—	—	—	—
9.	—	—	—	—
10.	—	—	—	—
11.	—	—	—	—
12.	—	—	—	—
13.	—	—	—	—
14.	—	—	—	—
15.	—	—	—	—
16.	—	—	—	—
17.	—	—	—	—

	Entry Requirement	Frequency	Importance	KSAP Differences
	A	B	C	D
18. Salvage and overhaul procedures. _____	—	—	—	—
19. Extinguishment practices. _____	—	—	—	—
20. _____	—	—	—	—
21. _____	—	—	—	—
22. _____	—	—	—	—
23. _____	—	—	—	—
24. _____	—	—	—	—
<i>Rescue Operations:</i>				
25. Procedures for removing persons. _____	—	—	—	—
26. _____	—	—	—	—
27. _____	—	—	—	—
28. _____	—	—	—	—
29. _____	—	—	—	—
30. _____	—	—	—	—
<i>First Aid Procedures:</i>				
31. Treatment of burns. _____	—	—	—	—
32. Artificial respiration. _____	—	—	—	—
33. Care of wounds (head, face, _____ internal injuries.)	—	—	—	—
34. Hemorrhage (types and control _____ of bleeding.)	—	—	—	—
35. Fractures, slings. _____	—	—	—	—
36. Shock, poisoning. _____	—	—	—	—
37. _____	—	—	—	—
38. _____	—	—	—	—
39. _____	—	—	—	—
<i>Pre-fire Planning and Fire Prevention:</i>				
40. Properties of chemicals, chemical _____ changes.	—	—	—	—
41. Hazardous conditions. _____	—	—	—	—
42. Explosives, explosions. _____	—	—	—	—

	Entry Requirement	Frequency	Importance	KSAP Differences
	A	B	C	D
43. Water supply. _____	—	—	—	—
44. Inspection practices. _____	—	—	—	—
45. Safety practices. _____	—	—	—	—
46. Elementary principles of mechanics. _____	—	—	—	—
47. Elementary principles of mechanics. _____	—	—	—	—
48. Street system, physical layout, and principal buildings. _____	—	—	—	—
<i>General Operational Duties:</i>				
49. Maintenance and repair of apparatus _____ equipment, and tools.	—	—	—	—
50. Procedures for maintenance of _____ facilities.	—	—	—	—
51. _____	—	—	—	—
52. _____	—	—	—	—
53. _____	—	—	—	—
54. _____	—	—	—	—
ABILITY TO:				
<i>(Present power to perform a function, verbal or mental.)</i>				
55. Read, comprehend, and correctly _____ interpret texts, manuals, and other instructional materials.	—	—	—	—
56. Recall and explain written information. _____	—	—	—	—
57. Understand and interpret maps, _____ charts, tables, and sketches.	—	—	—	—
58. Understand and follow oral _____ and written directions.	—	—	—	—
59. Add, subtract, multiply, and _____ divide whole numbers.	—	—	—	—
50. Perform arithmetic calculations _____ involving fractions, decimals, and percentages.	—	—	—	—

	Entry Requirement	Frequency	Importance	KSAP Differences
	A	B	C	D
61. Solve elementary algebra problems. ___	—	—	—	—
62. Solve elementary geometry problems. ___	—	—	—	—
63. Solve computational problems ___ involving units of measurement.	—	—	—	—
64. Solve elementary hydraulics ___ problems relating to firefighter responsibilities.	—	—	—	—
65. See the relationships between ___ different parts of a machine.	—	—	—	—
66. Visualize an object when rotated ___ in space.	—	—	—	—
67. Visualize the operations of a machine in motion.	—	—	—	—
68. Visualize spatial relationships in ___ positioning equipment.	—	—	—	—
69. Operate complicated equipment such ___ as pumping apparatus, aerial ladders, pulmotors, and oxygen units.	—	—	—	—
70. Analyze situations and reason ___ proper course of action.	—	—	—	—
71. Respond to rapid changes in ___ instruction.	—	—	—	—
72. Make job related decisions based ___ on knowledge of facts, scientific principles, and reasoning abilities.	—	—	—	—
73. _____	—	—	—	—
74. _____	—	—	—	—
75. _____	—	—	—	—
76. _____	—	—	—	—
77. _____	—	—	—	—
78. _____	—	—	—	—
79. _____	—	—	—	—

SKILL IN:

(Ability to perform psychomotor acts with ease and precision.)

80. Climbing ladders. _____
81. Assembling, operating, and _____
dissembling equipment.
82. Connecting hoses using proper _____
couplings and nozzles.
83. Performing standard first aid _____
procedures.
84. _____
85. _____
86. _____

PERSONAL CHARACTERISTICS:

(Physical and personalitu qualities.)

87. Physical strength for lifting, _____
carrying.
88. Agility for climbing, making _____
rapid changes in movements.
89. Physical coordination. _____
90. Physical stamina. _____
91. Alertness. _____
92. Willingness to accept assignments
and orders without question.
93. Ability to remain clam in emer-
gency situation.
94. Ability to work cooperatively _____
as part of a team.
95. Ability to establish effective _____
public relations.

	Entry Requirement	Frequency	Importance	KSAP Differences
	A	B	C	D
80. Climbing ladders. _____	—	—	—	—
81. Assembling, operating, and _____ dissembling equipment.	—	—	—	—
82. Connecting hoses using proper _____ couplings and nozzles.	—	—	—	—
83. Performing standard first aid _____ procedures.	—	—	—	—
84. _____	—	—	—	—
85. _____	—	—	—	—
86. _____	—	—	—	—
87. Physical strength for lifting, _____ carrying.	—	—	—	—
88. Agility for climbing, making _____ rapid changes in movements.	—	—	—	—
89. Physical coordination. _____	—	—	—	—
90. Physical stamina. _____	—	—	—	—
91. Alertness. _____	—	—	—	—
92. Willingness to accept assignments and orders without question.	—	—	—	—
93. Ability to remain clam in emer- gency situation.	—	—	—	—
94. Ability to work cooperatively _____ as part of a team.	—	—	—	—
95. Ability to establish effective _____ public relations.	—	—	—	—

(continued)

Appendix D

96. _____
97. _____
98. _____
99. _____

	Entry Requirement	Frequency	Importance	KSAP Differences
	A	B	C	D
	—	—	—	—
	—	—	—	—
	—	—	—	—
	—	—	—	—

Appendix E

TABLE 29

INDEX OF ITEM DIFFICULTY ON FIREFIGHTER TEST
20-C (1966) FOR 189 FIREFIGHTER APPLICANTS

Item	Percent Failed						
1	20.6	31	23.3	61	45.5	91	40.2
2	24.9	32	6.3	62	8.5	92	33.9
3	81.0	33	31.7	63	29.6	93	63.0
4	54.5	34	59.8	64	58.7	94	70.4
5	19.6	35	10.1	65	15.3	95	40.2
6	58.2	36	12.2	66	4.8	96	16.4
7	26.5	37	76.7	67	67.2	97	31.2
8	24.3	38	6.9	68	85.2	98	64.6
9	55.0	39	18.5	69	9.0	99	64.0
10	73.0	40	24.3	70	51.9	100	70.9
11	83.1	41	42.3	71	32.3	101	46.0
12	72.0	42	57.1	72	18.0	102	46.0
13	58.2	43	48.1	73	55.0	103	41.8
14	41.8	44	69.8	74	51.3	104	3.2
15	8.5	45	38.1	75	57.1	105	16.4
16	26.5	46	63.5	76	66.1	106	47.6
17	42.3	47	12.7	77	64.0	107	20.6
18	15.3	48	14.8	78	79.4	108	70.9
19	13.8	49	74.6	79	84.1	109	77.2
20	45.5	50	25.4	80	55.6	110	45.0
21	73.5	51	20.6	81	40.2	111	86.8
22	64.0	52	34.4	82	12.2	112	47.6
23	31.7	53	18.0	83	27.0	113	20.6
24	68.8	54	25.4	84	6.3	114	83.1
25	7.9	55	52.9	85	23.3	115	39.2
26	16.9	56	19.6	86	63.5	116	66.1
27	25.9	57	19.6	87	55.0	117	59.3
28	49.2	58	63.5	88	48.7	118	61.4
29	40.2	59	38.1	89	34.4	119	47.6
30	80.4	60	46.0	90	31.2	120	54.5

Appendix E
(Continued)

TABLE 30

INDEX OF ITEM DISCRIMINATION FOR FIREFIGHTER TEST
20-C (1966) FOR THE 189 FIREFIGHTER APPLICANTS

Item	r_{bis}	Item	r_{bis}	Item	r_{bis}	Item	r_{bis}
1	.81	31	.72	61	.43	91	.30
2	.54	32	.34	62	.68	92	.41
3	.16	33	.51	63	-.19	93	.14
4	.43	34	.07	64	.59	94	.30
5	.21	35	.39	65	.43	95	.42
6	.25	36	.55	66	.22	96	.60
7	.47	37	.24	67	.45	97	.44
8	.47	38	.38	68	.38	98	.52
9	.54	39	.29	69	.21	99	.49
10	-.04	40	.12	70	.38	100	.32
11	.27	41	.44	71	.47	101	.47
12	.20	42	.49	72	.58	102	.50
13	-.07	43	.33	73	.39	103	.37
14	.34	44	.35	74	.47	104	.46
15	.46	45	.46	75	.42	105	.79
16	.42	46	.47	76	.36	106	.32
17	.37	47	.34	77	.52	107	.54
18	.59	48	.51	78	.03	108	.47
19	.37	49	.34	79	.18	109	.18
20	.38	50	.40	80	.47	110	.64
21	.03	51	.40	81	.44	111	.31
22	.19	52	.44	82	.74	112	.36
23	.45	53	.72	83	.50	113	.46
24	.19	54	.72	84	.78	114	.44
25	.44	55	.32	85	.65	115	.27
26	.64	56	.44	86	.04	116	.36
27	.07	57	.16	87	.39	117	.23
28	.57	58	.59	88	.22	118	.32
29	.35	59	.59	89	.25	119	.50
30	.05	60	.23	90	.38	120	.50

Appendix E
(Continued)

TABLE 31

INDEX OF ITEM DIFFICULTY FOR FIREFIGHTER TEST
B-1 P (1973) FOR THE 189 FIREFIGHTER APPLICANTS

Item	Percent Failed						
1	50.8	36	84.7	71.	49.2	106	46.0
2	48.1	37	64.0	72	60.8	107	66.7
3	63.5	38	74.1	73	92.6	108	67.2
4	12.7	39	21.2	74	45.5	109	63.5
5	8.3	40	39.2	75	20.1	110	82.5
6	24.9	41	32.5	76	52.4	111	48.1
7	30.2	42	69.3	77	64.0	112	63.0
8	52.4	43	60.3	78	59.3	113	42.3
9	87.3	44	41.8	79	94.2	114	81.0
10	46.6	45	93.7	80	72.0	115	67.7
11	24.3	46	24.9	81	71.4	116	95.8
12	73.5	47	27.5	82	60.3	117	68.3
13	34.4	48	50.3	83	47.1	118	47.1
14	13.2	49	56.1	84	39.2	119	45.5
15	12.7	50	17.5	85	64.0	120	65.6
16	9.5	51	50.3	86	64.6	121	64.6
17	27.5	52	53.4	87	50.3	122	70.4
18	44.4	53	45.0	88	45.0	123	70.9
19	24.9	54	16.9	89	52.9	124	74.6
20	59.3	55	46.0	90	68.8	125	50.8
21	47.6	56	46.0	91	61.9	126	78.8
22	35.4	57	16.4	92	48.7	127	80.4
23	33.3	58	36.5	93	63.5	128	67.2
24	36.0	59	40.7	94	67.7	129	75.7
25	60.8	60	24.3	95	50.8	130	82.0
26	79.9	61	55.0	96	65.1	131	76.2
27	23.3	62	25.4	97	60.8	132	75.7
28	39.7	63	8.3	98	70.9	133	75.1
29	31.7	64	17.5	99	73.0	134	68.3
30	93.7	65	14.8	100	62.4	135	62.4
31	73.0	66	48.1	101	71.4	136	60.3
32	32.8	67	65.6	102	75.1	137	70.9
33	68.8	68	50.8	103	47.1	138	81.0
34	44.4	69	61.9	104	60.8	139	86.2
35	50.3	70	57.1	105	57.7		

Appendix E
(Continued)

TABLE 32

INDEX OF ITEM DISCRIMINATION ON FIREFIGHTER TEST
B-1 P (1973) FOR THE 189 FIREFIGHTER APPLICANTS

Item	r_{bis}	Item	r_{bis}	Item	r_{bis}	Item	r_{bis}
1	.38	36	-.02	71	.34	106	.57
2	.38	37	.33	72	.37	107	.59
3	.27	38	.41	73	.24	108	.70
4	.15	39	.41	74	.49	109	.64
5	.22	40	.38	75	.33	110	.01
6	.36	41	-.08	76	.33	111	.37
7	.26	42	.19	77	.42	112	.52
8	.06	43	.08	78	.26	113	.47
9	.28	44	.33	79	.32	114	.20
10	.24	45	.14	80	.18	115	.26
11	.45	46	.35	81	-.01	116	.23
12	-.02	47	.22	82	.37	117	.32
13	.33	48	.18	83	.64	118	.36
14	.42	49	.33	84	.56	119	.50
15	.51	50	.52	85	.56	120	.43
16	.35	51	.38	86	.63	121	.48
17	.39	52	.32	87	.52	122	.32
18	.21	53	.49	88	.56	123	.31
19	.26	54	.28	89	.63	124	.34
20	.20	55	.51	90	.62	125	.38
21	.20	56	.61	91	.51	126	.27
22	.33	57	.37	92	.62	127	.07
23	.33	58	.44	93	.74	128	.43
24	.52	59	.55	94	.69	129	.38
25	.06	60	.46	95	.55	130	.33
26	-.22	61	.24	96	.68	131	.32
27	.14	62	.46	97	.44	132	.39
28	.35	63	.43	98	.54	133	.25
29	.30	64	.48	99	.56	134	.29
30	-.17	65	.59	100	.54	135	.33
31	-.00	66	.52	101	.52	136	.36
32	.31	67	-.10	102	.62	137	.34
33	.28	68	.23	103	.50	138	.44
34	.36	69	.43	104	.68	139	.43
35	.20	70	.45	105	.63		

APPENDIX F

TABLE 33

COMPARATIVE FREQUENCY DISTRIBUTION OF SCORES ON
 FIREFIGHTER TEST 20-C (1966)
 (Number of Items = 120)

Score Interval	Total Group	Blacks	Whites
113-120	--	--	--
105-112	1	--	1
97-104	3	--	3
89-96	11	--	11
81-88	25	1	24
73-80	41	3	38
65-72	42	6	34
57-64	27	10	17
49-56	21	7	14
41-48	10	3	7
33-40	5	3	2
25-32	1	1	--
17-24	2	2	--
9-16	--	--	--
0-8	--	--	--
	$\bar{X} = 68.86$	$\bar{X} = 55.61$	$\bar{X} = 72.03$
	S.D. = 14.84	S.D. = 14.19	S.D. = 13.29
	N = 189	N = 36	N = 151

Note: Total group includes two members of other minority races.

APPENDIX F

(Continued)

TABLE 34

COMPARATIVE FREQUENCY DISTRIBUTION OF SCORES ON
FIREFIGHTER TEST B-1 (1973)
(Number of Items = 139)

Score Interval	Total Group	Blacks	Whites
(121-140)	--	--	--
113-120	--	--	--
105-112	3	--	3
97-104	5	--	5
89-96	8	--	8
81-88	21	1	20
73-80	21	1	19
65-72	25	4	21
57-64	42	6	36
49-56	28	6	22
41-48	19	9	9
33-40	10	5	5
25-32	4	2	2
17-24	3	2	1
9-16	--	--	--
0-8	--	--	--
	$\bar{X} = 63.81$	$\bar{X} = 49.78$	$\bar{X} = 67.22$
	S.D. = 17.69	S.D. = 14.24	S.D. = 16.82
	N = 189	N = 36	N = 151

Note: Total group includes two members of other minority races.

APPENDIX G

TABLE 35
 COMPARATIVE FREQUENCY DISTRIBUTION OF SCORES ON
 FIREFIGHTER TEST 20-C (1966)
 (Number of Items = 120)

Score Interval	Total Group	H.S. GED Only	Post High School
113-120	--	--	--
105-112	1	1	--
97-104	3	--	3
89-96	11	2	9
81-88	25	8	17
73-80	41	20	21
65-72	42	20	22
57-64	27	14	13
49-56	21	16	5
41-48	10	8	2
33-40	5	4	1
25-32	1	1	--
17-24	2	1	1
9-16	--	--	--
0-8	--	--	--
	$\bar{X} = 68.86$	$\bar{X} = 64.36$	$\bar{X} = 73.41$
	S.D. = 14.84	S.D. = 14.55	S.D. = 13.76
	N = 189	N = 95	N = 94

Note: Total group includes two members of other minority races.

APPENDIX G

(Continued)

TABLE 36

COMPARATIVE FREQUENCY DISTRIBUTION OF SCORES ON
 FIREFIGHTER TEST B-1 (1973)
 (Number of Items = 139)

Score Interval	Total Group	H.S. GED Only	Post High School
121-140	--	--	--
113-120	--	--	--
105-112	3	--	3
97-104	5	1	4
89-96	8	2	6
81-88	21	6	15
73-80	21	8	13
65-72	25	10	15
57-64	42	24	18
49-56	28	21	7
41-48	19	12	7
33-40	10	6	4
25-32	4	3	1
17-24	3	2	1
9-16	--	--	--
0-8	--	--	--
	$\bar{X} = 63.81$	$\bar{X} = 58.23$	$\bar{X} = 69.45$
	S.D. = 17.69	S.D. = 15.37	S.D. = 18.16
	N = 189	N = 95	N = 94

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