DRAFT
Technical Report

Job Analysis and Development of Selection Instruments for Entry-Level Firefighters City of Tucson

May 25, 2001

Prepared by

CPS Human Resource Services
241 Lathrop Way
Sacramento, California 95815
(800) 822-4277 Phone
(916) 263-3613 Fax

TABLE OF CONTENTS

EXECUTIVE SUMMARY

In November 2000, the City of Tucson requested the services of a vendor to conduct a job analysis and select and/or develop selection instruments for entry-level firefighters. As a result of the competitive bidding process, CPS was awarded the contract in January 2001.

CPS consultants reviewed relevant literature, conducted job observations, and worked extensively with subject matter experts from the City of Tucson Fire Department (TFD) to develop a job analysis questionnaire to assess the tasks and knowledge, skills, abilities, and other characteristics (KSAOs) required for successful performance of the job of an entry-level firefighter in the City of Tucson. Sixty percent of TFD firefighters and 90 percent of TFD captains completed the job analysis questionnaire. The results of the questionnaire administration were analyzed based on the *CPS Job Analysis Guidelines* (2000) and a final list of tasks and KSAOs important to the job of an entry-level TFD firefighter was developed.

The job analysis results were used to link tasks and KSAOs, and to create an initial test plan. The examination components identified as appropriate for the TFD included a written examination, the PDI Performance scale, a structured oral interview, and the Candidate Physical Ability Test (CPAT). The written examination will be designed to measure four competency areas: Memory and Understanding Oral Instructions; Understanding Written Materials; Arithmetic Reasoning; and Understanding Maps, Diagrams, and Mechanical Drawings. In addition to the written examination, the job analysis process supported the use of the PDI Performance Scale which measures characteristics associated with reliability, dependability, motivation, and conscientiousness. The use of a structured oral interview to measure personal characteristics not tapped by the PDI was also supported. Finally, the use of the Candidate Physical Ability Test developed by *The Fire Service Joint Labor Management Wellness/Fitness Initiative* (1999) was found to be job relevant for TFD entry-level firefighters.

INTRODUCTION

Purpose

This report presents the steps taken to provide validation evidence for the City of Tucson entry-level firefighter examination process. The job analysis process described in this report complies with all relevant professional and legal guidelines for the development of procedures used for employment selection. The specific steps were designed to meet the project deadline and the requirements of the *Uniform Guidelines on Employee Selection Procedures* (1978), the *Principles for the Validation and Use of Personnel Selection Procedures* (1987), and the *Standards for Educational and Psychological Testing* (1999).

The primary researchers for this project were Jeanné D. Makiney, Ph.D., Jerry L. Thompson Ph.D., and Christian Wright, Ph.D. This technical report was prepared to meet the documentation requirement for the current project.

Background

In November 2000, the City of Tucson requested the services of a vendor to conduct a job analysis and select and/or develop selection instruments for entry-level firefighters. As a result of the competitive bidding process, CPS was awarded the contract in January 2001.

The City of Tucson employs approximately 170 incumbent firefighters assigned to four Divisions. The City had conducted a job analysis in the 1990s to provide a foundation for its selection practices. The City's current selection practice consists of a written test, a physical agility test, and an oral interview board. The written test is comprised of multiple choice questions designed to measure one's knowledge of the content of a study guide. The study guide is provided to all candidates and its content is fire related. The guide was developed by the City's Human Resources Department and designed to be inclusive of the requisite knowledge of an entry-level firefighter. The study guide exhibits a direct link with the examination because each test question is sourced directly to the guide. The City's physical agility test contains a series of job-related events designed to correspond with physical tasks performed on the job. Finally, the oral board consists of questions designed to measure the behavioral components of the job such as "getting along with others," "teamwork," and "motivation."

The City believes the written test has been effective in selecting candidates. However, the City does not share this belief about the physical agility test. Data collected by the City indicates that the current physical agility test is ineffective in screening candidates because of a liberal cutoff score. It must be noted, however, that the City was under a Consent Decree and forced to redesign its physical agility test and revisit the passing score based upon a claim filed by female applicants. Currently, each candidate participates in a structured interview before an oral board. The format is a prescribed set of job-related interview questions administered by a number of panels. Candidates' scores are standardized within oral boards to offset potential systematic panel biases (e.g., rater leniency or severity). Interview scores are combined with the written test scores to create a composite score.

History and Capabilities of CPS

CPS has been in the business of providing assessment tools for over six decades. A significant portion of these tools have been related to the needs of the fire service. Toward this end, CPS staff has extensive expertise developing and collecting validation evidence for entry-level firefighters. Tools developed by CPS to select entry-level firefighters include written tests, behavioral inventories, physical agility exercises, and oral interviews. Many of these tools have been used successfully by firefighter agencies throughout the United States and Canada.

CPS currently has six stock examinations used by fire agencies. In general, the examinations contain 100 items with four subscales. These subscales include "Understanding Oral Information," "Understanding Written Firefighting Material," "Arithmetic Reasoning," and "Maps, Diagrams, and Mechanical Drawing." The content of these examinations was derived from a job analysis study of 18 fire agencies in 1991. Items (test questions) from the examinations are subject to statistical and content review on an on-going basis by fire service subject matter experts. In addition, new item development for stock tests is continuous to mitigate the effects of item exposure and scale drift (i.e., an increase in test scores over time).

CPS, using the results of the 1991 job analysis study, has prepared a series of interview questions designed to predict performance as an entry-level firefighter. These questions are designed to measure cognitive and non-cognitive correlates of behavior. Questions are structured and designed to be assessed by multiple raters. CPS has also developed customized questions based on job analysis data for a number of firefighter agencies.

CPS has partnered with Personnel Decisions International (PDI) to provide a measure of Conscientiousness to public sector clients. Conscientiousness is one of the Big Five personality constructs shown to be associated with behaviors such as responsibility, dependability, attention to detail, motivation, and work ethic. PDI's measure has been used by a number of organizations and there are hundreds of validations studies documenting its effectiveness in a variety of settings (Paajanen, G. E., Hansen, T. L., & McLellan, R. A., 1993).

CPS's experience also includes firefighter physical agility testing. In addition to designing its own measures, CPS has assisted agencies to collect local validation evidence for the Candidate Physical Agility Test (CPAT) developed by *The Fire Service Joint Labor Management Wellness/Fitness Initiative* (1999).

Content Validation and Job Analysis Process

A critical component of providing validation evidence for assessment tools is a job analysis. According to Standard 14.8 of the *Standards for Educational and Psychological Testing* (American Educational Research Association, American Psychological Association, and National Council on Measurement in Education, 1999): "Evidence of validity based on test content requires a thorough and explicit definition of the content domain of interest. For selection, classification, and promotion, the characterization of the domain should be based on job analysis" (p. 160).

The *Standards* are clear in that it is necessary to understand the job tasks or worker knowledge, skills, abilities, and other personal characteristics to define the job content domain. Furthermore, the knowledge, skills, abilities, and other characteristics must be those that the applicant should possess prior to being considered for the job as opposed to being learned on the job.

The job analysis process conducted by CPS is designed to meet and/or exceed the requirements specified in the *Standards*. For example, CPS uses a task-based **and** worker-based approach instead of the "or" approach described in the *Standards*. The importance and frequency of tasks are measured, as are the importance and necessity at time of hire for knowledge, skills, abilities, and other characteristics.

Once the job has been defined through a combination of statistical and rational analyses, the next step is to design selection instruments. Here, Standard 14.9 stipulates the following: "When evidence of validity based on test content is a primary source of validity evidence in support of the use of a test is selection or promotion, a close link between test content and job content should be demonstrated" (p. 160).

In many cases this link is established by subject matter expert judgment. Once the knowledge, skills, abilities, and other characteristics have been identified, CPS staff will hypothesize selection methods for each knowledge, skill, ability, and other characteristic. From here, test questions and assessment exercises will be developed. Then, subject matter experts will be required to explicitly link the content of each question or assessment exercise back to the job analysis results.

The summary above provides a brief overview of the job analysis/content validity process. The job analysis process described here was designed to meet three primary goals: 1) development and validation of a written examination; 2) validation of a personality inventory (PDI Employment Inventory Performance Scale); and 3) validation of the Candidate Physical Agility Test (CPAT, 1999). The specific steps used to define the job of entry-level firefighter and the related examination components for the City of Tucson Fire Department are described in detail below.

DEVELOPMENT OF THE JOB ANALYSIS QUESTIONNAIRE (JAQ)

Literature Review

A comprehensive literature review was undertaken to develop a job analysis questionnaire and provide methodological guidance. Existing validity studies and other job analyses of entry-level firefighters were gathered and evaluated. A listing of the more relevant studies and other background information is included in Appendix A. Although the studies differed in complexity, scope, and end products, all showed strong similarity among the job tasks identified, the knowledge, skills, and abilities required, and the test content areas utilized. Based on these

studies, there appears to be a high degree of similarity in firefighters' jobs among different jurisdictions and states.

The results of the literature review were used to develop a preliminary list of 300 task statements and 216 knowledge, skill, ability, and other characteristics (KSAOs) statements for review by subject matter experts (SMEs).

Subject Matter Expert Panel Interviews

Composition of Subject Matter Expert Panel. In preliminary discussions with City of Tucson representatives, CPS project staff requested a panel of SMEs be convened to develop a job analysis questionnaire for administration to incumbents and their immediate supervisors in the Tucson Fire Department (TFD). The request was for between 10 and 15 SMEs who were most familiar with the job of firefighter and representative of the Department with respect to variations in work assignments, work locations, race, and ethnicity. The meeting with the SMEs was conducted on January 18-19 at the City of Tucson, Fire Training Academy. Although CPS had requested the same panel members for both days, work assignments precluded this. However, there was a core of five panel members present both days. Also, a member of the Tucson Human Resources Department, Ms. Marge Achong, Senior Human Resources Analyst, was present each morning the panel met. Dr. Jerry L. Thompson, CPS consultant, conducted the two-day panel. Table 1 provides demographics for the participants.

Table 1. Subject Matter Expert Meeting Participants

January 18 and January 19, 2001

Name	Rank	Tenure	Gender	Ethnicity
Diana J. Benson	Captain	13 months	Female	Caucasian
Ron Huerta	Captain	25-1/2 years	Male	Hispanic
James Kearney	Fire Engineer	3 years	Male	Caucasian
Ronald J. Lopez	Captain	2-1/2 years	Male	Hispanic
Douglas Seeger	Captain	2 years	Male	Caucasian

January 18, 2001 only

Name	Rank	Tenure	Gender	Ethnicity
Shannon Adams	Firefighter	8 years	Female	Caucasian
Nancy R. Avery*	Inspector/Firefighter	10 years	Female	Caucasian
Frank Mulvaney	Firefighter	28 years	Male	Caucasian
Donald L. Pugliese	Fire Engineer	22 years	Male	Caucasian
Joe Pierce	Fire Captain	2 years	Male	Native American

*left at noon due to family emergency

January 19, 2001 only

Name	Rank	Tenure	Gender	Ethnicity
Jerome P. Manion	Fire Captain	7 months	Male	Caucasian
John Kirby Comaduran	Firefighter	< 1 year	Male	Hispanic
Kevin Deardorff	Firefighter	18-1/2 years	Male	Caucasian
Carl Mare	Fire Captain	2 years	Male	Caucasian
Sharon A. McDonough	Fire Captain	14 months	Female	Caucasian
David Taylor	Fire Engineer	5 years	Male	Caucasian

Editing the Job Analysis Questionnaire. The major purpose of the two-day panel was to review the existing task statements and knowledge, skill, ability, and other characteristics (KSAO) statements for appropriateness to the TFD. Because there were some different panel members each day, Dr. Thompson provided introductory remarks both days about the corporate history and experience of CPS and an overview of the entire development and validation project being undertaken jointly between CPS and the City of Tucson.

The members of the SME panel completed a SME form documenting their expertise as a Tucson firefighter. They were provided with a copy of the draft job analysis questionnaire that was divided into the following six sections:

Section 1 – Background Information
Section 2 – Emergency Equipment
Section 3 – Task Statements
Section 4 – Knowledge, Skills, Abilities, and Other Characteristics
Section 5 – PDI Dependability Scale
Section 6 – CPAT Physical Task Statements

The SMEs from the first day of the panel covered Sections 1, 2, and 3. The SMEs from the second day covered the remaining three sections. The SMEs were asked to take a few minutes to peruse the questionnaire to familiarize themselves with the content and format. After reviewing the questionnaire, the format of the editing process was discussed. The process agreed upon was to review a certain number of statements (i.e., emergency equipment, task statements, KSAOs) independently, then assemble as a group and discuss any comments, agree on the changes to be made, then continue with the independent review of another set of statements, and so on. This process was followed for the remainder of the questionnaire for both days of the panel.

The SMEs were then asked to review each of the background questions for relevancy and completeness. Several questions were edited for content (e.g., removal of references to Lieutenant because this rank is not utilized in the TFD) and some were deleted, being deemed inappropriate for inclusion (e.g., a question about training received in fire suppression technology because all recruits hired by the TFD receive the same 22-week training provided by the Department).

Next, the SMEs reviewed the list of emergency equipment. Again, a number of the emergency equipment pieces were deleted from the list as inappropriate, others were edited for correct wording, and finally, quite a few pieces of equipment were added to the list.

Examples of emergency equipment deleted were:

- Artificial ventilation devices
- Demand valve resuscitators
- Esophageal gastric tube airways
- Pediatric mast suits
- Belt knives
- Fuse pullers
- Gas crimping pliers

Examples of emergency equipment edited for correct wording are:

Original Statement	Revised Statement
Oxygen inhalation units	Oxygen delivery devices such as nasal cannula
Jaws of life	Amkus power plant
Battery pliers	Pliers
Burn Jel blankets	Burn sheets
Ambu-bag	Bag valve mask

Examples of emergency equipment added were:

- Line gun
- Pulse oxymeter
- Portable stang monitor
- Throwbacks
- Sprinkler stops
- Infrared detector
- Flame fighter nozzle

Finally, this panel was asked to review the task statements for inclusiveness and relevancy. Because the task statements were categorized by job dimensions, the SMEs were also asked to determine if the job dimensions were appropriately named and if the task statements under each dimension were applicable to that dimension. A large number of task statements were edited, and several were deleted. Also, a few individual task statements were moved from one dimension to another. Two dimensions were collapsed into one, one dimension was broken into two dimensions, and three dimensions were included as part of other dimensions. Finally, one dimension name was revised (Perform Hose Evolutions and Apply Extinguishing Agents was reworded to read Hose Evolutions and Extinguishment). Examples of task statements edited are:

Original Task Statement	Edited Task Statement
Positions apparatus in station for emergency response	Assists in positioning apparatus in station for emergency response
Performs periodic tests of pumping capacity and pressure or of aerial ladder structural strength	Performs periodic tests of pumping capacity and pressure
Cleans, tests, inspects and refuels mounted electrical generators	Cleans, tests, inspects and refuels electrical generators, chain saws, Amkus, etc.
Assesses the smell and color of smoke to ascertain what is burning. Responds with appropriate extinguishing agent and uses mask if necessary	Assesses the color of smoke and flame to ascertain what is burning. Responds with appropriate extinguishing agent

Examples of task statements deleted were:

- Contacts public utility companies for street shutoffs through dispatcher
- Fills out complaint or inspection forms listing type of building, hazards, etc.
- Investigates complaints of fire dangers and violations of fire ordinances to prevent fires
- Demonstrates any class of fire extinguisher
- Observes or conducts and times fire drills in schools and businesses

Examples of task statements moved from one dimension to another are:

Task Statement	Original Dimension	New Dimension
Removes ventilation fans or smoke ejectors from apparatus and positions in windows or floor in front of doorways to safely inject fresh air and exhaust heat, smoke, and gasses	Use and Operation of Ladders	Ventilation Procedures
Responds to calls about gas leaks	Respond to Emergencies Other than Fires or Medical Calls	General Firefighting Activities
Reports and prepares for duty on time	Miscellaneous	Station Duties and Maintenance
Assists Personnel in recruitment, test development, and administration	Miscellaneous	Training Activities

The two dimensions collapsed into one were:

- Perform Rescue Operations dimension and Forcible Entry dimension became Forcible Entry and Rescue Operations

The one dimension broken into two dimensions was:

- Operate Apparatus dimension became Operate Apparatus dimension and Community Service dimension.

The three dimensions included as part of other dimensions were:

Original Dimension	New Dimension
Respond to Emergencies Other Than Fires or Medical Calls	General Firefighting Activities
Interaction With Peers	Station Duties and Maintenance
Miscellaneous	Station Duties and Maintenance Training Activities

The new SMEs from the second day received similar introductory remarks and a chance to review the questionnaire as did the members from the first day. The SMEs who were present from the first day made several clarifying comments that seemed to facilitate understanding of the process by the new panel members.

The SMEs were asked to review the KSAO statements for inclusiveness and relevancy. A number of statements were deleted as inappropriate for the TFD. Also, the wording of a large number of statements was changed to make the terminology more appropriate for the Department. Finally, a few KSAO statements were added to the list.

Examples of KSAO statements added were:

- Ability to adapt to changing priorities/situations
- Ability to awaken frequently throughout the night to respond to emergencies while maintaining alertness
- Ability to safely carry hose and equipment up six floors wearing portable gear including SCBA.
- Skill in use of forcible entry tools

Examples of KSAO statements deleted were:

- Knowledge of basic geometry
- Knowledge of water supply
- Skill in operation of portable pump
- Skill in operation of explosimeter
- Ability to compare information from several sources for similarities and differences
- Ability to safely lift and carry an unconscious person

Examples of KSAO statements edited were:

Original KSAO Statement	Edited KSAO Statement
Knowledge of limits of vehicle	Knowledge of operational limits of vehicle
Knowledge of fire alarms, alarm codes, and fire communications systems	Knowledge of fire alarms and fire communications systems
Skill in operation of radiological survey meter	Skill in operation of atmospheric monitoring equipment
Skill in use of portable ladders	Skill in use of ground ladders
Ability to work at tearing down a ceiling with a pike pole	Ability to tear down a ceiling with a pike pole or other appropriate tools
Ability to advance uncharged 2-1/2" line from the nozzle unassisted, assuming sufficient slack	Ability to advance uncharged 2-1/2" line from the nozzle unassisted

The last two sections of the questionnaire were handled differently from the previous four. Section 5 – PDI Dependability Scale is a standardized examination published by Personnel Decisions, Incorporated to measure a candidate's dependability, responsibility, work ethic, and conscientiousness while performing the job. The task statements for this scale were presented to the SME panel for their review and comment only, not to edit the statements. The SMEs were instructed that the statements reviewed would be included in the job analysis to document the appropriateness of the use of the PDI test. The reaction was favorable with some discussion of the statements. The general opinion was that this type of test would assist in the evaluation of candidates.

Section 6 – Candidate Physical Agility Test (CPAT) is a standardized physical agility test that was constructed and validated using a sample of ten agencies throughout the nation. The City of Tucson has expressed a desire to use the CPAT as their physical agility test. Inclusion of the task statements from the CPAT job analysis will allow CPS to document the appropriateness of that use through a transportability methodology described in the in *The Fire Service Joint Labor Management Wellness/Fitness Initiative Candidate Physical Ability Test* (1999). The SMEs were requested to review the task statements and comment on them, again, with the understanding they could not change them. There was a great deal of discussion generated about the CPAT, particularly since some of the SMEs were somewhat familiar with the CPAT. Overall, the consensus of the SME panel was that the task statements presented for the CPAT examination were representative of the type of tasks performed by the TFD.

Panel Results. The end product of the two-day panel was a job analysis questionnaire to be administered to all current firefighters for the City of Tucson. Sixteen members of the TFD reviewed this questionnaire. As requested by CPS project staff, these 16 members are representative of the fire department as a whole. After reviewing the questionnaire, the SMEs felt the questionnaire was exhaustive and accurate in its coverage of the various aspects of the job of firefighter for the TFD. Information gathered during the panel was consistent with the information gathered through the interviews and job observations described below.

Site Visit Interviews and Job Observations

On January 17 – 19, 2001, Drs. Christian Wright and Jeanné Makiney, CPS consultants, conducted site visits at the following locations:

Date	CPS consultant	Location	Time
1/17/01	Christian Wright	Ladder 9, "A" crew	9:30am – 6:00pm
1/18/01	Christian Wright	Engine 8, "B" crew	9:30am – 5:30pm
1/18/01	Jeanné Makiney	Engine 14, "B" crew	10:00am – 6:00pm
1/19/01	Christian Wright	Ladder 1, "A" crew	9:00am – 4:30pm
1/19/01	Jeanné Makiney	Engine 7, "A" crew	9:15am – 4:15pm

The purpose of the site visits was to gather information regarding the tasks and knowledge, skills, abilities, and other characteristics (KSAOs) needed to perform the task of firefighter in the City of Tucson. The site visits were intended to complement the SME panel review described previously. This multidimensional approach permitted the examination of the job of firefighter from a number of perspectives: SME panel reviews of existing task and KSAO statements, first-hand observations of tasks and equipment, and structured interviews with firefighters and their immediate supervisors (captains). At each location, CPS consultants toured the station, conducted job analysis interviews to gather information on typical tasks, physical requirements, knowledge, skills, abilities, and other characteristics (KSAOs), and went on emergency calls (ride-a-longs). (See Appendix B for a copy of the interview protocol and Appendix C for a list of the individuals who participated in the interviews.) Presented below, is a summary of the site visits.

Station 9 Site Visit. On January 17, 2001, Christian Wright conducted a site visit of Station 9 from 9:30am to 6:00pm. He was assigned to ride with Ladder Company 9's "A" crew, which consisted of the following members: Captain Mark Wallace, Engineer Michael Milne, Firefighter Kris Blume, and Firefighter Randy Kneuer. Ladder 9 was not dispatched during the visit, so the time was spent observing a newly appointed firefighter. His daily tasks included inspecting all equipment on the ladder truck, updating the Daily Activity Recording Schedule (DARS), and performing general cleaning and maintenance duties. Examples of cleaning and maintenance duties included checking fuel levels in equipment and air levels in Self-Contained Breathing Apparatus (SCBA), changing and cleaning rugs, cleaning bathrooms, and washing vehicles. The firefighter referred to either a standard checklist or department protocol to complete these tasks. In addition, the firefighter completed mandatory physical training and participated in a confined space drill designed by the captain to simulate escape from a structure under low visibility conditions. To perform the confined space drill, firefighters were required to don their turnout gear and SCBA. Visibility was removed by covering the helmet faceplate with electrical tape. The firefighters were then led to the floor of the station garage, where hose line had been stretched through a variety of obstacles (e.g., under the ladder truck, over furniture, and around corners). The goal of the exercise was to follow the hose line out of the building before exhausting the SCBA air supply.

One job analysis interview was conducted during the visit. With the exception of noted differences in equipment usage (e.g., water rescue equipment, differences in hose size), the information gathered during the visit was consistent with the job analysis materials prepared by CPS.

Station 8 Site Visit. On January 18, 2001, Christian Wright conducted a site visit of Station 8 from 9:30am to 5:30pm. He was assigned to ride with Engine Company 8's "B" crew, which consisted of the following members: Captain Scott Krause, Engineer Mario Rivas, Firefighter Bill Carrell, and Firefighter David Velador. Engine 8 was dispatched four times during the visit. On each dispatch, firefighters responded at a rapid pace and left the station within one minute. The first call was medical in nature and involved a patient complaining of chest pains. The engineer drove to the scene without consulting a map. Upon arrival, firefighters carried medical equipment (e.g., medical bag and 12-lead EKG) approximately 100 feet to the patient's residence. The captain took the patient's medical history and asked him for a description of his symptoms. The firefighters performed general EMS duties (checked vital signs, took EKG readings). They transmitted the results of the EKG to the hospital via modem hookup to the patient's telephone line. They determined the cause was acid reflex and ordered an ambulance to transport the patient. When medical transport arrived, the firefighters briefed the paramedics and led the patient to the ambulance. When the patient entered the ambulance, the firefighters departed the scene.

The second call was a natural gas leak that resulted when construction workers punctured an underground line. The engineer drove to the scene without consulting a map. Firefighters donned turnouts and SCBAs on the way to the scene. On arrival, firefighters were responsible for maintaining a protective posture with a charged hose line and sealing off the impacted area while gas company employees patched the line. The captain directed the actions of the firefighters and communicated with gas company employees. When the line was patched, firefighters wound the firehose to the top of the engine and placed street cones back on the vehicle before returning to the station. The third call was a fire alarm that was pulled in error. Dispatch recalled Engine 8 while it was en route to the scene.

The fourth call was a report of smoke in a commercial building. The engineer conferred with the captain to determine the location. After donning turnout gear and SCBAs, firefighters inspected the interior of the building to identify the smoke source and possible fire. Two firefighters also raised a 24-foot ladder to the second story roof and climbed up to perform a similar inspection. No fire was found, and the captain determined that a newly repaired heating unit was emitting smoke-like debris. The captain explained that he had encountered this situation several times during his tenure. One job analysis interview was conducted during the visit. With the exception of differences noted from the previous site visit, the information gathered during the visit was consistent with the job analysis materials prepared by CPS.

Station 14 Site Visit. On January 18, 2001, Jeanné Makiney conducted a site visit of Station 14 from 10:00am to 6:00pm. Dr. Makiney was assigned to ride with Engine Company 14's "B" crew, which consisted of the following members: Captain Roger Soriano, Engineer Ken Hansen, Firefighter Troy Larkin, and Firefighter Tomas Campazano. During her visit, Dr. Makiney also participated in a ride-a-long with the paramedic crew. Engine 14 was dispatched four times

during the visit. All of the calls were medical in nature. The first call involved a male who reported that he had fallen down and was feeling very weak. Firefighters responded to the engine at a brisk pace (upon questioning, Dr. Makiney was informed that the typical response time from call to leaving the station was usually less than 1 minute). The engineer discussed the location of the house with the captain. The captain had access to a map but did not need to use it for the incident. The engineer pulled up to the sidewalk in front of the house and the man was in his front yard near the gate. One of the firefighters lifted and carried a box of medical equipment out of a compartment in the engine to the man who was approximately 10 feet away. After putting on protective gloves, the firefighter then performed a medical assessment (pulse, blood pressure, etc.). The captain took the man's medical history using a standard form with short responses and check boxes. One of the firefighters gathered information from the man's caseworker who was on scene (i.e., medications the individual was taking). Another firefighter used the radio and called for a paramedic truck. When medical transport arrived on the scene, a firefighter briefed the paramedics. Firefighters then assisted the paramedics with helping the man onto a gurney and loading the patient into the ambulance. The man appeared average in build. Upon questioning, one of the firefighters indicated that on average patients weigh approximately 150 to 180 pounds. The firefighter then described a recent incident where a 400 pound man had to be lifted onto a gurney and then lifted onto the ambulance with the assistance of two firefighters. The firefighters then loaded their equipment back onto the engine and departed the scene.

The second call involved an elderly woman who had fallen and could not walk. The engineer drove to the scene without consulting a map and parked in front of the woman's house. The firefighters carried their equipment into the house (a distance of approximately 15-20 feet). As with the previous call, the firefighters did not run but instead responded at a reasonably brisk pace. Once in the house, firefighters performed a general medical assessment (pulse, blood pressure, etc.), measured her blood sugar, and examined her for evidence of injury from her fall. The captain took the woman's medical history using the standard form. When the ambulance arrived, firefighters moved furniture (i.e., shoved a coffee table out of the way) to make room for the gurney and helped to lift the woman onto the gurney and place her in the ambulance. The woman was of medium build. The firefighters then returned their equipment to the engine and returned to the station.

The third call was made in the paramedic truck in response to an automobile accident. The paramedics responded to the their truck at a brisk pace. When the paramedics arrived on the scene, a man was laying on the ground in the middle of the intersection with his neck in a brace. Police officers were diverting traffic around the incident. Firefighters had already arrived on the scene and had used an extinguishing agent on the engine of the automobile. With the assistance of the firefighters on the scene, the paramedics placed the man on a backboard and taped him to the board. The man was then placed on a gurney and put into the paramedic truck. The paramedics then drove the man to the hospital, briefed the attending physician, completed the necessary paperwork, returned the gurney to the truck, and returned to the station. While Dr. Makiney was on the ride-a-long with the paramedic crew, Engine 14 was dispatched to a call of a person in a wheelchair struck by a vehicle. Engine 14 was recalled when no sign was found of such an incident.

The fourth call observed was a diabetic male who reported feeling dizzy. The man lived in a trailer park and the engineer consulted with the captain as to the location of the trailer. While one firefighter performed a medical assessment, another firefighter took the man's medical history, and the captain called the man's doctor to confirm that his parents could take him to the doctor's office. The firefighters then assisted the man to his truck and his parents took him to the doctor. In addition to the ride-a-longs, Dr. Makiney toured the station, was briefed on equipment, had informal discussions with the paramedics and engineer, and conducted job analysis interviews with the captain and two firefighters. General station interactions among the crew observed during the visit included eating lunch together, and doing push-ups together after each call (to maintain physical endurance, an activity promoted by the captain at this Station). Additionally, interviews indicated that the crew worked out together each shift and ate dinner together at night. All personnel interviewed stressed the importance of maintaining good working relationships with the other firefighters on the crew. With the exception of one additional task (placing a patient on a gurney/stretcher) and ability (Ability to awaken frequently throughout the night to respond to emergencies with full alertness), the information gathered during the visit was consistent with the job analysis materials prepared by CPS.

Station 1 Site Visit. On January 19, 2001, Christian Wright conducted a site visit of Station 1 from 9:00 to 4:30pm. He was assigned to ride with Ladder Company 1's, "A" crew, which consisted of the following members: Captain Ray Sayre, Engineer Dan Sotelo, Firefighter Steve Foree, Firefighter Rudy Baez. Ladder 1 was dispatched four times during the visit. On each dispatch, firefighters responded at a brisk pace and left the station within one minute. The first and third calls were fire alarms from the same building that were pulled in error. Construction in the building was determined to be the source of the alarms. Dispatch twice recalled Ladder 1 while it was en route to the scene. The second call was a report of smoke in a trailer home. The engineer drove to the scene without consulting a map, but conferred with the captain to select the best route. Ladder 1 arrived on the scene and briefly served in a staging capacity for another engine company that resolved the situation. Staging involved positioning the truck on the street in a way that would have allowed rapid access to the scene. The fourth call was medical in nature and involved a report of an individual lying on the sidewalk. Upon arrival at the dispatch address, the Ladder 1 crew could not find a victim and subsequently returned to the station. Station 1 also housed the department's Hazardous Materials (HAZMAT) Unit, so Dr. Wright requested to ride with the HAZMAT truck as well. One firefighter was responsible for that unit. Dr. Wright rode with the HAZMAT unit once during the visit. The call involved a report of a chemical spill on a freeway exit ramp. The HAZMAT was one of several units dispatched to the address, and none of the units could locate a chemical spill.

The Station 1 visit also included displays of the equipment on the Ladder and HAZMAT trucks, a demonstration of the aerial ladder, and a public service video shoot with a local television station. Two job analysis interviews were conducted during the visit. In general, the job tasks and KSAOs observed during the site visits were reflected in the job analysis materials prepared by CPS. There were, however, minor changes to the CPS equipment list. For example, references to 3-inch hose lines were removed because the City of Tucson does not use them. In addition, several pieces of swift water rescue equipment were added to the list, including 1) Live Bait Vests, 2) 75' Throw Bags, 3) Line Gun, and 4) Stokes Litter Basket.

Station 7 Site Visit. On January 19, 2001, Jeanné Makiney conducted a site visit of Station 7 from 9:15am to 4:15pm. She was assigned to ride with Engine Company 7's "A" crew, which consisted of the following members: Captain Bill Bathe, Engineer Fred Bair, Firefighter Greg Chmara, and Firefighter Tracy Eger. Engine 7 was not called out during the visit. Therefore, Dr. Makiney participated in two ride-a-longs with the Ladder 7 crew, which consisted of the following members: Captain Stuart Peterman, Engineer Don Schwarzman, Firefighter Larry Briggs, and Firefighter Aaron Snyder. Both of the calls were medical in nature and were traveled to in the Ladder Tender (a vehicle used by the Ladder crew to respond to non-fire related emergencies).

The first call involved an elderly woman who was experiencing difficulty breathing and fatigue. The crew was dispatched to a medical center where her doctor had requested an ambulance. The firefighters responded to the vehicle at a brisk pace. The engineer drove to the medical center without consulting a map and parked the vehicle on the curb outside the medical center. The crew then removed their medical equipment from the vehicle, entered the building, and climbed one flight of stairs to the floor the patient was on. One of the firefighters performed a general medical assessment while another firefighter gathered the woman's medical history and relayed the information to the paramedic truck crew when they arrived. Two firefighters assisted the woman to the gurney by lifting her in her chair and carrying her into the hallway. The woman was of medium build. The firefighters then assisted her onto the gurney, took her downstairs using the elevator, and lifted the gurney into the paramedic truck.

The second call was in response to an out-of-state call from a man's daughter who had reported that her father was ill. The firefighters responded to the vehicle at a brisk pace. The engineer consulted with the captain as to the location of the street. Upon arrival at the scene, no one answered the door. After briefly looking around the outside of the house, one firefighter decided to check to see if the door was locked and found the door to be unlocked. The firefighters then entered the house through the unlocked front door and searched for the man. While conducting the search, a neighbor arrived to inform the firefighters that he had already taken the man to the hospital. The crew then returned to the station.

During the afternoon, the two captains at the station conducted line-up which had been delayed due to an early morning call. The line-up involved the captains reading various memos, providing information about positions recently filled, positions available for bid, promotions, community service (cancer walk), training classes (rope rescue, HAZMAT), and information on changes to buildings in the area (a high school with a new sprinkler system). The firefighters then shared information on other items of interest (called Good of the Order). Additionally, during the afternoon, the Engine captain and one of the firefighters quizzed the probationary firefighter on various topics as part of her probationary training. During this time, other firefighters took their monthly EMT quiz as part of their continuous learning to maintain EMT certification.

In addition to the ride-a-longs, Dr. Makiney followed one of the firefighters as he conducted his daily station maintenance duties (e.g., taking out the trash, cleaning the kitchen, vacuuming the sleeping quarters), had informal discussions with various station personnel, and conducted job analysis interviews with the captain and three firefighters. When questioned about decisions

made by firefighters, the consensus was that decisions were primarily task based. One of the firefighters provided an example of how the captain had provided instruction about the appropriate usage of a manifold lay emphasizing the need for firefighters to determine where to put the wye based on how far the hose could reach. With the exception of the additional task and ability statements noted above, the information gathered during the visit was consistent with the job analysis materials prepared by CPS.

General Conclusions. Overall, the information gathered during the site visits described above was consistent with the tasks, and knowledge, skills, abilities, and other characteristics included in the job analysis materials prepared by CPS. The site visits provided the consultants with an opportunity to observe firefighters in a variety of settings. Tasks observed ranged from routine station maintenance and inspection to incident response. Firefighters also spent time conducting drills and engaging in physical fitness training. Incidents were primarily medical, and no fires were observed. Information gathered in interviews suggests that the incidents observed on the ride-a-longs reflected typical situations encountered by firefighters. However, due to the critical nature of responding to fire related emergencies, firefighters emphasized the need to remain prepared to respond to all types of incidents (fire, rescue, medical) through various training activities.

Final Job Analysis Questionnaire

The results of the panel interviews, site visit interviews, and job observations were integrated to develop a final review copy of the job analysis questionnaire. This questionnaire was presented for review to David Alegria, Human Resources Administrator, Dan Larkin, Assistant Chief Training Division, and Alan Moritz, Battalion Chief. After minor edits based on comments from this review, the questionnaire was finalized and administered to the full population of TFD firefighters (n = 174) and their captains (n = 79). As of March 9th, 226 job analysis questionnaires were completed and returned to the Human Resources Department. Information on the characteristics of these participants is presented in the results section.

A copy of the full job analysis questionnaire is presented in Appendix D. The questionnaire was presented in five sections: background/supplemental information; task statements; knowledge, skills, abilities, and other characteristics; candidate physical ability test task statements; and the PDI employment inventory. These sections are described briefly below.

Job Analysis Questionnaire Sections

Section 1: Background/Supplemental Information. Section 1 was designed to gather general information to describe the demographic characteristics of the sample. Example questions included age, gender, and years of experience as a firefighter.

Section 2: Task Statements. Section 2 included 241 job task statements. Two scales were used to rate the task statements: Frequency and Importance.

Section 3: Knowledge, Skills, Abilities, and Other Characteristics. Section 3 included 174 knowledge, skill, ability, and other characteristics (KSAO) statements that are necessary to

perform the job tasks. Two scales were used to rate the KSAO statements: Importance and Needed at Entry.

Section 4: Candidate Physical Ability Test Task Statements. Section 4 included 31 physical tasks used for the evaluation of the Candidate Physical Ability Test (CPAT).

Section 5: PDI Employment Inventory. Section 5 included a list of 16 employee activities and competencies associated with Performance.

Administration

To assist firefighters with completing the questionnaire, an instructional video was created. Jeanné D. Makiney, Ph.D. and Kathy Tinios, M.A. created the script for the video and Bruce W. Davis, Ph.D. presented the information on video during a session at the TFD Training Academy on February 21, 2001. Captains were then provided with the instructional video and used it as a resource to address firefighter questions regarding the completion of the questionnaire. Captains distributed the questionnaire packets to the firefighters under their supervision and completed questionnaires were returned to the department representative.

TASK AND KSAO ANALYSIS AND LINKAGES

Preliminary Screening

Prior to scanning the questionnaire responses, a visual examination of the questionnaires was conducted to identify clear patterns of anomalous or random responses. Eight questionnaires were identified as containing unusable data (e.g., no variability in responses, clearly random patterns of response) and were eliminated from the scanning process. The remaining 218 questionnaires were scanned for further analysis. Prior to the analysis, it was determined that data would only be gathered for firefighters and their supervisors (i.e., captains). In addition, it is important that individuals rating the position have a sufficient amount of time on the job to be familiar with the task and KSAO requirements of the position. Because the first year of a Tucson firefighter's employment is considered a training period, it was decided that only individuals with one or more years of experience as a firefighter would be included in the analysis.

After the scanning was completed, all results were imported into SPSS. The data was then examined to ensure that all of the participants met the criteria for inclusion. This examination resulted in the elimination of data from an additional 41 respondents: thirty-six respondents indicated they were a trainee and/or had less than one year of experience as a firefighter; two respondents indicated they were engineers; and three respondents failed to provide sufficient information to determine rank. Therefore, the final sample included 106 firefighters and 71 fire captains (N = 177), resulting in an overall response rate of 70% (firefighters, 61%; captains 90%).

Sample Description

Table 2 presents the TFD sample and population frequency information for rank, gender, and ethnicity. The majority of captains (90%) responded to the survey with usable data. In addition, the final sample included 61% of the TFD firefighters. The sample was representative in terms of gender and ethnicity. Ten of the fifteen female firefighters and/or captains were included in the final sample (67%). In both the sample and the population data, the two largest ethnic groups were Caucasians (69.5% of the sample, 82.5% of the population) and Hispanics (19.2% of the sample, 15% of the population).

Table 2. Comparison of TFD Sample and Population Demographic Information

Demographic Characteristic	TFD Sample		TFD Population	
	Frequency	Percent*	Frequency	Percent*
Rank				
Firefighter	106	59.9	174	68.8
Captain	71	40.1	79	31.2
Gender				
Male	154	87.0	238	94.1
Female	10	5.6	15	5.9
Missing	13	7.3	0	0.0
Ethnic Background				
African American	2	1.1	3	1.2
Asian/Pacific Islander	1	.6	1	
Caucasian	123	69.5	208	82.2
Filipino	1	.6	2	.8
Hispanic	34	19.2	38	15.0
Native American	3	3.0	0	0.0
Other**	8	4.5	2	.8
Missing	5	2.8	0	0.0

* Percentages do not always add up to 100% due to rounding.

** The TFD database designated two members as Cuban. For purposes of comparison, these members are listed under "Other".

In addition to the above demographic information, other demographic data were collected as part of the job analysis process. The mean age of respondents in the sample was 40.03 years (*SD* = 8.62). Respondents were employed by the TFD an average of 13.42 years (*SD* = 9.34). Respondents spent an average of 8.24 years (*SD* = 7.52) performing the duties of a firefighter. fire captains reported spending an average of 3.89 years (*SD* = 6.48) supervising firefighters.

Tables 3 through 6 present the results of the experience and job knowledge questions. The majority of firefighters (50%) reported having one to four years of experience as a firefighter. The next highest category of respondents was firefighters with more than 16 years of experience. There was a fairly even distribution of experience levels among the captain respondents, with somewhat fewer captains having 13 or more years of experience as a captain, as compared to captains in the other experience categories. When including experience as a supervisor, the majority of respondents had more than 16 years of firefighting experience (38.4%), followed by

respondents with one to four years of experience (29.9%). The majority of respondents reported that they knew the duties and responsibilities of the firefighter job extremely well (73.9%).

Table 3. Years in Current Rank: Firefighters

	Frequency	Percent	Cumulative Percent
1-4 years	53	50.0	50.0
5-8 years	15	14.2	64.2
9-12 years	7	6.6	70.8
13-16 years	8	7.5	78.3
More than 16 years	23	21.7	100.0
Total	106	100.0	

Table 4. Years in Current Rank: Captains

	Frequency	Percent	Cumulative Percent
1-4 years	17	23.9	23.9
5-8 years	17	23.9	47.9
9-12 years	15	21.1	69.0
13-16 years	11	15.5	84.5
More than 16 years	11	15.5	100.0
Total	71	100.0	

Table 5. Total Years of Firefighting Experience (as Firefighter or Captain)

	Frequency	Percent	Cumulative Percent
1-4 years	53	29.9	29.9
5-8 years	18	10.2	40.1
9-12 years	19	10.7	50.8
13-16 years	19	10.7	61.6
More than 16 years	68	38.4	100.0
Total	177	100.0	

Table 6. Knowledge of Job Duties

	Frequency	Percent	Cumulative Percent
Extremely well	130	73.4	73.9
Very well	44	24.9	98.9
Somewhat well	2	1.1	100.0
Total	176	99.4	
Did not report	1	.6	
Total	177	100.0	

As can be seen in Table 7, the majority of respondents (57.6%) reported having attended some college without obtaining a degree. An additional 22.6% of the respondents reported that they had obtained an Associate's degree. A small percentage of respondents (3.4%) did not report educational level.

Table 7. Education

	Frequency	Percent	Cumulative Percent
High school graduate	6	3.4	3.5
Some college without degree	102	57.6	63.2
Associate's degree	40	22.6	86.5
Bachelor's degree	15	8.5	95.3
Some post graduate education without advanced degree	7	4.0	99.4
Master's degree	1	.6	100.0
Total	171	96.6	
Did not report	6	3.4	
Total	177	100.0	

Tables 8 and 9 pertained to work and station assignments. Approximately half (50.3%) of the respondents were assigned to an Engine and another 20.9% of the respondents were assigned to a Ladder. The remaining work assignments were Swing (8.5%), Hazardous Materials (7.9%), Paramedic Assessment (5.6%), and Technical Rescue (4.5%). The largest percentage of respondents were assigned to Station 1 (12.4%), Station 17 (9.6%), Swing (9.6%), and Station 10 (9.0%).

Table 8. Current work assignment

	Frequency	Percent	Cumulative Percent
Engine	89	50.3	51.4
Ladder	37	20.9	72.8
Swing	15	8.5	81.5
Paramedic Assessment Unit	10	5.6	87.3
HazMat	14	7.9	95.4
Technical Rescue	8	4.5	100.0
Total	173	97.7	
Did not report	4	2.3	
Total	177	100.0	

Table 9. Station

	Frequency	Percent	Cumulative Percent
1	22	12.4	12.5
3	3	1.7	14.2
4	5	2.8	17.0
5	12	6.8	23.9
7	12	6.8	30.7
8	5	2.8	33.5
9	10	5.6	39.2
10	16	9.0	48.3
11	8	4.5	52.8
12	6	3.4	56.3
13	4	2.3	58.5
14	4	2.3	60.8
15	6	3.4	64.2
16	15	8.5	72.7
17	17	9.6	82.4
18	6	3.4	85.8
19	7	4.0	89.8
37	1	.6	90.3
Swing	17	9.6	100.0
Total	176	99.4	
Did not report	1	.6	
Total	177	100.0	

As can be seen in Table 10, slightly less than half of the respondents (42.9%) indicated that they had responded to more than 20 structural and/or wildland/brush fires during the past 12 months. Only 5.1% of the respondents indicated that they had responded to fewer than 5 such fires.

Table 10. Number of structural and/or wildland/brush fires

	Frequency	Percent	Cumulative Percent
Less than 5	9	5.1	5.1
5-10	28	15.8	20.9
11-15	32	18.1	39.0
16-20	32	18.1	57.1
More than 20	76	42.9	100.0
Total	177	100.0	

The final two questions from the Background/Supplemental section of the job analysis questionnaire applied to firefighters only. As can be seen in Table 11, The majority of firefighters (67%) reported that with the exception of training, other group activities, and emergency responses (where their role is to follow their supervisor's instructions), they are responsible for determining their work priorities and deciding on methods for accomplishing tasks. Therefore, for routine functions, firefighters appear to have a high amount of autonomy in decision making and planning.

Table 11. Supervision received: Firefighters

	Frequency	Percent	Cumulative Percent
All activities for each shift are determined and supervised by a supervisor.	2	1.9	1.9
With the exception of some free time and sleep, all activities for each shift are planned and supervised by a supervisor.	15	14.2	16.2
With the exception of emergency responses, my activities are set by a predetermined schedule.	17	16.0	32.4
With the exception of training, other group activities, and emergency responses (where my role is to follow my supervisor's instructions), I am responsible for determining my work priorities and deciding on methods for accomplishing tasks.	71	67.0	100.0
Total	105	99.1	
Did not report	1	.9	
Total	106	100.0	

*Note. Firefighter responses only.

As can be seen in Table 12, very few firefighters reported injuries on the job resulting in days off work. Nearly 85 percent (85.8%) of the respondents indicated that they had not had any days off work due to injury in the past 12 months. Slightly less than six percent of the firefighters (5.6%) reported having taken three or more days off work due to injury in the past 12 months.

Table 12. Number of days off work due to injury (past 12 months)

	Frequency	Percent	Cumulative Percent
none	91	85.8	86.7
1-2	8	7.5	94.3
3-5	3	2.8	97.1
10 or more	3	2.8	100.0
Total	105	99.1	
Did not report	1	.9	
Total	106	100.0	

*Note. Firefighter responses only.

Task Analysis and Results

Task Ratings

Section 2 of the job analysis questionnaire included 241 job task statements. Two scales were used to rate the task statements: Frequency and Importance. Task Frequency was rated using a 6-point scale with a response range from 0 through 5. A response of 0 indicated the task was not part of the job. A response of 1 indicated the task was part of the job but not performed. Each of the four remaining responses was accompanied by a phrase that described how often a task was performed, with the larger values indicating greater frequency: 2 = Performed every few months to yearly; 3 = Performed every few weeks to monthly; 4 = Performed every few days to weekly; and 5 = Performed every few hours to daily. Task Importance was rated by a 4-point scale with a response range from 0 through 3. Each response indicated a degree of importance to successful job performance, with the larger values indicating greater importance: 0 = Not Important to successful job performance; 1 = Somewhat Important to successful job performance; 2 = Important to successful job performance; 3 = Very Important to successful job performance.

The data analysis was performed to identify the tasks performed by entry-level firefighters as part of their job. Based on the *CPS Job Analysis Guidelines* (CPS, 2000), in order for a task to be retained, *at least* 60% of the respondents had to indicate that the task is performed or is part of the job (i.e., assign a Task Frequency rating of 1 *or greater*) and the Task Importance rating had to be *at least* 1.50, which is the midpoint of the rating scale. Only individuals who indicated the task was performed or part of their job were included in the analysis of the task Importance ratings.

Task Results

Because information was gathered from two sources (firefighters and their supervisors), it is informative to examine the level of agreement between these two perspectives. For the purposes of this analysis, agreement was operationalized in terms of the tasks retained/excluded based on the analysis. With the exception of tasks 111 (Mows, trims, weeds, and waters grass and flower beds, cleans sidewalks, removes litter) and 231 (Collects donations for special campaigns [money, toys, canned goods, etc.]), both groups were in agreement. As can be seen in Table 13, although more than 90% of both groups indicated that the tasks were performed or part of the job, firefighters felt that these two tasks were more important than did captains. Because the captain mean Importance ratings for these tasks was less than 1.5, they did not meet the criteria for inclusion based on the *CPS Job Analysis Guidelines* (CPS, 2000). For the remaining 239 tasks, data from both groups indicated that all of the tasks should be retained.

Table 13. Task Statement Ratings: Firefighter versus Captains

	Firefighters		Captains	
Task	Frequency	Importance Mean and (Standard Deviation)	Frequency	Importance Mean and (Standard Deviation)
111. Mows, trims, weeds, and waters grass and flower beds, cleans sidewalks, removes litter	.94	1.74 (.84)	.92	1.39 (.90)
231: Collects donations for special campaigns (money, toys, canned goods, etc.)	.97	1.96 (.84)	.92	1.49 (.90)

Due to the high level of agreement on the tasks, the decision was made to combine the data and analyze it as one set, with the exception of the two tasks where there was disagreement. The remaining 239 tasks met the criteria for inclusion based on the *CPS Job Analysis Guidelines* (CPS, 2000). Appendix E summarizes the task ratings for the entire group of respondents. The task list presents the Frequency rating and the mean and standard deviation for the Importance rating. Within each dimension, the tasks are presented in decreasing order of Importance. The sample size varies between tasks because the mean Importance ratings were calculated using only those respondents who rated the task as being part of the job. Some respondents also left some task ratings blank. The task dimensions used to group the tasks and the mean and standard deviation (*SD*) for the Importance ratings of the tasks within each dimension are presented in Table 14. The tasks in dimension G "Respond to Medical Emergency Calls" had the highest mean Importance rating ($M = 2.80$, $SD = .41$). Task 148 (Uses personal safety equipment to limit personal exposure [e.g., gloves, goggles, face mask]), which was in dimension G, had the highest mean Importance rating ($M = 2.97$, $SD = .18$).

Table14. Task Dimension Importance Ratings

Task Dimension		Number of Tasks	Dimension Importance Mean	Dimension Importance Standard Deviation
A.	Maintain, Inspect, and Inventory Equipment	18	2.495	0.612
B.	Forcible Entry and Rescue Operations	29	2.731	0.472
C.	Training Activities	22	2.290	0.665
D.	General Firefighting Activities	26	2.645	0.524
E.	Fire Prevention, Inspection, and Code Enforcement Activities	10	2.252	0.700
F.	Station Duties and Maintenance	21	2.322	0.675
G.	Respond to Medical Emergency Calls	22	2.800	0.405
H.	Salvage and Overhaul	13	2.437	0.636
I.	Hose Evolutions and Extinguishment	21	2.670	0.516
J.	Operate Apparatus	22	2.586	0.612
K.	Use and Operation of Ladders	5	2.679	0.538
L.	Ventilation Procedures	8	2.722	0.469
M.	Fire Cause Investigation	5	2.428	0.668
N.	Wildland Firefighting	7	2.258	0.766
O.	Community Service	10	2.084	0.759

KSAO Analysis and Results

KSAO Ratings

Section 3 of the job analysis questionnaire included 174 knowledge, skill, ability, and other characteristics (KSAO) statements that are necessary to perform the duties of an entry-level firefighter. Two scales were used to rate the KSAO statements: Importance and Needed at Entry. Importance was rated using a 4-point scale with a response range from 0 through 3. Each response indicated a degree of importance to successful job performance, with the larger values indicating greater importance: 0 = Not Important to successful job performance; 1 = Somewhat Important to successful job performance; 2 = Important to successful job performance; 3 = Very Important to successful job performance. Participants were also asked to rate the necessity of possessing each KSAO at the time of hire (i.e., before beginning the academy). Needed at Entry was rated using a 3-point scale ranging from not needed to essential: 0 = Not Needed; 1 = Needed; 2 = Essential.

Based on the *CPS Job Analysis Guidelines* (CPS, 2000), in order for a KSA to be retained, *at least* 60% of the respondents had to indicate that the KSA is *Needed* or *Essential* (i.e., assign a KSA Expected at Entry rating of 1 or 2) and the KSA Importance rating had to be *at least* 1.50, which is the midpoint of the rating scale.

KSAO Results

As with the tasks, there was a high level of agreement on the KSAOs which were retained/excluded based on the analysis. With the exception of KSAO 111 (Ability to rake or hoe soil and rocks for a continuous period of time) and 113 (Ability to communicate in signs and signals), both groups were in agreement. As can be seen in Table 15, for KSAO 111 and 113, less than 60% of the captain raters indicated that the KSAO was needed or essential at the time of hire for the position of firefighter. Therefore, in the captain sample, these two KSAOs failed to meet the criteria for inclusion based on the *CPS Job Analysis Guidelines* (CPS, 2000). In the firefighter sample, both of these statements met the criteria for inclusion.

Table 15. KSAO Statement Ratings: Firefighters versus Captains

	Firefighters		Captains	
KSAO	Needed at Entry	Importance Mean and (Standard Deviation)	Needed at Entry	Importance Mean and (Standard Deviation)
111. Ability to rake or hoe soil and rocks for a continuous period of time	.61	1.81 (1.07)	.55	1.45 (1.14)
113. Ability to communicate in signs and signals	.69	2.17 (.79)	.59	1.99 (.82)

Due to the high level of agreement on the KSAOs, the decision was made to combine the data and analyze it as one set. However, the two KSAOs where there was disagreement were excluded from further analysis. One-hundred and twelve of the remaining 172 KSAOs were retained based on the *CPS Job Analysis Guidelines* (CPS, 2000); 60 KSAOs were excluded. Appendix F summarizes the final list of essential KSAOs, in decreasing order of Importance ratings and includes the sample size (N), the percent of respondents indicating the KSAO is needed or essential (Needed at Entry), and the mean and standard deviation (*SD*) for the KSAO Importance ratings. Shaded KSAOs indicate those KSAOs that did not meet the decision rules for inclusion in the final KSAO list.

Linkage Analysis

Introduction

One important component of documenting content validity of an examination is to establish a variety of linkages. CPS project staff requested from TFD a panel of SMEs to provide the necessary linkages as part of the job analysis process. These linkages occurred over a 1-1/2 day meeting with a panel of experienced firefighters from the TFD. CPS project staff requested a panel of between 10 and 15 SMEs who were most familiar with the job of firefighter and representative of the Department with respect to variations in work assignments, work locations, race, and ethnicity. The TFD selected and notified the SMEs who were asked to participate. Dr. Thompson, CPS consultant, conducted the meeting on April 5th and 6th, 2001 at the City of Tucson, Fire Training Academy. Although CPS had requested the same panel members for both

days, work assignments precluded this. However, there was a core of four panel members present both days. Also, two members of the Tucson Human Resources Department, Jody R. Tom, and Wendy K. Olson, were present as observers the first day the panel met.

The SMEs were asked to participate in four activities. The following is an overview of the activities accomplished in this panel meeting.

- Activity 1 – Link each KSAO statement to one or more job dimensions using a 3-point scale
- Activity 2 – Identify which KSAO distinguishes superior performance for the job of firefighter
- Activity 3 – View a video tape of each of the eight events in the Candidate Physical Ability Test (CPAT) to determine the appropriateness of the events for use by the TFD
- Activity 4 – Link each KSAO statement to one or more examination components

Prior to beginning the above activities, the SMEs were required to fill out a two-part form:

- A Subject Matter Expert form documenting their expertise as a subject matter expert
- A confidentiality agreement form agreeing not to divulge any information gained in this panel that would possibly compromise the examination process.

The observers from the Department of Human Resources were also required to fill out the confidentiality agreement.

Composition of Subject Matter Expert Panel

Table 16 provides demographics for the SME panel members.

Table 16. Subject Matter Expert Meeting Participants

April 5th and April 6th, 2001

Name	Rank	Tenure	Gender	Ethnicity
Dan Burke	Captain	7-1/2 years	Male	Caucasian
James Kearney	Engineer	8-1/2 years	Male	Caucasian
Ronald J. Lopez	Captain	11-1/2 years	Male	Hispanic
Douglas Seeger*	Captain	12-1/2 years	Male	Caucasian

*left at noon April 5th due to work conflict and did not complete the superior job performance ratings.

April 5th, 2001 only

Name	Rank	Tenure	Gender	Ethnicity
Shannon Adams	Firefighter	8 years	Female	Caucasian
Nancy R. Avery	Inspector/Firefighter	10 years	Female	Caucasian
Ron Huerta	Captain	25-1/2 years	Male	Hispanic
Gus Mazon	Captain	30 years	Male	Caucasian
Sharon A. McDonough	Captain	10-1/2 years	Female	Caucasian
Frank Mulvaney	Firefighter	28-1/2 years	Male	Caucasian
Donald L. Pugliese	Engineer	27 years	Male	Caucasian

April 6th, 2001 only

Name	Rank	Tenure	Gender	Ethnicity
John Kirby Comaduran	Firefighter	< 1 year	Male	Hispanic
Kevin Deardorff	Firefighter	18-1/2 years	Male	Caucasian
Rich Johnson	Captain	16 years	Male	Caucasian
Jerome P. Manion	Captain	18-1/2 years	Male	Caucasian
Karl Mare	Captain	11-1/2 years	Male	Caucasian
Steve Naber	Engineer	11 years	Male	Caucasian

Linking KSAO Statements to Job Dimensions

The first activity of the workshop was to complete a matrix comprised of KSAO statements and job dimensions based on the results of the job analysis. To complete this activity, three documents were provided to the SMEs:

- A matrix of KSAO statements and job dimensions
- A set of directions on how to respond to the matrix
- A list of the 15 job dimensions, each with the five task statements with the highest mean importance ratings from the job analysis listed under each job dimension.

Copies of these documents are contained in Appendix G. The SMEs were asked to review the three documents to familiarize themselves with the content.

After the SMEs familiarized themselves with the material, the CPS project staff member gave the SMEs a brief presentation on the activities that had occurred up to this point in the job analysis process. This update helped set the stage for the activities to be conducted during the workshop. It also provided some continuity of the project since most of the SMEs participating in this workshop had participated in the previous workshop where the job analysis questionnaire was finalized. The 15 job dimensions included in this phase of the workshop are listed in Table 17.

Table 17. Job Dimensions

Job Dimension Number	Job Dimension Title	Job Dimension Number	Job Dimension Title
1	Maintain, Inspect, and Inventory Equipment	9	Hose Evolutions and Extinguishment
2	Forcible Entry and Rescue Operations	10	Operate Apparatus
3	Training Activities	11	Use and Operation of Ladders
4	General Firefighting Activities	12	Ventilation Procedures
5	Fire Prevention, Inspection, and Code Enforcement Activities	13	Fire Cause Investigation
6	Station Duties and Maintenance	14	Wildland Firefighting
7	Respond to Medical Emergency Calls	15	Community Service
8	Salvage and Overhaul		

The SMEs were requested to perform several steps in linking the KSAO statements to the job dimensions.

- Step 1 – The SMEs read and familiarized themselves with the five most important task statements (i.e., highest importance ratings) listed under job dimension one (Maintain, Inspect, and Inventory Equipment).
- Step 2 - The SMEs read the first KSAO statement and made a determination of how necessary that KSAO was to performance of the job dimension. A three-point scale was used in this linkage process: 0 = Not Needed; 1 = Helpful; 2 = Essential
- Step 3 – The SMEs repeated this process for each of the remaining 111 KSAO statements for the dimension.
- Step 4 – The SMEs repeated this process for each of the remaining 14 job dimensions.

At several points during this linkage process, the CPS project staff member stopped the rating process to ask SMEs to identify how they had rated specific KSAO statements and to provide their rationale for the ratings. The first purpose of these discussions was initially to ensure all SME panel members understood the process. The second purpose was for the SMEs to discuss their thought process in arriving at ratings so all other panel members could hear individual rationales and respond to them. This was to help ensure that SMEs were using similar thought processes in their rating process. The SMEs were informed they could change their ratings if they felt the need to do so as a result of the discussions.

Leads to Superior Performance

The next activity for the members of the SME panel was to use the same matrix of KSAO/job dimension statements and rate each of the 112 KSAO statements on a Superior Job Performance scale. The purpose of this scale is to decide whether a KSAO has a linear relationship with job performance. If the relationship is judged to be linear, the examination(s) measuring the KSAOs can be scored on a continuous basis (i.e., number of correct responses). If not, the examination(s) measuring the KSAOs should be scored on a pass-fail basis. The scale used was a two-point scale: 0 = No; 1 = Yes

The Dr. Thompson directed an extensive discussion on what the Leads to Superior Performance scale means, that is, "more is better." Most of the discussion involved clarifying the SMEs' understanding of the concept that if one has an acceptable level of knowledge or ability, anything beyond that level makes no difference to performance. As a result, the CPS project staff member chose KSAO statement number 58 "Ability to read gauges" and asked the SMEs to identify what types of behaviors would indicate a greater ability to read gauges. Some examples given were: able to read different types of gauges, able to read gauges more quickly, able to read gauges more accurately. After these examples were given, the discussion turned to whether this would lead to better job performance. This type of discussion was held with several other KSAO statements. At this point the consensus of the SME panel was that they understood the purpose of this activity and were ready to begin the rating process. Throughout the rating process the SMEs were stopped and asked to identify what their rating had been for specific KSAO statements. Where there was a relatively even split between 0's and 1's, SMEs were asked to discuss their thought process as to why they made their respective ratings. The SMEs were also told they could change their rating as a result of the discussion.

On the second day, the first activity of the SME panel involved providing ratings to assist with the validation of the CPAT events. This rating process is described in the CPAT Event Rating section.

Linkage of KSAO Statements to Examination Components

The last activity requested of this SME panel was to link each of the 112 KSAO statements to the most appropriate selection procedure(s) for evaluating candidates. This process was undertaken to supplement the review of the selection methods performed by CPS staff. The SME panel members were provided a Firefighter Examination Method Identification Form for this linkage process. The linkage form and results are provided in Appendix H. The examination components used in this linkage process are presented in Table 18.

Table 18. Examination Components

Component Number	Component Title
1	Memory and Understanding Oral Instructions (written examination)
2	Understanding Written Materials (written examination)
3	Arithmetic Reasoning (written examination)
4	Maps, Diagrams, and Mechanical Drawings (written examination)
5	PDI Performance Scale
6	Physical Ability Test (CPAT)
7	Structured Oral Interview

Dr. Thompson led a discussion of the purpose of this linkage process. The SME panel members were informed this linkage process would assist in determining the types of examination components that would be included in the entry-level examination developed. The SMEs were given an overview of the examination components listed in Table 18 to provide basic information about the examination components. After this overview, component one "Memory and Understanding Oral Instructions" was discussed in detail. The SMEs discussed several of the KSAO statements as a group and whether they would be appropriate to be measured by this examination component. This discussion was to familiarize the SME panel members with the linking process. As part of this discussion, SME members were asked to indicate what their thought process was when determining whether this was an appropriate examination component. This discussion was to ensure all the members of the SME panel were using the same frame of reference in their linkage process. After the SME panel members linked the selected KSAO statements, they were then asked to link all remaining KSAO statements to the first examination component. When all SME panel members had completed their linkages on the first examination component, a discussion was held on the process. Additional KSAO statements were discussed to see how the SMEs had linked those KSAO statements. Where there were relatively even splits of opinion, individual SMEs were asked to describe why they had made their choice. SMEs were told they could change their linkages based on the discussion.

Upon completion of the linkages of the first examination component, SMEs were asked if they felt there were other examination components that were appropriate to be included in the linkage process. One other type of examination –the leaderless group discussion—was mentioned; however, the majority of the SME panel participants felt this was not desirable for inclusion in an entry-level examination. As a result, no additional components were added to the document.

After this discussion, each of the remaining examination components was discussed in detail. Significant discussion was held to ensure the SMEs understood each examination component—especially the written components and the PDI Performance Scale. The SMEs were then instructed to indicate which of the remaining examination components is the most appropriate measure for each KSAO statement.

Once the SME panel members had completed all of the KSAO/examination component linkages, a brief discussion was held. This was to ensure everyone felt comfortable with the process and to give them a chance to indicate their understanding of and satisfaction with the process. All SME panel members indicated a satisfaction with the process.

PDI EMPLOYMENT INVENTORY – PERFORMANCE

Performance Scale Ratings

Section 5 of the job analysis questionnaire included a list of 16 employee activities and competencies associated with Dependability. Through discussions with the subject matter experts and on-site observations, it was determined that a measure of dependability, responsibility, and conscientiousness would be relevant for this position. The measure hypothesized to correlate with the requirements of this job is the Performance subscale of the Employment Inventory (EI) developed by Personnel Decisions International. The EI is a personality-based employment inventory comprised of one to five separate scales that predict dependability, customer service orientation, teamwork, sales orientation/ability, and likelihood of staying on the job for an extended period of time (Paajanen, G. E., et. al., 1993).

The Federal Uniform Guidelines on Employee Selection Procedures (1978) require that a test used in the selection process be job-related and consistent with business necessity. The EIQ-P used in this study was designed to include competencies and behaviors that have been predicted by the EI in previous validation studies. This report indicates which of these characteristics are required for successful job performance and which behaviors are most important to the job. The EIQ-P contains 16 items describing competencies or work behaviors associated with Performance. To determine the appropriateness of the Performance scale, the 16 scale items from the full 80-item Employment Inventory job analysis questionnaire were administered to TFD SMEs (firefighters and their captains). The Performance scale measures how reliable, dependable, motivated, and conscientious an applicant is likely to be. Each competency was rated on a five-point scale measuring Importance. Participants rated the Criticality of each of the scale statements using the following 5-point scale: 0 = Unimportant; 1 = Of Minor Importance; 2 = Important; 3 = Very Important; 4 = Crucial.

Results

Firefighter and captain responses to the PDI Employment Inventory Performance Scale Questionnaire (EIQ-P) Importance ratings were compared using t-tests for each item. No significant differences in responses between these two rating groups was found. Therefore, it can be concluded that firefighters and captains were in agreement as to the importance of each of these behaviors. Therefore, the combined results were examined.

When examining the results of the EIQ-P, it is helpful to consider the amount of inter-rater reliability. The intraclass correlation coefficient (ICC) provides an indication of inter-rater reliability. The average ICC for the EIQ-P Importance ratings was .99, indicating a strong level of inter-rater reliability.

Table 19 lists the means and standard deviations for each of the 16 items from the EIQ-P. It is evident from the results that the Performance behaviors measured by the EI are considered important for success as a TFD firefighter. The overall mean for the EIQ-P was 2.80 (*SD* = .82). With the exception of one behavior, all of the competencies/behaviors within the Performance dimensions were rated as important (average rating of 2 or higher), providing a solid link to other jobs for which the EI Performance scale has been validated. As such, these results clearly support the use of the EI Performance scale for the selection of firefighters in the City of Tucson.

Table 19. Employment Inventory Questionnaire – Performance Scale Results

		N	Mean	Standard Deviation
RELIABILITY/RULE-FOLLOWING				
1.	Follow company policies exactly.	177	3.06	.77
2.	Report a co-worker who has violated an important rule.	177	2.55	.85
3.	Maintain order and organization in one's work.	177	2.90	.78
4.	Perform in the expected or agreed upon way.	177	3.24	.76
5.	Follow through on commitments.	177	3.32	.72
ATTENDANCE				
6.	Return from meals and breaks in the allotted time.	177	2.62	.92
7.	Accept necessary schedule changes.	177	2.79	.83
8.	Willingly work overtime when needed.	177	2.46	.86
9.	Change vacation plans, if necessary, to stay at work.	177	1.86	1.02
10.	Offer to stay late when work is very busy.	177	2.20	.94
WORK ETHIC				
11.	Clean up work area before leaving.	177	2.84	.75
12.	Keep working, even when co-workers are not working.	177	2.70	.84
13.	Take initiative to find another task when finished with regular work.	177	2.76	.73
14.	Exert sustained effort for long periods of time.	177	3.27	.77
15.	Start work quickly; stay busy and active; show urgency in getting work done.	177	2.79	.91
16.	Take corrective action after making a mistake.	177	3.51	.67

Summary

Using the PDI Employment Inventory Performance scale to hire Tucson firefighters will capture important characteristics needed for success on the job. The use of the Performance scale will help in measuring a candidate's likelihood of performing well in the position.

Candidates' scores on the PDI Performance scale will be weighted and used in combination with their written test scores to determine their scores for the selection process. Weighting options for the PDI Dependability scale are discussed in the examination weighting portion of this report.

CANDIDATE PHYSICAL ABILITY TEST (CPAT)

Background

Currently, the TFD uses a physical ability test as part of its procedure to select firefighters. As part of the job analysis and test development process, CPS was asked to determine an appropriate measure for evaluating firefighter physical ability. Interviews with TFD SMEs indicated that the Candidate Physical Ability Test (CPAT) might provide an effective measure of candidate physical ability. The CPAT was developed through the Fire Service Joint Labor Management Wellness/Fitness Initiative. This initiative involved a collaborative study by the International Association of Fire Fighters (IAFF) and the International Association of Fire Chiefs (IAFC). One of the primary purposes of the initiative was to develop a measure of candidate physical performance that would be both legally defensible and provide a standardized procedure for hiring physically capable firefighters. This research initiative is fully described in *The Fire Service Joint Labor Management Wellness/Fitness Initiative Candidate Physical Ability Test* (1999). Hereafter referred to as the CPAT (1999) research or report as applicable.

The CPAT (1999) research was conducted with the participation of ten fire departments in the United States and Canada. This multi-agency effort permitted the development of a validated measure of candidate physical ability in the ten participating agencies. However, the report emphasized the need for conducting local validation studies "to prove its validity for other cities or counties outside the group of ten jurisdictions involved in the validation study" (p.91).

The CPAT (1999) report outlined the steps for conducting a transportability study for other fire departments wanting to use the CPAT. These steps included: 1. conducting a job analysis study to identify the essential tasks and KSAs required for success as a firefighter in the department; 2. Develop a written job description based on the job analysis; 3. Identify the KSA areas to be measured by the test; 4. Ensure that the content of the proposed test measures KSAs important for success as a firefighter. Therefore, CPS conducted a comprehensive job analysis to determine the appropriateness of using the CPAT for assessing the physical requirements of entry-level firefighters in the TFD, and underwent a process of determining the similarity of the physical requirements of TFD firefighters with those of the ten agencies that participated in the initial validation of the CPAT.

With the cooperation of the ten participating agencies, the CPAT study identified 31 tasks representing the critical firefighter skills requiring physical effort. A job analysis survey based on these tasks was then developed to assess how critical each task was to successful job performance and the level of physical effort required while performing each task. The results of this survey were used to develop the eight events that comprise the CPAT.

CPAT Task Analysis

CPAT Rating Scales

Section 4 of the job analysis questionnaire lists 31 physical task statements associated with the CPAT. These statements are to be rated using two scales: Criticality and Physical Effort. Criticality was rated using the following 5-point scale: 1 = Not Performed; 2 = Least Critical (failure to perform results in no negative consequences.); 3 = Important (beneficial for the successful performance of the job.); 4 = Critical (essential for the successful performance of the job.); 5 = Extremely Critical (failure to perform results in extreme negative consequences.). Participants also rated each task for the physical effort required to perform the task. Physical Effort was rated using the following 5-point scale: 1 = No Effort; 2 = Minimal Physical Effort; 3 = Moderate Physical Effort; 4 = Excessive Physical Effort; 5 = Maximal Physical Effort. Table 20 provides a list of the 31 CPAT task statements.

Table 20. CPAT Task Statements

1	Wear full protective clothing and equipment, including SCBA	17	Raise or lower equipment from windows
2	Extend (i.e., advance) dry hoseline from fire apparatus to fire occupancy	18	Carry stretcher or gurney (e.g., auxiliary, stokes, backboard, etc.)
3	Enter through door using force	19	Move heavy objects to gain access to fire and/or free trapped persons
4	Crawl through smoke filled structure pulling charged hoseline	20	Extend (i.e., advance), hold and support a charged attack line with flowing water
5	Remove ladder from fire apparatus, carry and place at structure	21	Start power tools
6	Climb ladder carrying tools	22	Walk along uneven/narrow surfaces (i.e., roof)
7	Remove equipment from fire apparatus and carry to scene	23	Operate at elevated heights
8	Ventilate roof with power tools	24	Pull self up and over an obstacle or into an opening
9	Ventilate roof with hand-held axe	25	Remove debris from fire scene
10	Climb stairs with high rise packs	26	Climb fence or wall in full protective clothing with equipment
11	Hook up to hydrant	27	Remove, carry and throw salvage covers to protect equipment
12	Pull ceiling to check for fire extension	28	Climb stairs in full protective clothing carrying firefighting equipment
13	Drag dry supply line from apparatus to hydrant	29	Roll up hose and place on apparatus
14	Search for victim in fire occupancy with limited visibility	30	Advance (i.e., pull) charged attack line around obstacles while remaining stationary
15	Remove victim or injured partner from fire scene	31	Operate fire extinguishers
16	Extricate victim from vehicle		

CPAT Task Results

To facilitate comparisons, the analysis of the CPAT results was designed to mimic the design of the original CPAT research as much as possible.

Demographic Comparison With CPAT Sample. For the purposes of comparison, Table 21 provides demographic information on the composition of the TFD sample and the CPAT research sample. Participant age and gender were comparable across the two samples. Ethnic background was somewhat less diverse, with Hispanics making up a larger percentage of the TFD sample (19.2%) than in the CPAT sample (6.6%). In addition, African Americans made up a much smaller percentage in the TFD sample (1.1%) than in the CPAT sample (10.8%). This discrepancy can be attributed to the characteristics of the population in the City of Tucson and its surrounding areas (Pima County). Data from the 2000 Census indicates that 29.3% of the Pima County population is Hispanic, while only 3% are African American. Only firefighters and their supervisors (captains) were surveyed for TFD accounting for differences in rank. Finally, the TFD sample contained a larger percentage of firefighters with less than 4 years of experience (29.9%) than did the CPAT sample (13.8%).

Table 21. Comparison of Tucson and CPAT Demographic Characteristics

Demographic Characteristic	Tucson		CPAT	
	Frequency	Percent *	Frequency**	Percent*
Age				
20 or under			1	.1
21 to 30	23	13.0	144	14.8
31 to 40	66	37.3	410	42.1
41 to 50	64	36.2	323	33.2
51 or over	20	11.3	95	9.8
Missing	4	2.3		
Gender				
Male	154	87.0	921	95.4
Female	10	5.6	44	4.6
Ethnic Background				
African American	2	1.1	103	10.8
Hispanic	34	19.2	63	6.6
Asian/Pacific Islander	1	.6	3	.3
Native American	3	3.0	5	.5
Caucasian	123	69.5	784	81.8
Filipino	1	.6		
Other	8	4.5		
Missing	5	2.8		
Rank				
Firefighter	106	59.9	668	70.1
FST/FST II				
Lieutenant			154	16.2
Captain	71	40.1	140	14.7
Experience				
1 – 4 years	53	29.9	133	13.8
5 – 8 years	18	10.2	140	14.5
9 – 12 years	19	10.7	180	18.7
13 – 16 years	19	10.7	120	12.4
over 16 years	68	38.4	394	40.7
Total	177	100.0	980	100.0

*Total percent within each category does not always equal 100% due to rounding.
**Totals vary by category due to missing data.

Rating Characteristics by Group. In order to examine whether demographic characteristics impacted respondents' Criticality and Physical Effort ratings, where practical, the mean ratings between groups in each of the demographic categories were examined. Potential differences due to gender were not analyzed because the relatively few number of females in the sample did not permit reliable comparisons between the two groups. For the remaining demographic categories, a series of one-way Analysis of Variance (ANOVA) procedures were conducted, with each rating as the dependent variable and the demographic variable as the independent variable. To

adjust for multiple comparisons, the Bonferroni procedure which yields a more conservative alpha level was used. Therefore, for each set of 31 Criticality and Physical Effort ratings, the alpha level of .05 was divided by the number of comparisons (31), resulting in an alpha level of .002.

Examination of the results from the age category revealed statistically significant differences due to age for two of the Criticality ratings, with individuals in the 31 to 40 year age category giving the highest ratings for these statements and individuals in the 51 or older category giving the lowest ratings for these statements: Task 11 Criticality, $F(3, 169)$, $p = .001$; Task 31 Criticality, $F(3,168) = 6.31$, $p = .000$. Table 22 presents the mean criticality ratings for each age category where tasks showed significant mean differences. For the Physical Effort ratings, there were no statistically significant differences due to age.

Table 22. Criticality Ratings by Age Category

CPAT Statement	Age Category	Age Category Means	Age Category Standard Errors
11. Hook up to hydrant			
	21 to 30	4.52	.15
	31 to 40	4.76	.09
	41 to 50	4.52	.09
	51 or over	4.00	.16
31. Operate fire extinguishers			
	21 to 30	4.17	.20
	31 to 40	4.21	.12
	41 to 50	3.89	.12
	51 or over	3.20	.21

Potential differences due to ethnicity were only examined for the Caucasian and Hispanic respondents. The remaining ethnic categories contained sample sizes that were too small to permit reliable group comparisons. For both the Criticality and Physical Effort Ratings, there were no significant differences due to ethnicity. The demographic comparisons based on rank and experience revealed no statistically significant differences in either Criticality or Physical Effort ratings.

Tucson CPAT Criticality and Physical Effort Ratings. Tables 23 and 24 present the means and standard deviations of the Criticality and Physical Effort ratings for each of the 31 task statements for the combined sample of TFD respondents. For the purposes of comparisons, the mean rating for the total CPAT sample of ten agencies, as well as the highest and lowest mean rating from the participating CPAT research agencies, are also reported in each table.

Table 23. CPAT Survey Criticality Results

Task#	TFD Sample			CPAT Sample		
	N	Mean	Standard Deviation	Total Mean	Low Mean	High Mean
1	177	4.94	0.26	4.78	4.64	4.90
2	177	4.70	0.58	4.30	4.01	4.56
3	177	4.48	0.73	3.87	3.43	4.33
4	177	4.75	0.53	4.45	4.21	4.69
5	177	4.41	0.75	4.02	3.50	4.42
6	177	4.34	0.75	3.90	3.39	4.38
7	177	4.30	0.77	3.94	3.64	4.15
8	177	4.65	0.53	4.14	3.56	4.65
9	177	4.44	0.74	3.70	3.37	4.18
10	177	4.49	0.65	4.01	3.61	4.34
11	177	4.55	0.73	4.28	4.08	4.64
12	177	4.44	0.73	4.13	3.76	4.44
13	177	4.47	0.73	3.97	3.54	4.32
14	177	4.89	0.35	4.71	4.51	4.91
15	177	4.95	0.27	4.80	4.65	4.96
16	177	4.68	0.61	4.39	4.16	4.62
17	176	3.99	0.92	3.41	2.99	3.74
18	177	4.31	0.82	3.47	3.08	3.90
19	175	4.67	0.62	4.26	4.03	4.63
20	176	4.77	0.55	4.45	4.24	4.66
21	177	4.28	0.83	3.88	3.64	4.18
22	176	4.13	0.91	3.68	3.48	3.92
23	176	4.33	0.74	3.95	3.77	4.24
24	174	4.41	0.75	3.99	3.70	4.39
25	176	3.61	1.03	3.13	2.81	3.41
26	176	4.01	0.91	3.42	3.08	4.03
27	176	3.73	0.95	3.08	2.66	3.38
28	176	4.54	0.66	4.21	3.96	4.53
29	176	3.48	1.00	3.09	2.78	3.42
30	176	4.38	0.84	3.75	3.27	3.96
31	176	3.99	0.99	3.46	3.02	3.84

Table 24. CPAT Survey Physical Effort Results

Task#	TFD Sample			CPAT Sample		
	N	Mean	Standard Deviation	Total Mean	Low Mean	High Mean
1	176	3.14	0.87	3.11	2.63	3.69
2	176	3.39	0.77	3.08	2.77	3.69
3	175	3.79	0.71	3.58	3.27	4.28
4	174	4.39	0.71	4.09	3.78	4.59
5	176	3.32	0.77	3.25	2.99	3.86
6	176	3.42	0.77	3.18	2.91	3.77
7	175	3.01	0.80	2.85	2.62	3.56
8	175	3.77	0.71	3.57	3.27	4.15
9	176	4.62	0.62	4.40	4.10	4.73
10	176	4.16	0.83	4.07	3.64	4.32
11	176	2.89	0.87	2.50	1.92	3.14
12	175	3.73	0.80	3.53	3.19	4.15
13	176	3.56	0.85	3.16	2.76	3.58
14	176	3.91	0.87	3.86	3.48	4.30
15	176	4.83	0.46	4.70	4.54	4.82
16	174	3.91	0.72	3.60	3.39	3.95
17	176	3.28	0.74	3.19	2.99	3.65
18	176	3.29	0.84	3.00	2.75	3.33
19	175	4.43	0.67	4.25	4.05	4.56
20	176	4.34	0.67	3.85	3.67	4.63
21	174	2.65	0.82	2.51	2.19	3.15
22	175	2.73	0.89	2.58	2.15	3.30
23	175	2.94	1.00	2.67	2.29	3.52
24	173	3.85	0.90	3.71	3.61	4.15
25	174	3.27	0.78	2.99	2.68	3.50
26	175	3.87	0.86	3.84	3.63	4.18
27	175	2.98	0.73	2.65	2.31	2.96
28	175	4.05	0.80	4.00	3.80	4.38
29	175	2.70	0.78	2.49	2.24	3.02
30	174	4.11	0.80	3.73	3.51	4.31
31	175	2.42	0.81	2.11	1.79	2.86

Mean Criticality ratings by TFD respondents exceeded the mean values from the CPAT study for all survey tasks, with differences in magnitude ranging from .15 to .84. The Pearson correlation between the two sets of ratings was .95, so even where ratings differed in magnitude, they still showed a strong association in direction (i.e., tasks rated low, medium, or high by CPAT sample respondents were also rated low, medium, or high by the TFD respondents). Mean Physical Effort ratings by TFD respondents exceeded the mean values from the CPAT study for all survey tasks, with differences in magnitude ranging from .03 to .49. As with the Criticality ratings, the Pearson correlation between the two sets of ratings was very strong ($r = .98$). This rating consistency between the TFD and CPAT sample respondents is illustrated in Figures 1 and 2.

Figure 1. Comparison of Tucson and CPAT Criticality Ratings

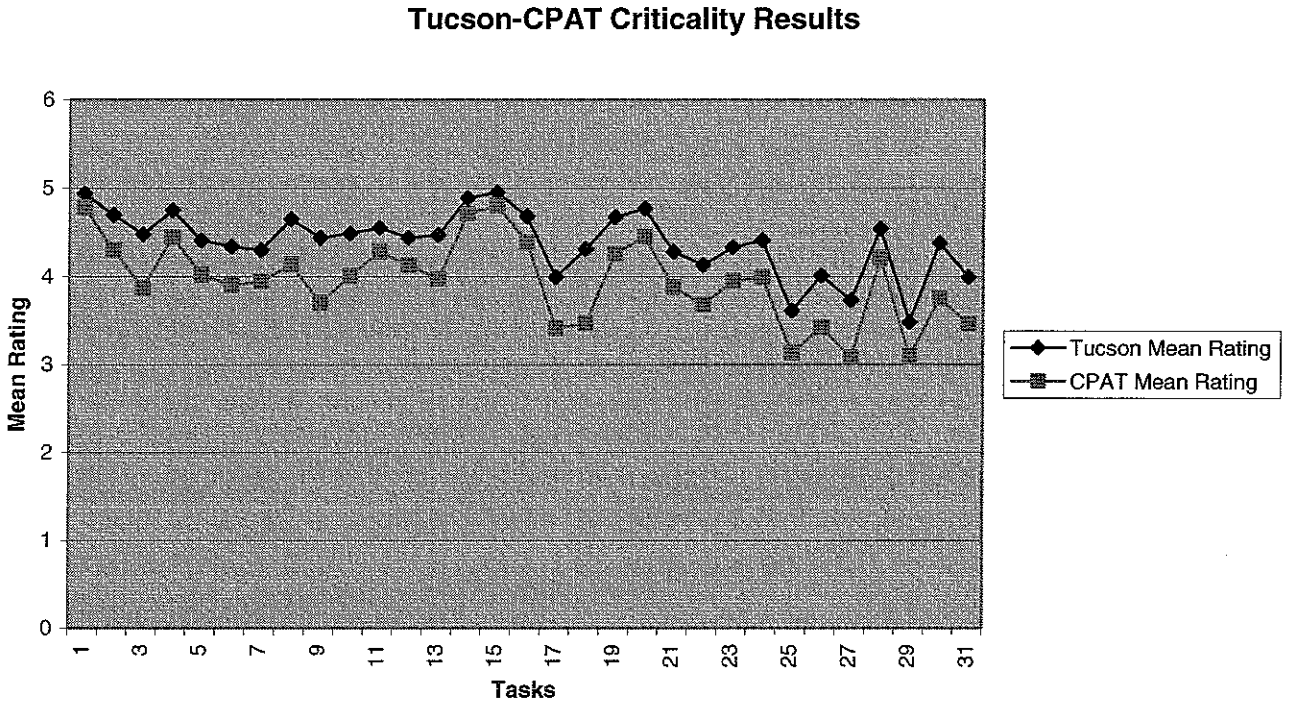
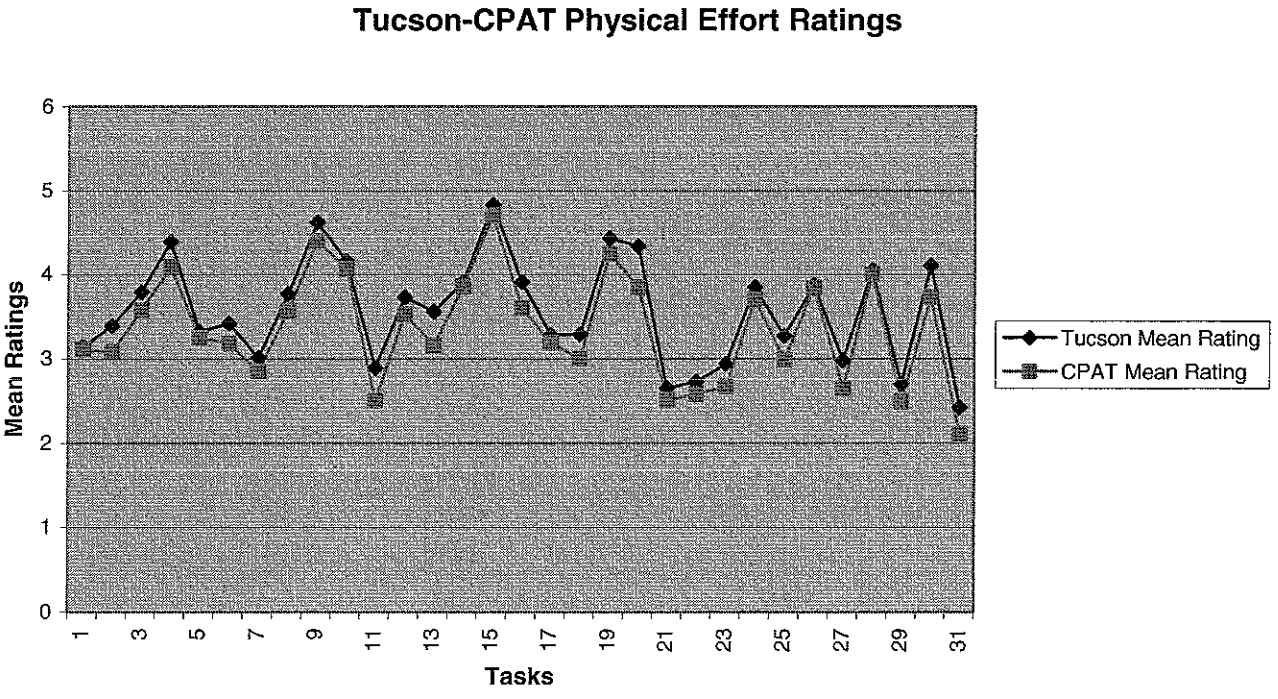


Figure 2. Comparison of Tucson and CPAT Physical Effort Ratings



Summary

Overall, the job analysis ratings made by the TFD respondents were very similar to the ratings obtained in the CPAT study, particularly for the nine tasks used to justify and form the basis of the eight CPAT test events. The CPAT report conducted reviews to demonstrate a linkage between the eight events of the CPAT and the following tasks: Tasks #2, "Extend dry hoseline from fire apparatus to fire occupancy," #3, "Enter through door using force," #5, "Remove ladder from fire apparatus, carry and place at structure," #7, Remove equipment from fire apparatus and carry to scene," #10, "Climb stairs with high rise packs," #12, Pull ceiling to check for fire extension," #14, "Search for victim in fire occupancy with limited visibility," #15, "Remove victim or injured partner from fire scene," and #28, "Climb stairs in full protective clothing carrying firefighting equipment." A summary of the mean ratings for the nine tasks is presented in Table 25. The conclusion drawn from this portion of the study was that the requirements for performing firefighter physical tasks in the TFD are comparable to the physical requirements for tasks demonstrated to be critical in the CPAT study. The next phase of the validation process for the CPAT involved demonstrating the appropriateness of the CPAT events. This process is described in detail below.

Table 25. Descriptive Statistics for Tasks Linked to CPAT Events

Task#	TFD Sample			CPAT Sample		
	N	Mean	Standard Deviation	Total Mean	Low Mean	High Mean
Criticality						
2	177	4.70	0.58	4.30	4.01	4.56
3	177	4.48	0.73	3.87	3.43	4.33
5	177	4.41	0.75	4.02	3.50	4.42
7	177	4.30	0.77	3.94	3.64	4.15
10	177	4.49	0.65	4.01	3.61	4.34
12	177	4.44	0.73	4.13	3.76	4.44
14	177	4.89	0.35	4.71	4.51	4.91
15	177	4.95	0.27	4.80	4.65	4.96
28	176	4.54	0.66	4.21	3.96	4.53
Physical Effort						
2	176	3.39	0.77	3.08	2.77	3.69
3	175	3.79	0.71	3.58	3.27	4.28
5	176	3.32	0.77	3.25	2.99	3.86
7	175	3.01	0.80	2.85	2.62	3.56
10	176	4.16	0.83	4.07	3.64	4.32
12	175	3.73	0.80	3.53	3.19	4.15
14	176	3.91	0.87	3.86	3.48	4.30
15	176	4.83	0.46	4.70	4.54	4.82
28	175	4.05	0.80	4.00	3.80	4.38

CPAT Event Survey

As described previously, a SME panel meeting was convened on April 5th and 6th to conduct linkage analyses and gather additional validation evidence for the CPAT. Dr. Jerry L. Thompson, CPS consultant, conducted the panel meeting. On the morning of April 6th, the focus of the SME panel was to documenting the appropriateness of the events in the CPAT examination for the TFD. For this documentation process, the members of the SME panel were asked to view a program overview video and a candidate instruction video where each of the eight events is demonstrated and described in detail. Table 26 identifies the eight events in the CPAT examination.

Table 26. CPAT Events

Event Number	Event Title
1	Stair Climb
2	Hose Drag
3	Equipment Carry
4	Ladder Raise and Extension
5	Forcible Entry
6	Search
7	Rescue
8	Ceiling Breach and Pull

Prior to beginning the exercise, a 15-minute CPAT Program Overview video was shown to the SME panel. This video provides an overview of the development of the CPAT and a brief description of the eight events. Afterwards, the CPS project staff member discussed with the SMEs the CPAT examination procedures. The SMEs felt generally this was a reasonable examination and not significantly different from their current physical ability examination.

After the discussion, a 15-minute CPAT Candidate Instruction video was played, giving detailed instructions on each of the eight events. After the first event the tape was stopped and the SMEs were asked to read what activities the event was designed to simulate and then answer three questions about the event. This process was repeated for each of the remaining seven events. A copy of the CPAT event survey is presented in Appendix I.

CPAT Event Questions

The three questions associated with each event are presented below:

1. Compare the physical effort required to complete this test event with the effort that would be extended during the performance of the job tasks described above. Which of these would demand the greatest amount of physical effort?

   - ❑ The test event requires a greater effort than the job task at a fire.
   - ❑ Both the test event and the job tasks require about the same amount of effort.
   - ❑ The job task at a fire requires a greater amount of effort than the test event.

2. Candidates with no prior job experience as a firefighter will be asked to perform the test event described above. How much training will be needed to enable a candidate to complete this test event in a successful fashion?

   - ❑ Candidates will be able to complete this test event with no prior experience of any kind.
   - ❑ Candidates will be able to complete this test event if they have a brief orientation to the test event.
   - ❑ Candidates will require extensive training to be able to complete this test event.

3. This test event was designed to simulate the actions required to complete the job tasks described above. To what extent does this test event successfully simulate the job tasks described above?

   - ❑ This test event does not simulate these actions at all.
   - ❑ This test event is a reasonable simulation of the job tasks.
   - ❑ This test event is an accurate simulation of the job tasks.

As noted above, for each event, the SMES were asked to respond to the following three questions:

- Does the test event require a level of physical exertion that is similar to the physical exertion required by essential job duties?
- Can the test event be performed by individuals with little or no prior orientation or training?
- Does the test event require a range of activities that is similar in nature to the activities required by actual job tasks?

According to *The Fire Service Joint Labor Management Wellness/Fitness Initiative: Candidate Physical Ability Test* (1999), the first and third questions are the essential components of the study. These questions assess the ability of test events to reflect the job demands made upon firefighters. The first question assesses the level of physical exertion required by test events as compared to the physical exertion required by actual job demands. The third question assesses the similarity of test events to actual job demands.

The second question asks respondents to evaluate the training needed to enable a job candidate to successfully complete each of the test events. It addresses the external validity of testing materials, according to *The Fire Service Joint Labor Management Wellness/Fitness Initiative: Candidate Physical Ability Test* (1999). Because the CPAT is an entry-level exam, the question was included to avoid creating test components that require prior training for successful completion.

CPAT Event Rating Results

The following is a summary of the results of the Incumbent Surveys as they relate to each test event.

Event 1 – Stair Climb

Physical Effort Needed: A total of 10% of respondents stated candidates would be expending **more** effort during this event than at a fire, 50% of the respondents stated candidates would be expending the **same** amount of effort during this event as they would at a fire, and 40% of the evaluators stated candidates would be expending **less** effort during this event than at a fire.

Training Needed: A total of 100% of respondents stated candidates would need a brief orientation to complete the event.

Job Relatedness: A total of 90% of respondents stated this task is a reasonable simulation of what a firefighter does at a fire, and 10% of respondents stated it is an accurate simulation of what a firefighter does at a fire.

Event 2 – Hose Drag

Physical Effort Needed: A total of 50% of the respondents stated candidates would be expending the **same** amount of effort during this event as they would at a fire, and 50% of the evaluators stated candidates would be expending **less** effort during this event than at a fire.

Training Needed: A total of 100% of respondents stated candidates would need a brief orientation to complete the event.

Job Relatedness: A total 90% of respondents stated this task is a reasonable simulation of what a firefighter does at a fire, and 10% of respondents stated it is an accurate simulation of what a firefighter does at a fire.

Event 3 – Equipment Carry

Physical Effort Needed: A total of 10% of the respondents stated candidates would be expending **more** effort during this event than at a fire, 80% of the respondents stated candidates would be expending the **same** amount of effort during this event as they would at a fire, and 10% of the evaluators stated candidates would be expending **less** effort during this event than at a fire.

Training Needed: A total of 10% of respondents stated candidates would not need prior experience to complete the event, and 90% of respondents stated candidates would need a brief orientation to complete the event.

Job Relatedness: A total of 60% of respondents stated this task is a reasonable simulation of what a firefighter does at a fire, and 40% of respondents stated it is an accurate simulation of what a firefighter does at a fire.

Event 4 – Ladder Raise and Extension

Physical Effort Needed: A total of 50% of the respondents stated candidates would be expending the **same** amount of effort during this event as they would at a fire, and 50% of the evaluators stated candidates would be expending **less** effort during this event than at a fire.

Training Needed: A total of 100% of respondents stated candidates would need a brief orientation to complete the event.

Job Relatedness: A total of 90% of respondents stated this task is a reasonable simulation of what a firefighter does at a fire, and 10% of respondents stated it is an accurate simulation of what a firefighter does at a fire.

Event 5 – Forcible Entry

Physical Effort Needed: A total of 10% of the respondents stated candidates would be expending **more** effort during this event than at a fire, 40% of the respondents stated candidates would be expending the **same** amount of effort during this event as they would at a fire, and 50% of the evaluators stated candidates would be expending **less** effort during this event than at a fire.

Training Needed: A total of 100% of respondents stated candidates would need a brief orientation to complete the event.

Job Relatedness: A total of 100% of respondents stated this task is a reasonable simulation of what a firefighter does at a fire.

Event 6 – Search

Physical Effort Needed: A total of 30% of the respondents stated candidates would be expending the **same** amount of effort during this event as they would at a fire, and 70% of the evaluators stated candidates would be expending **less** effort during this event than at a fire.

Training Needed: A total of 10% of respondents stated candidates would not need prior experience to complete the event, and 90% of respondents stated candidates would need a brief orientation to complete the event.

Job Relatedness: A total of 100% of respondents stated this task is a reasonable simulation of what a firefighter does at a fire.

Event 7 – Rescue

Physical Effort Needed: A total of 20% of the respondents stated candidates would be expending the **same** amount of effort during this event as they would at a fire, and 80% of the evaluators stated candidates would be expending **less** effort during this event than at a fire.

Training Needed: A total of 10% of respondents stated candidates would not need prior experience to complete the event, and 90% of respondents stated candidates would need a brief orientation to complete the event.

Job Relatedness: A total of 100% of respondents stated this task is a reasonable simulation of what a firefighter does at a fire.

Event 8 – Ceiling Breach and Pull

Physical Effort Needed: A total of 50% of the respondents stated candidates would be expending the **same** amount of effort during this event as they would at a fire, and 50% of the evaluators stated candidates would be expending **less** effort during this event than at a fire.

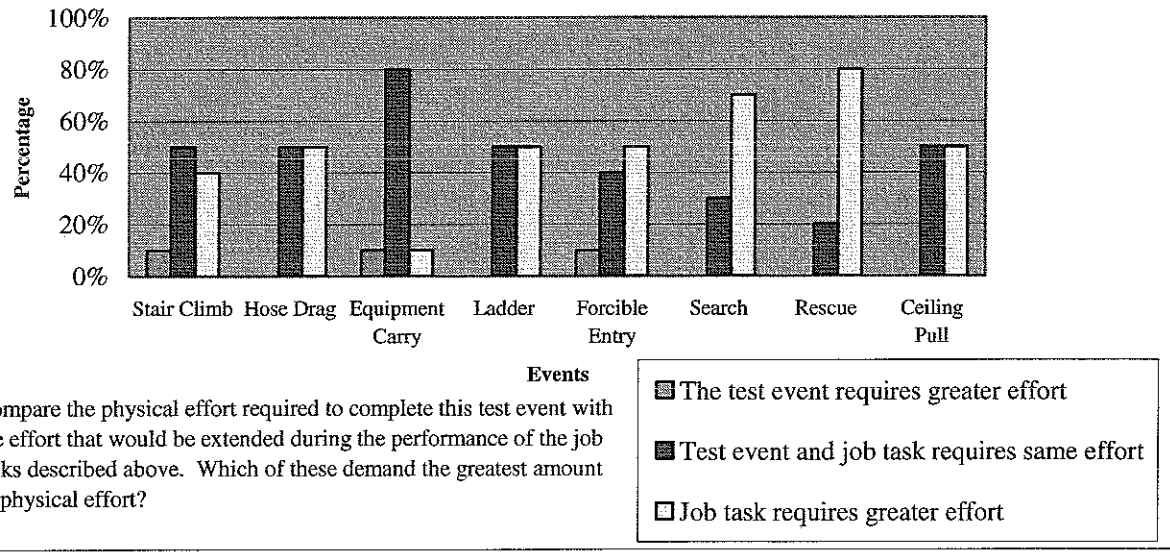
Training Needed: A total of 100% of respondents stated candidates would need a brief orientation to complete the event.

Job Relatedness: A total of 100% of respondents stated this task is a reasonable simulation of what a firefighter does at a fire.

The results of the study strongly support the following three conclusions.

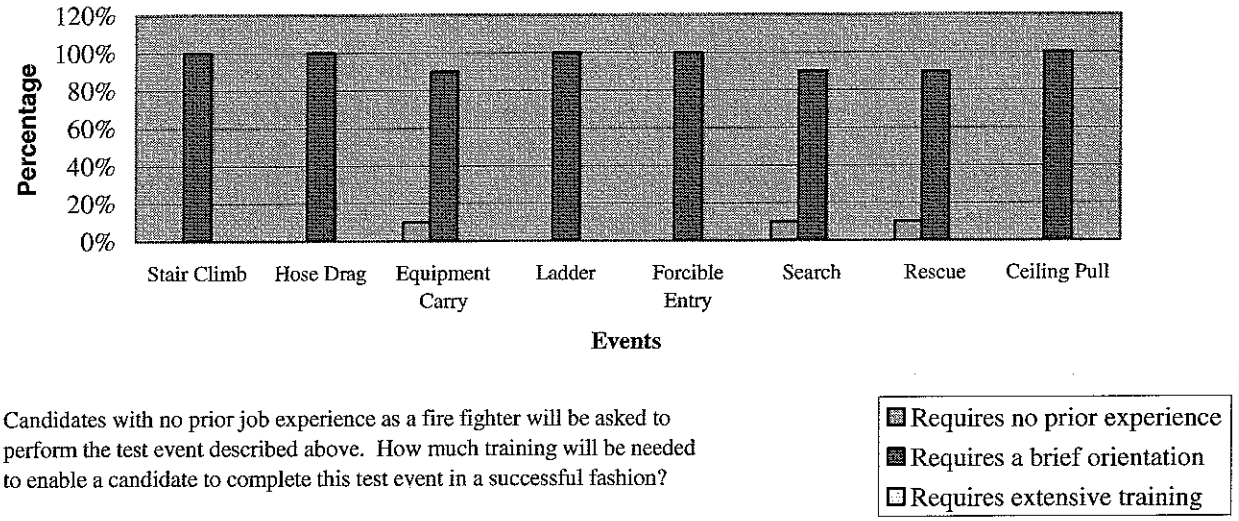
- Test events require a level of physical exertion that is similar to the physical exertion required by essential job duties (See Figure 3).

Figure 3 Question 1 Responses (Physical Effort)



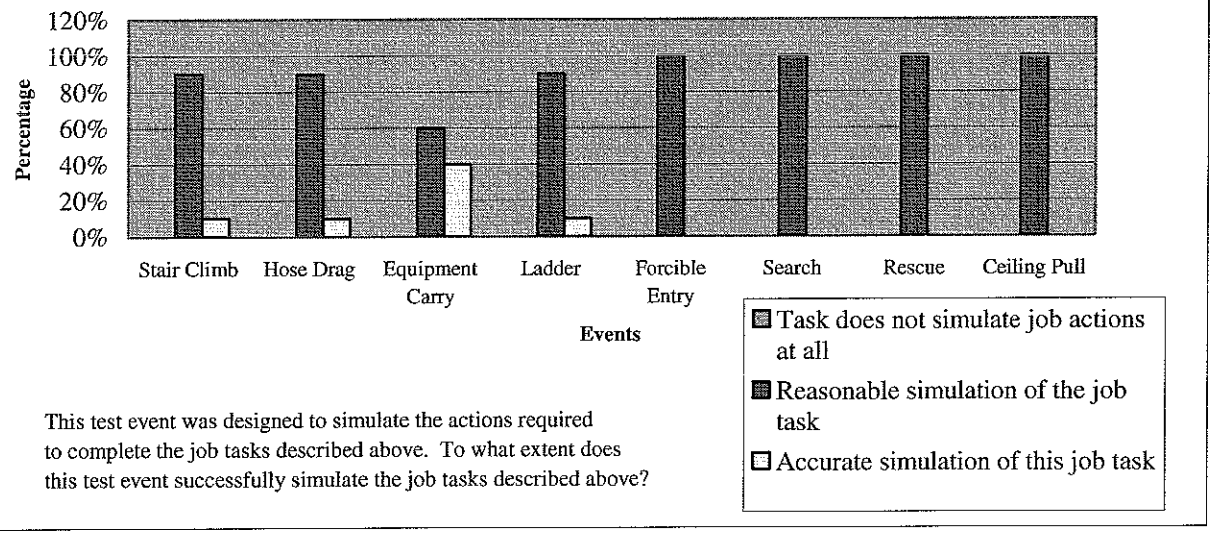
- Test events can be performed by individuals with little prior orientation or training (See Figure 4).

Figure 4 Question 2 Responses (Training Needed)



- Test events require a range of activities that is similar in nature to the activities required by actual job tasks (See Figure 5).

Figure 5 Question 3 Responses (Job Relatedness)



CPAT Equipment Survey

The CPAT events require firefighters to interact with a variety of equipment (e.g., ladders, pike poles, sledgehammers, saws) and to carry weights simulating standard protective equipment and SCBA. To establish the type and weight of the equipment used, the CPAT (1999) researchers asked training officers from the participating agencies to complete an Equipment and Demographic Survey. For the purposes of the TFD job analysis, Captain Ron Lopez, the Public Safety Academy Training Officer, completed the CPAT Equipment and Demographic Survey. Appendix J presents the results of the survey. The results of the survey demonstrate that while there is some variability in the weights of the equipment, the equipment used for the CPAT events (e.g., 24' aluminum extension ladder, 1 ¾" attack hose, sledgehammer, 6-foot pike pole, automatic nozzle, circular saw, chain saw) is also used by firefighters in the TFD.

CPAT Conclusions

The results of the job analysis survey provided evidence that the tasks and KSAs found important in the CPAT study are also important for the TFD. The remaining step for demonstrating the transportability of the CPAT research findings to the TFD was to establish the job relatedness of the CPAT events with critical firefighter tasks as they are performed by the Department. The survey results presented here for assessing the job relatedness of the CPAT events are consistent with the findings reported in the CPAT study. Moreover, TFD SMEs judged the CPAT events to be highly similar to critical firefighter tasks as they are performed on the job.

The job analysis survey results reported earlier provide evidence that the physical requirements for performing firefighter duties in Tucson were similar to those found important or critical in the CPAT validation study. The CPAT event analysis presented here demonstrates that the CPAT test events provide a reasonable simulation of the physical requirements needed to perform the important tasks of the TFD. The combined results of the two surveys provide strong support for using the CPAT to assess the physical ability of TFD entry-level firefighter candidates.

As indicated in the CPAT (1999) report, the technical committee and the SMEs involved in the original research concluded that the CPAT completion times should only be used on a pass/fail basis. The technical committee determined, based on its research, that using cutoff time of 10 minutes, 20 seconds effectively differentiated between acceptable and unacceptable performance of the CPAT and was therefore the most job related and defensible approach.

WEIGHTING OF EXAMINATION COMPONENTS

Written Test Plan Development

The following procedure was used to determine the competencies to be included in the calculation of the examination weights for the written examination (*CPS Job Analysis Guidelines,* 2000). For each of the 1,680 cells (112 KSAOs by 15 job dimensions) in the Job Competency-Job Dimension Linkage Form, the number of linkage ratings that were either 1 or 2 was tallied. In order for a KSAO to be retained, it had to show at least one cell with *at least* 60% of the ratings of either 1 or 2. All but two KSAOs were retained at this stage (KSAO 109 "Ability to drag 150 feet of 3" hose" and KSAO 110 "Ability to drag 200 feet of 3" hose"). Conversely, in order for a job dimension to be retained, it had to be linked to at least one KSAO (i.e., *at least* one cell with 60% of the ratings of either 1 or 2). Because there were 15 job dimensions, the maximum number of cells that could be retained for a given KSAO was 15. All of the job dimensions were retained at this stage. The KSAO-Job Dimension Linkage Form in Appendix G presents, for each cell, the number of ratings that were either 1 or 2; each cell that was retained contains an asterisk. The final column of the linkage form summarizes the Superior Job Performance ratings for each KSAO. In order for a KSAO to be scored on a continuous basis (i.e., be used to rank candidates), *at least* 60% of the SMES had to give a rating of 1 (yes, leads to superior job performance). Each KSAO that met the continuous scoring criterion is indicated by an asterisk in the cell that appears under the *Superior Job Performance* heading. Ninety-one of the KSAOs met the continuous scoring criterion.

To facilitate the test plan development process, two CPS project staff members grouped the KSAOs into ten competency areas (See Table 27 and Appendix K).

Table 27. Competency Areas

1. Reading Comprehension - Understanding Written Materials
2. Math and Arithmetic Reasoning
3. Written Communication/Report Writing
4. Maps, Diagrams, and Mechanical Drawings/Knowledge
5. Memory and Understanding Oral Information
6. Oral Communication
7. Interpersonal
8. Personal Characteristics (conscientiousness, flexibility, motivation, tolerance, etc.)
9. Miscellaneous
10. Physical

The results from the SME panel linkage process, together with judgments by the CPS project staff members were used to identify which KSAOs would be appropriate for testing using a written examination format. KSAOs from the following competencies were judged to be appropriate for the written exam: 1. Reading Comprehension - Understanding Written Materials; 2. Math and Arithmetic Reasoning; 4. Maps, Diagrams, and Mechanical Drawings/Knowledge; 5. Memory and Understanding Oral Information. Although Competency 3. Written Communication/Report Writing would also generally be appropriate for a written examination,

the results of the leads to superior performance ratings discussed above indicated that the examination component measuring these KSAOs should only be scored on a pass-fail basis. Therefore, it was determined that this competency would not be included in the written exam, where scores are intended to be used in a top-down fashion.

The examination weights for the four continuously scored competencies were calculated according to the formulas presented in the *CPS Job Analysis Guidelines* (CPS, 2000). The mean Importance ratings for each task and KSA and the number of competencies that were linked to each job dimension were used to calculate the examination weights. To reduce the impact of number of KSAOs linked to a particular job dimension, average KSAO weights within each dimension were used in the calculation of the suggested weights for the examination components. The Microsoft Excel 2000 electronic spreadsheet was used to perform the calculations.

The final decision regarding the number of examination items for each competency involves two additional considerations: reliability and content coverage. It is important that there are enough items in each subscale to ensure adequate reliability. In our experience, this problem is avoided when subscales consist of at least 10 to 15 items. When the examination weighting methodology results in a large number of items compared to the total number of examination items, the number of items for that competency may need to be reduced to ensure each of the remaining competencies contains an adequate number of items. The examination weights based on the linkage analysis for the four competencies included in the written examination are presented in Table 28.

Table 28. Competency Areas Included in Written Exam Based on Linkage Analysis

Competency	Weight from Linkage Analysis
1. Reading Comprehension - Understanding Written Materials	.25
2. Math and Arithmetic Reasoning	.19
4. Maps, Diagrams, and Mechanical Drawings/Knowledge	.24
5. Memory and Understanding Oral Information	.32

The final phase of the test plan development will involve additional input from TFD SMEs. The weights presented above are intended to serve as initial benchmarks for review by TFD SMEs who will review the weights to ensure adequate content coverage. It is anticipated that the final weights based on input by the SMEs will differ from the above weights to some degree.

Additional Examination Components

PDI Performance Scale

The results of the job analysis for the PDI Performance scale, discussed previously, support the use of the PDI as part of the examination process for entry-level TFD firefighters. During the linkage meeting on April 6th, SMEs were asked to link individual KSAOs to various exam components. Two of those components included a personality inventory (the PDI Performance scale) and a Structured Oral Interview. Because the SMEs linked nearly all of the KSAOs associated with personal characteristics to the personality inventory, CPS consultant Dr. Jeanné

Makiney identified a subset of these personal characteristics as best representing what the PDI is designed to measure (e.g., employees who are reliable, dependable, motivated, conscientious, and trustworthy; see Table 29). The weighting process for the PDI was much the same as the process used for the written examination components; however, the weights indicated reflect the weighting of the individual KSAs not the suggested section weights.

Table 29. KSAOs related to the PDI Performance Scale

KSAOs		Weights
138	Ability to complete work assignments on time	0.0130
139	Ability to work irregular hours	0.0129
163	Desire to contribute a fair share to any group effort	0.0135
164	Willingness to perform undesirable, routine, or monotonous duties	0.0129
166	Thoroughness	0.0131
167	Integrity	0.0140
170	Good organization skills	0.0120
172	Dependability (being on time or being there when needed)	0.0138
173	Motivation for all aspects of the job	0.0129
	Average Weight	**0.0131**

Structured Oral Interview

In addition to the personal characteristics measured by the PDI Performance scale, the results of the linkage analysis indicate that a number of KSAOs would best be measured using a structured oral interview. As part of the linkage process, the SMEs identified those KSAOs appropriate for testing using a structured oral interview (See Table 30). The weighting process for the structured oral interview was much the same as the process used for the written examination components, although the weights indicated reflect the weighting of the individual KSAs not the suggested section weights.

Table 30. KSAOs Related to the Structured Oral Interview

KSAOs		Weights
65	Ability to extract important information during oral communication (listening ability)	0.0131
127	Ability to follow oral directions	0.0136
63	Ability to express thoughts orally in a clear, understandable manner	0.0132
64	Ability to explain complicated information in simple language	0.0122
115	Ability to speak clearly and audibly	0.0128
118	Ability to work with others as a team	0.0139
119	Ability to treat all persons with dignity and respect	0.0123
121	Ability to live harmoniously with others in a community living situation	0.0048
125	Ability to handle sensitive public contacts with tact and courtesy	0.0058
126	Ability to comfort victims of fires, accidents, or illnesses	0.0044
163	Desire to contribute a fair share to any group effort	0.0135
170	Good organization skills	0.0120
173	Motivation for all aspects of the job	0.0129
123	Ability to analyze problems quickly and take appropriate action under stress	0.0113
130	Ability to maintain sense of humor	0.0105
155	Ability to adapt to changing priorities/situations	0.0130
168	Self-confidence	0.0130
174	Common sense	0.0140
142	Ability to learn quickly	0.0123
	Average Weight	**0.0115**

CPAT

As indicated in the CPAT (1999) report, the technical committee and the SMEs involved in the original research concluded that the CPAT completion times should only be used on a pass/fail basis. The technical committee determined, based on its research, that using cutoff time of 10 minutes, 20 seconds effectively differentiated between acceptable and unacceptable performance of the CPAT and was therefore the most job related and defensible approach.

Test Type Weighting

To arrive at the suggested weights for each examination component, the individual average weights for the KSAOs included in the examination components were totaled and the average weights were divided by the total of the average weights. The suggested weights for the exam components are presented in Table 31. As can be seen from the table, the weighting analysis indicates that each of the three examination components appropriate for scoring on a rank-order basis should receive approximately equal weight. There appears to be some support for

weighting the PDI higher than either the written test or the oral interview. The next step in the process will be to present these weights to the SMEs for review and potential modification.

Table 31. Test Weights

Test Types	Average Weight	Suggested Weight
Written Test	0.0098	0.29
PDI	0.0131	0.38
Oral	0.0115	0.33
CPAT		pass/fail
Total Average Weights	0.0344	

CONCLUSION

The purpose of this report is to document the job analysis and test plan development process for TFD entry-level firefighters. To accomplish these goals, CPS consultants reviewed relevant literature, conducted job observations, and worked extensively with subject matter experts from the City of Tucson Fire Department (TFD) to develop a job analysis questionnaire to assess the tasks and knowledge, skills, abilities, and other characteristics (KSAOs) required for successful performance of the job of an entry-level firefighter in the City of Tucson. Sixty percent of TFD firefighters and 90 percent of TFD captains completed the job analysis questionnaire. The results of the questionnaire administration were analyzed based on the *CPS Job Analysis Guidelines* (2000) and a final list of tasks and KSAOs important to the job of an entry-level TFD firefighter was developed.

The job analysis results were used to link tasks and KSAOs, and to create an initial test plan. The examination components identified as appropriate for the TFD included a written examination, the PDI Performance scale, a structured oral interview, and the Candidate Physical Ability Test (CPAT). The written examination will be designed to measure four competency areas: Memory and Understanding Oral Instructions; Understanding Written Materials; Arithmetic Reasoning; and Understanding Maps, Diagrams, and Mechanical Drawings. In addition to the written examination, the job analysis process supported the use of the PDI Performance Scale which measures characteristics associated with reliability, dependability, motivation, and conscientiousness. The use of a structured oral interview to measure personal characteristics not tapped by the PDI was also supported. Finally, the use of the Candidate Physical Ability Test developed by *The Fire Service Joint Labor Management Wellness/Fitness Initiative* (1999) was found to be job relevant for TFD entry-level firefighters.

REFERENCES

American Educational Research Association, American Psychological Association, & National Council on Measurement in Education. (1999). *Standards for educational and psychological testing*. Washington, DC: American Educational Research Association.

Cooperative Personnel Services. (2000, June). *CPS job analysis guidelines*. Sacramento, CA: Author.

Paajanen, G. E., Hansen, T. L., & McLellan, R. A. (1993). PDI Employment Inventory and PDI Customer Service Inventory Manual. Personnel Decisions, Inc.

Society for Industrial and Organizational Psychology, Inc. (1987). *Principles for the validation and use of personnel selection procedures* (3rd ed.). College Park, MD: Author.

Uniform guidelines on employee selection procedures (1978). *Federal Register, 43*, 38290-38315.