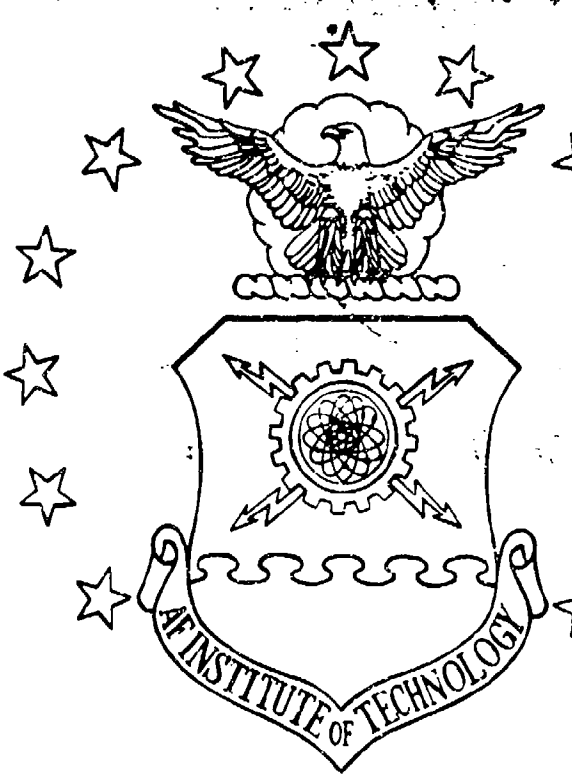


AN ANALYSIS OF THE EFFECTIVENESS OF THE AIR FORCE DRUG TESTING PROGRAM AND FOUR POTENTIAL MODIFICATIONS

THESIS

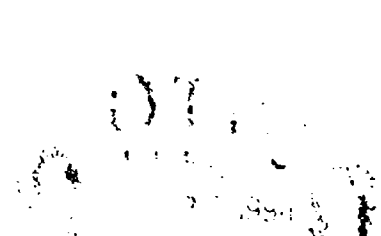
Thomas R. Doster, Captain, USAF
Hubert A. Ross, Captain, USAF

AFIT/GSM/LAR/93S-5

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT/GSM/LAR/93S-5



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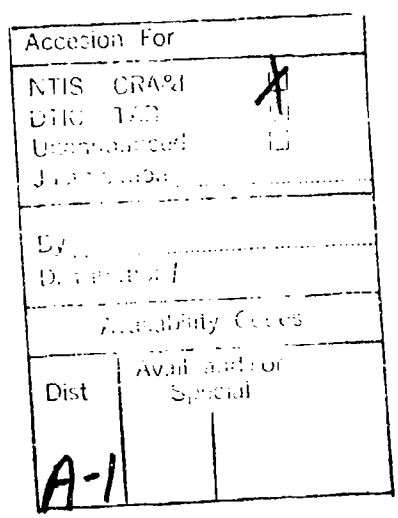

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AN ANALYSIS OF THE EFFECTIVENESS OF THE AIR FORCE DRUG TESTING PROGRAM AND FOUR POTENTIAL MODIFICATIONS

THESIS

Presented to the Faculty of the Graduate School of Logistics and Acquisition Management

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Systems Management

Thomas R. Doster, B.S.

Captain, USAF

Hubert A. Ross, B.S.

Captain, USAF

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Preface

The purpose of our study was to find smarter ways to identify members of the USAF who are drug users. Initially, we were intrigued by survey data that suggested the proportion of drug users in the USAF was much greater than the proportion detected through drug testing. Also, the USAF's first reduction in force (RIF) since the 1970's motivated us to find ways to increase the number of drug users identified and separated from the USAF. In addition, we questioned the deterrent value of the USAF Drug Testing Program because we believed the majority of USAF members would not use drugs even without the random urinalysis program. Finally, we questioned the cost to the credibility of the USAF when on one hand, we expect our personnel to serve with integrity and on the other hand, we require everyone be observed when they provide a specimen for drug testing.

In our research, we examined four potential modifications to the drug testing program that we thought would increase the number of drug users detected. For each modification, we determined the expected number of drug users detected and cost impact. We also identified the legal issues associated with implementing each potential modification. First, we determined the effects of simply increasing the amount of random testing because the USAF is in the process of doubling the number of annual random urinalysis. We also examined two other methods of selecting personnel for drug testing that resulted in more drug users being detected. Finally, we examined the potential use of testing hair for drugs. We found hair testing offers many benefits, but has some disadvantages. When our research was completed, we were struck by two items. First, no one in the USAF seems to have a good estimate of what drug testing really costs each year (the total cost, not just the lab cost). Support for the program appears to be based on

the assumption that the benefits of testing outweigh any costs of testing. Second, it appears to us that the USAF has not explicitly defined the level of deterrence it desires nor the amount of random testing required to achieve the desired level. We believe the total program cost and the amount of random testing required to achieve a specified level of deterrence are required to efficiently manage the USAF Drug Testing Program.

We have been helped immeasurably in this research by numerous people who took time from hectic days of "doing more with less" to answer our questions, provide detailed data, or provide guidance. Our special thanks goes to our thesis advisors, LTC LaRita Decker and LTC (Select) Rodney Rice. They have been especially encouraging, insightful, and an absolute pleasure to work with. We appreciate the efforts of Mr John Mellman and Maj Mary Jane Wygle, who quickly provided us detailed data when we needed it the most. In addition, we must mention the respect and appreciation we have gained for the many people at every level of the drug testing program who are working very hard on a daily basis to make the program successful. Last, and most of all, we thank our families. Our wives, Trudy and Cheryl, have shouldered an extra load during our many months of effort. Our children, Timothy, Joshua, and Nicholas, in their own way, sacrificed during this time. Their love, patience, and encouragement has helped us accomplish this research and so much more.

Thomas R. Doster and Hubert A. Ross

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Abstract

This study evaluated the 1992 USAF Drug Testing Program and potential improvements, based on the number of drug users detected, cost, and legal issues. Four potential improvements were examined: 1) increasing the annual amount of random urinalysis; 2) increasing the proportion of commander-directed testing; 3) using a weighted selection technique; and 4) replacing urinalysis with hair testing. For each improvement, the researchers used test and survey results to estimate the number of drug users detected, a cost formula to estimate any changes in cost, and interviews with legal experts to identify any legal issues associated with implementing the modification. Researchers found the proportion of drug users detected by the testing program was significantly less than the proportion estimated by a 1992 survey of military personnel. In addition, the researchers found the potential modifications should each increase the number of drug users detected. However, the percentage of drug users detected would remain small and implementation of each modification would result in increased costs or legal challenges or decreased deterrence. Researchers found hair testing has the greatest potential for significantly increasing the number of drug users detected. However, widespread use is not recommended because of technical issues and higher costs.

AN ANALYSIS OF THE EFFECTIVENESS OF THE AIR FORCE DRUG TESTING PROGRAM AND FOUR POTENTIAL MODIFICATIONS

I. Introduction

This thesis examines one aspect of the effectiveness of the United States Air Force (USAF) Drug Testing Program for military members. For this research, effectiveness is defined by how well the program deters illegal drug use and how well it detects drug users. Survey and test results clearly show the current testing program has played an important part in deterring drug abuse. In fiscal year 1992, only 2.3 percent of the members surveyed reported any drug abuse in the previous 12 months, and of the 196,476 urine specimens tested in fiscal year 1992, less than 0.5 percent tested positive (2:14; 8:Ch 5, 12). Given the testing program's effectiveness in deterring drug abuse, this research focuses on how well the program detects drug users and examines whether potential modifications would increase program effectiveness. Four potential program modifications are examined: three different methods for selecting who is tested and one new test method. The effectiveness of the current program to detect drug users is assessed by comparing the number of users detected by random urinalysis with an estimate of the true number of drug users in the USAF based on self-reported drug use. The effectiveness of each potential modification is assessed by comparing its expected cost and results (number of users detected) with the costs and results of the fiscal year 1992 USAF Drug Testing Program. Finally, the legal issues associated with the potential modifications are identified and discussed.

General Issue

The end of the Cold War brought significant budget reductions for the Department of Defense (DOD) and USAF. In recent years, reduced funding has forced the USAF to reduce its forces, restructure itself, and examine existing programs either to eliminate them or improve their efficiency. One existing program, the USAF Drug Testing Program, is examined in this research. The program has been effective in its primary objective of deterring drug use, but is still a valid program since drug use remains a problem for the USAF. However, improvements in the program's efficiency can be made.

Few substantial changes, other than testing for new types of abused drugs and lowering the drug screening thresholds, have been made to the program since its inception in the early 1980's (19:71). A new test method could increase the number of drug users detected or decrease the amount of testing required without reducing the program's contribution to deterrence. Using test and survey results in the selection process could also increase the number of drug users detected without increasing cost or decreasing the program's deterrence value. An added benefit of increasing the number of drug users detected would be the corresponding one-for-one decrease in the number of people involuntarily separated from the USAF solely as a result of the large manpower reductions required by smaller budgets. Admittedly, even if testing could detect every drug user and result in separation from the service, the contribution to the required manpower reductions would not be enough to eliminate the need for all the other force reduction programs. However, in real terms, every drug user separated from the USAF means one less "good" person's career has to be cut short by a reduction in force, or a forced early retirement.

The military has long recognized the negative impact that drug use and abuse by service members can have on readiness, mission execution, and national security. There is no question drug use impairs performance, sometimes at great cost to human life or property (12:22). Also, the general public expects the military to maintain a high state of

readiness to deter aggression and defend our national interest. Drug use among military members threatens to erode public confidence in the military's ability to accomplish its mission and thus threatens public support.

To combat the negative effects of drug use by service members, the DOD requires the services to implement drug abuse prevention programs. In response, the USAF developed a program documented in Air Force Regulation (AFR) 30-2. AFR 30-2 states that any illegal drug use is incompatible with military service (19:10). To deter illegal drug use among USAF members and to identify those members who do abuse drugs, the USAF conducts random urinalysis, the unannounced drug testing of random samples of active duty personnel. In addition, commanders may direct an individual to test if there is reasonable suspicion that the individual may be using drugs. Testing is also conducted incident to medical treatment and where legal probable cause of drug use exists (17:2). In fiscal year 1992, the USAF tested a total of 196,476 specimens for drugs (2:14). Of the total number of specimens tested, random urinalysis accounted for 189,699 specimens tested, about 97 percent of the total, and resulted in 195 drug users identified (40; 56).

Problem Statement

According to the 1992 Worldwide Survey of Substance Abuse and Health Behaviors Among Military Personnel, 2.3% of active duty USAF members surveyed reported using illegal drugs in the previous 12 months (8:Ch 5, 12). However, fiscal year 1992 USAF Drug Testing Program random urinalysis results indicate only 0.1 percent of USAF personnel use illegal drugs (56; 2:4). Therefore, based on the fiscal year 1992 end-strength of 466,060 active duty personnel, the survey indicates over 10,000 people abused drugs in the past year, while the random urinalysis results suggest there were only 466 drug users (39:29). This large difference between self-reported drug use and the results of

random urinalysis is consistent with the results of surveys and random urinalysis in previous years, and suggests inefficiencies exist in the testing program (8:Ch 5, 7; 2:14). This research examines the impact proposed modifications in the selection process have on the current USAF Drug Testing Program's effectiveness. The current selection process relies heavily on random sampling to determine who tests for drugs; however, this research evaluates modified selection techniques based on the drug identification results from the previous fiscal year and data from surveys of drug abuse. In addition, the research evaluates the impact of adopting hair testing, in place of urinalysis.

Scope and Limitations

Historically, the USAF has assessed the effectiveness of its Drug Testing Program strictly by how well the program deters illegal drug use as measured by the percentage of urine specimens that do not test positive each year. This research does not attempt to measure changes in deterrence caused by modifications to the program. Instead, the authors assume modifications to the program that increase the number of users detected will either have minimal effect or improve the aggregate deterrent value of the program. Effectiveness of the current USAF Drug Testing Program is measured by comparing the USAF population proportion of users detected by random urinalysis to the USAF population proportion of self-reported users. The research focuses on the random urinalysis portion of the USAF Drug Testing Program because random urinalysis represents about 97 percent of the total drug testing performed annually and random urinalysis results provide an unbiased estimate of the population proportion of drug users. Following the comparison of the estimates of the population proportion of drug users, the modifications are assessed based on the following considerations: anticipated increases in the number of users detected and cost.

In addition to affecting the detection of drug users and costs, the program modifications would affect the legality of the drug testing program. Although the constitutionality of drug testing by the military is established, changes to the drug testing program could affect the USAF's ability to discipline and legally separate drug users. Consequently, the preferred outcome of the potential modifications is no negative impact on the USAF's ability to remove drug users. This research identifies and discusses the legal issues associated with each potential modification and presents any anticipated impacts. Finally, although the USAF tests its civilian employees for drug abuse, this research focuses on the drug testing program for the active duty military only.

Research Questions

The objectives of this research are to assess the effectiveness of the current USAF Drug Testing Program in detecting drug users and the potential for program modifications to increase the number of drug users detected without significantly increasing the cost of the program or impacting the USAF's ability to legally remove drug users from the service. The research addresses the potential change in the number of drug users detected, the cost, and legal issues associated with four potential modifications to the USAF Drug Testing Program. The potential modifications are defined by the following research questions:

1. **What effect would increasing the percentage of the USAF population randomly tested for drug use have on the number of users detected?** In mid-1992, the USAF was directed to increase the percentage of the population it randomly tests annually from 30 to 60 percent and may be directed to increase testing even more in the future. This question examines what the expected impact of an increase would be if other factors, such as drug screening thresholds, are held constant.

2. **What effect would increasing the proportion of commander-directed tests have on the number of users detected?** As previously mentioned, commander-directed tests are conducted when there is a reasonable suspicion of drug abuse based on cases of aberrant, bizarre, or unlawful behavior. Such behavior may include, but is not limited to, unauthorized absences, safety violations, disobedience of direct orders, apprehension or investigation for drug offenses or intoxicated driving, involvement in crimes of violence, or other incidents involving repeated or serious breaches of discipline (19:27).

3. **What effect would weighted random selection, based on data from the prior fiscal year and surveys on the prevalence of drug use in the officer and enlisted ranks, have on the number of users detected?** Weighted random selection is a term coined by the researchers. Statisticians would refer to weighted random selection as stratified random sampling. In weighted random selection, the number of personnel randomly selected for testing is proportional to the historical drug use within the group, in this case, within the rank strata.

4. **What effect would changing the test method from urinalysis to hair testing have on the number of users detected?** Urinalysis and hair testing would employ similar assay techniques to detect drugs in a specimen. The primary difference between the two test methods is the specimen needed for the test.

Summary

The USAF Drug Testing Program is an effective deterrent. However, survey and random urinalysis results suggest that if the program were improved, more drug users could be detected. This thesis investigates potentially cost effective improvements to the program that would increase the detection of drug users. A literature review in the second chapter traces the historical development of the program and reviews the current status of USAF drug testing and hair testing. This information provides a basis for suggesting potential improvements to the current program. The third chapter defines the methodology used to assess the effectiveness of the current program and each potential modification considered. The fourth chapter presents data analysis and results, including the estimated increase in detection of drug users, the associated cost of implementing

each potential modification, and a discussion of the legal issues. The fifth and final chapter presents conclusions and recommendations for additional research.

II. Literature Review

This literature review summarizes the history, policies, method, and results of the USAF Drug Testing Program for active duty military personnel. This review also describes DOD policies on drug abuse, a term the DOD defines as any nonmedical use of drugs. In addition, it reviews some of the controversy surrounding drug testing, and a new approach to drug testing. Source information is limited to data clearly related to the USAF Drug Testing Program history, policy, methodology, cost, and status. This review provides the background for evaluating the effectiveness of the current program and potential modifications.

History of Drug Use and Testing in the Military

The military has had problems with drug abuse for many years. Researchers at Arthur D. Little, Incorporated, found that morphine dependency, as a result of medical treatment, was a problem as early as the Civil War (6:Ch 1, Sec 2, 1). By the end of the nineteenth century, heroin and cocaine, which had both been used to relieve the addiction to morphine, proved to be addictive themselves. After the turn of the century, a growing number of addictive drugs and drug abusers raised public concern which resulted in several movements and laws, including the 18th Amendment to the Constitution, which attempted to control substance abuse. In the 1920's and 30's, marijuana was commonly used as a substitute for alcohol during prohibition (1:4-7). In the 1940's, the country was so consumed by the war effort, that drug abuse was of minor consequence (29:8-11). However, in the 1950's, recently discovered D-lysergic acid diethylamide (LSD), methaqualone (quaalude), and phencyclidine (PCP) joined heroin, amphetamines, and marijuana as drugs abused by increasing numbers of American youth (1:8). Drug abuse

became a major problem for the country and the military in the early 1960's when drug abuse skyrocketed in most major cities. Because the majority of people entering the Armed Forces came from these same communities, the nation's drug problem directly affected the USAF (9:2).

In the 1960's, Arthur D. Little researchers noted a change from drug dependency caused by medical treatment to dependency caused by experimentation (6:Ch 1, Sec 2, 2). This occurred when many young servicemen, who were inclined to experiment with drugs, found themselves in Southeast Asia where drugs were plentiful and cheap. The most commonly used drugs were heroin and marijuana. Initially, the DOD policy was to punish and discharge identified drug users. However, as the drug problem continued to grow through the 1960's, the DOD responded with programs providing education, enforcement of drug use prohibition, and amnesty for those personnel requesting rehabilitation. In 1971, President Nixon expanded these programs to include a worldwide program focusing on identification and treatment (6:Ch 1, Sec 2, 1-14). That summer all the services began a world-wide program of random drug testing using urinalysis (6:Ch 1, Sec 2, 24).

Even though urinalysis did not detect the use of marijuana, the DOD considered the program successful because urinalysis provided a reliable indicator of the drug abuse problem, permitted early identification of drug use, and facilitated removal of drug users from their units (18:25). The DOD attributed part of the success to the fact that detection of drug use via urinalysis did not result in punitive actions, only detoxification and rehabilitation (18:32). However, other research indicated the urinalysis program was not as successful as the DOD believed. In 1973, Army researchers from the National Resources Research Organization, compared drug usage rates as detected by urinalysis and as revealed by anonymous survey. They found the rate of drug usage reported in surveys was about ten times the rate indicated by urinalysis and that those inclined to try drugs were not deterred by random urinalysis. The researchers recommended numerous

administrative and procedural changes to the drug testing program and concluded that a commander-directed test program might be more successful in identifying drug users than random urinalysis (48:6-7). However, the timing of the report severely limited the impact of the researchers' conclusions. The urinalysis program was abruptly halted in July 1974 as a result of a Military Court of Appeals decision that a service member could not be ordered to provide a urine sample if it could result in punitive actions. In this case, the punitive action would have been a punitive discharge for failing a urinalysis test following the completion of rehabilitation (15:3). Nonetheless, the DOD continued to use urinalysis solely to identify drug users for rehabilitation until 1980 (24:4).

In 1980, the Court of Military Appeals fundamentally changed the DOD urinalysis program when it reversed several prior decisions and allowed the results of involuntary urinalysis tests to be used for punitive actions against the drug user. In addition, the technology of urinalysis advanced to include accurate and reliable detection of marijuana, and to provide the necessary evidence for prosecuting drug users (44:18). A new DOD drug policy was also approved in 1980. DOD Directive 1010.4, Alcohol and Drug Abuse by DOD Personnel, 25 August 1980, focused on prevention by identification and punitive action, instead of rehabilitation. This shift in policy from rehabilitation to punishment occurred when researchers discovered most drug users were young service members who were not addicts, but merely lacked the discipline to abstain from drug use (7:479). The need for the stronger drug policy was further supported by a jet crash in May 1981 on the aircraft carrier USS Nimitz. Autopsies of 13 personnel killed in the crash revealed that 6 had recently used marijuana and the pilot had especially high levels of antihistamine not prescribed by a doctor (12:22-23). Survey results and the Nimitz accident appear to have galvanized the policy of punitive action for drug abuse set forth in DOD Directive 1010.4, the foundation for present drug abuse policy.

Current Drug Abuse and Testing Policy

The current USAF policy on drug abuse and testing is derived from DOD Directive 1010.4, Alcohol and Drug Abuse by DOD Personnel, which states:

> It is the goal of the Department of Defense to be free of the effects of alcohol and drug abuse; of the possession of and trafficking in illicit drugs by military and civilian members of the Department of Defense; and of the possession, use, sale, or promotion of drug abuse paraphernalia. Alcohol and drug abuse is incompatible with the maintenance of high standards of performance, military discipline, and readiness. (16:2)

The directive also identifies nine specific policies. Of those nine, four are especially relevant to the USAF: 1) not inducting alcohol or drug dependent persons into the military services; 2) deterring and detecting alcohol and drug abuse within the Armed Forces; 3) treating or counseling alcohol and drug abusers and rehabilitating the maximum feasible number of them; and 4) disciplining or discharging drug traffickers and alcohol and drug abusers who cannot, or will not be rehabilitated (16:2).

DOD Directive 1010.1, Drug Abuse Testing Program, provides policy guidance for urinalysis testing. According to DOD Directive 1010.1, the urinalysis testing program will:

> 1. Preserve the health of the members of the Military Services by identifying drug abusers in order to provide appropriate counseling, rehabilitation, or other medical treatment.
> 2. Permit commanders to assess the security, military fitness, and good order and discipline of their commands; and to take appropriate action based upon such an assessment. (17:2)

In addition, DOD 1010.1 defines four major uses of the urinalysis program: inspection, search and seizure, command-directed, and medical examination. These general uses are more commonly thought of as the types of urinalysis tests. "Inspection testing" includes random tests and unit sweeps. "Search and seizure," better known as testing based on

probable cause, is used by commanders when there is probable cause to believe that a military member has abused drugs or committed a drug related offense. "Command or commander-directed testing" is used when there is reasonable suspicion of drug abuse based on perceived changes of behavior or duty performance, to screen members enrolled in rehabilitation and those who have completed rehabilitation, or as a result of a mishap or safety investigation. "Medical examination testing" is any testing for a valid medical purpose and is often associated with routine medical examinations (17:2).

USAF policy on drug abuse and testing is covered primarily in two USAF Regulations (AFR), 30-2, Social Actions Programs, and 160-23, Drug Abuse Testing Program. Like DOD 1010.4, AFR 30-2 provides broad program policies and objectives. Specifically, it states:

> The illegal or improper use of drugs by Air Force members is a serious breach of discipline; is not compatible with service in the Air Force; and automatically places the members continued service in jeopardy. Such conduct will not be tolerated and can lead to criminal prosecution and discharge under other than honorable conditions. The Air Force will provide treatment when indicated, try to restore to duty drug abusers identified for retention and assist those being discharged in their transition to civilian life. (19:10)

While policy theoretically allows some discretion concerning the disposition of members found to have abused drugs, in today's environment, most users will be discharged and possibly face criminal charges. Additionally, USAF policy prohibits the enlistment or appointment of individuals if they have ever used, been arrested for, or been convicted of illegal use or involvement with drugs (19:14). In addition to establishing deterrence as the primary goal of the USAF Drug Testing Program, AFR 160-23 defines urinalysis as the method for achieving this goal (20:1).

Drug Testing Methods

The USAF has consistently used urinalysis for drug testing. However, new methods are being used in some civilian organizations that may one day be adopted by the USAF. The following discussion outlines the USAF method, then summarizes an alternate testing method using hair as the test specimen.

USAF Method. To satisfy DOD requirements, the USAF established the drug testing program documented in AFR 160-23. The program has two key elements: chain of custody and random urinalysis. "Chain of custody" is a procedure for collecting, handling, transporting and storing test specimens in a manner to provide legally admissible evidence of drug use. According to AFR 160-23, the chain of custody begins for the selected member with certification of his or her identity via a photo identification card and the preparation of an identification label for the specimen bottle. The completed label includes the date, the service member's identification number and initials and the observer's initials. Once this documentation is complete, the service member must fill a specimen bottle in full view of the observer. This aspect of the chain of custody is considered one of the most controversial. Once the bottle is filled, it is sealed by the observer with tamper-resistant tape and secured until it can be shipped in a specially sealed box to the USAF Drug Testing Laboratory at Brooks Air Force Base in Texas. Here the chain of custody continues with the inspection of the box and bottles to ensure neither has been opened nor tampered with, while in transit. The specimens are not tested if there is the slightest evidence of tampering. Once the specimens have passed this inspection, they are secured in a controlled access area until testing is complete. The chain of custody ends with a report to the base of origin director for base medical services who reviews positive results to determine cause. After this review, the unit commander determines the action to be taken for the individuals who tested positive for illegal drug use (20:5-9).

The other key element of the drug testing program is random urinalysis. Random urinalysis is the process of testing the urine of randomly selected personnel for drugs. All service members are eligible to be selected without regard to rank or any other factor and without advanced notice. The urinalysis test method currently consists of two different types of tests defined in AFR 30-2. The first type is radioimmunoassay, a highly automated screening test that detects 95 percent of the specimens containing drugs. Radioimmunoassay is a low cost assay test that uses radioactive antigen and antibody reagents to screen for drug metabolites, the remnants of drugs in the urine. If drug metabolites are present, the antibody reagents will bond with them instead of the radioactive antigens. The free radioactive antigens will emit an analytical signal that is proportional to the drug concentration. If the indicated concentration of drug metabolites is greater than established limits, a second screening test is performed. If the second screening test finds the concentration of drug metabolites above the established limits, a second type of test is used to provide a much more accurate measurement of drug content and legally admissible evidence of drug use. This confirmatory test is Gas Chromatography-Mass Spectrometry (GC/MS), which fragments drug molecules into ions and, via mass spectrometry, determines the presence and amount of any drugs in the urine (19:25-26). Both types of tests are performed by the USAF Drug Testing Laboratory which constantly monitors the accuracy of the tests to maintain its DOD certification.

One disadvantage of the urinalysis method is that radioimmunoassay requires radioactive chemicals and produces radioactive waste (25:264; 37:150). Also, urinalysis is only able to detect drugs only as long as the level of drug metabolites in the urine is above preset thresholds or cutoff levels. The time from drug use until the level of drug metabolites drops below the cutoff levels, called the "window of detection," depends on the drug used. For the occasional or light user, the average window of detection ranges from 12 to 24 hours for LSD to five to ten days for marijuana (50). These short windows

of detection allow some personnel to defeat the test by abstaining from drugs when they expect to be tested (32:174-177). Personnel may also defeat urinalysis by consuming large amounts of liquids to dilute the drug metabolites in the urine (25:272). Another limitation of both radioimmunoassay of urine and GC/MS is that neither can determine the timing or level of impairment caused by the use of drugs (51:79). Because urinalysis is unable to determine the time and severity of drug use and the level of impairment, civilian researchers have developed alternative test methods including the one described next.

Hair Test Method. Many civilian drug testing labs use radioimmunoassay of urine and GC/MS to test for drugs (10:129). However, a relatively new, but controversial, method of testing for drugs uses hair. The most common hair testing methodology is radioimmunoassay of hair (RIAH) which tests a sample of hair using the same assay technique and radioactive chemicals as urinalysis (41:134-138; 26:112). Another hair testing methodology uses an enzyme immunoassay (EIA) technique, which is also commonly used for testing urine for drugs in commercial laboratories (25:263; 42:1). The EIA technique uses antigens and antibodies like radioimmunoassay the difference is that enzymes compete with any drug present to combine with the antibodies and that the level of free enzymes indicates the level of drug present (51:68-69). A similar test method, called fluorescence polarization immunoassay (FPIA), uses fluorescent chemical groups to compete with drugs in a specimen (32:172). This assay test method has also been used to detect drugs in hair (34:329-331).

Hair provides a record of drug abuse because the blood feeding the hair root can carry drug metabolites that become embedded in the new hair material produced by the root. The drug metabolites remain fixed in the same hair material as new material is added by the root and the hair grows longer (54:241). Since the hair on the head grows approximately one half inch per month, a one and a half inch hair can provide approximately a three month record of any drug use. Body hair, which grows much

slower, can provided a much longer record (25:266). By cutting the hair shaft into sections and analyzing each section, laboratories can determine the time history of drug use (38:281). Additional research may enable toxicologists to associate the concentration of the drug in the hair to the severity or level of drug use (41:137). In summary, hair testing eliminates the invasion of privacy problems of collecting urine and direct observation while providing more detailed information about the level of drug use over a much greater period of time, thus resulting in a greater detection rate than urinalysis.

Some of the early controversy with hair testing stemmed from insufficient scientific research validating the RIAH techniques (29:93). In recent years hair testing research has increased significantly; however, several issues still exist. One issue is the possibility of passive drug contamination of the hair of people frequently exposed to small amounts of drugs, e.g., bank tellers who might frequently handle money contaminated with drugs. Another issue is the impact of other external contaminants such as dyes, bleach, and other hair care products. Today, various methods are used to wash hair specimens prior to testing to eliminate, or significantly reduce, the effects of external contaminants. In addition, both issues are resolved when testing body hair not normally exposed to external contaminants (50). Two other issues that may be minimized as research progresses are (1) individual hair characteristics, such as texture, rate of growth and color, may affect the hair test analysis and (2) hair testing is less effective in detecting very infrequent users (41:138-142). A final issue is the high cost of hair testing. Several steps in the hair testing process, such as weighing each hair sample and selecting an appropriate bottle for the hair sample, are labor intensive (50). Because hair testing is labor intensive, one commercial laboratory performing hair testing charges approximately $50 to test one specimen for five commonly abused drugs (43:242). Another laboratory charges approximately $100 to test a hair specimen for four drugs (50). However, as more organizations adopt hair testing or the hair test technique is automated, the unit cost of testing should decrease.

Current Results of the USAF Drug Testing Program

In fiscal year 1992, a total of 196,476 specimens were tested. Of the total, random urinalysis accounted for 189,699 specimens, which represents a level of random testing equal to 40.7 percent of the USAF population. Of the 196,476 total specimens tested, 696, or about 0.35 percent, tested positive for illegal drugs (2:14). This figure reflects a shrinking percentage of specimens that contain illegal drugs, a number that has dropped since 1985, when 4.9 percent of the specimens contained evidence of illegal drugs (3:14). Not all specimens that test positive equate to a drug user. In fiscal year 1992, only 562 drug abusers were identified. The difference between the numbers of positive specimens and drug users is explained by multiple reasons. In some cases, drug users are tested a second time before the result of their first test is released. In other cases, the medical review officer finds that the positive specimen is the result of a medicine, such as codeine, prescribed by a doctor. In addition, a known drug user may test positive while in a rehabilitation program.

Of the 562 drug abusers identified in fiscal year 1992, only 288 were initially identified by the USAF Drug Testing Program (2:4). The remaining 274 drug abusers were initially identified by other means including, self-identification, investigations or arrests, and traffic-related incidents. Of the 288 drug users initially identified by the USAF testing program, 195 were identified through random testing and 39 were identified through commander-directed testing. The 54 other drug users were initially identified by testing conducted for probable cause or testing incident to medical treatment (56). In terms of military rank, 85 percent of identified drug users were in the ranks of E-1 through E-5, a number consistent with the results of the 1992 Worldwide Survey which found the majority of military users are junior enlisted members (2:4; 8:Ch 5, 14). E-6 personnel accounted for nine percent of the identified drug users. Of the remaining six percent of

identified drug users, senior enlisted members and officers each accounted for about 3 percent (2:4).

Summary

Drug abuse and drug testing have been part of the USAF since the early 1970's when the focus was on testing, treating, and rehabilitating. Today's policies, while they mention rehabilitation, focus on zero tolerance and deterring drug use with unannounced random urinalysis and punitive actions. The USAF uses unannounced random urinalysis as the main deterrent to potential drug users. The USAF Drug Testing Program features two key parts: a strict chain of custody which includes direct observation, and two different urinalysis tests to ensure accuracy. New test technologies, that are currently more expensive than urinalysis, use hair specimens to provide a much larger window of detection. The larger window of detection greatly increases the probability of detecting a drug user. The most recent results of USAF drug testing indicate drug use is concentrated in the junior enlisted ranks.

III. Methodology

This chapter begins with a overview of the research design which includes a description of the research population. Following the overview, a discussion of data sources and collection methods builds the foundation for the specific methodologies used to estimate the proportion of drug users in the USAF. Next, the test of hypothesis technique used to statistically compare the two estimates of the USAF population proportion of drug users is developed. Finally, the methods used to assess the cost impact, legal issues, and expected change in drug users detected for each of the four potential modifications defined in the four research questions are discussed. All the anticipated changes caused by the potential modifications are compared to the standard USAF Drug Testing Program, which is defined as the program in place at the end of fiscal year 1992. The research design overview follows.

Research Design

The research design was selected to answer the four research questions that define potential modifications to the current USAF Drug Testing Program. The researchers used historical data to assess the impact of the modifications to cost and number of drug users detected. Also, the researchers identified legal issues associated with the potential modifications by gathering opinions from legal experts using structured interviews with open-ended questions. However, before the four research questions were evaluated, a hypothesis that the potential for improvement exists in the current USAF Drug Testing Program was tested by statistically comparing two estimates of the population proportion of drug users. By demonstrating that a survey-based estimate of the population proportion

of drug users is significantly larger than an estimate based on the random urinalysis results, the researchers support the need to address modifications to the current program.

Since the researchers did not have control over the variables of interest, the research is ex post facto. The focus of the research is the USAF Drug Testing Program in effect in fiscal year 1992 and the self reported drug use in the USAF as reported in the 1992 Worldwide Survey of Substance Abuse and Health Behaviors Among Military Personnel. Because there have been changes in the program and the drug user population over time, the researchers focused on the most recent fiscal year when assessing the impact of the potential modifications. Therefore, the USAF Drug Testing Program in effect at the end of fiscal year 1992 is the basis or standard for comparison for all the potential improvements evaluated in this research.

The population of interest for this research is active-duty USAF personnel. USAF reserves, national guard, service academy, reserve officer training corps, USAF civilian personnel are excluded from the population of interest. Descriptions of the populations of interest for the 1992 Worldwide Survey and the USAF Drug Testing Program are included with the data sources discussed next.

Data Sources and Collection Methods

Overview. The principle source of data for USAF member-reported drug use is the 1992 Worldwide Survey of Substance Abuse and Health Behaviors Among Military Personnel. This survey serves as a baseline for demographic data about drug users in the USAF and as a basis of comparison to drug testing results. A second source of data is provided by the USAF Military Personnel Center which compiles and reports results of the USAF Drug Testing Program in the annual USAF Social Actions Programs Statistical Summary. The summary provides data on the number and demographics of drug users

identified by testing. Cost elements necessary for analysis of the USAF Drug Testing Program and modifications were identified by the Wright-Patterson Air Force Base (WPAFB) Social Actions Office. Estimates of the cost of hair testing are based on estimates found in the literature. Legal issues associated with the modifications to the program were identified through interviews with USAF lawyers responsible for developing policies, administering the legal aspects of the drug testing program, and litigating cases involving drug testing. While each data source is described in the following subsections, the first source is described in detail due to the significance of its findings in justifying this research.

1992 Worldwide Survey of Substance Abuse and Health Behaviors Among Military Personnel. This report documents the results of a DOD funded survey conducted by Research Triangle Institute (RTI). The 1992 survey is the fourth survey on this topic conducted by an RTI team of researchers led by Robert M. Bray, Ph.D. In April and May of 1992, the RTI researchers surveyed approximately 25,000 personnel in the four military services at 63 geographic locations worldwide to investigate military health attitudes and practices, including the illegal use of drugs (8:Ch 2, 1). Of the 25,000 DOD personnel selected to participate in the survey, 5,880 were USAF personnel. Of the USAF personnel surveyed, 85.0 percent or 4,998, correctly completed the survey (8:Ch 2, 7). The eligible population for the survey was all active-duty military personnel. Personnel excluded from the survey were those unavailable for the survey, such as, members absent without leave (AWOL) or in the process of moving. In addition, service academy and reserve officer training corps cadets were excluded from the eligible population for the survey. The survey also excluded all personnel with less than 12 months of active duty service because they had not been in the service long enough to typify the service (8:Ch 2, 2).

Survey Methodology. As in three previous surveys, Bray conducted the 1992 survey in two phases using a two stage, deeply stratified sampling design. In the first

phase, Bray surveyed personnel selected from a two stage sampling frame. The first stage sampling frame, which contained sampling units made of geographically proximal organizations, was stratified according to service and geographic location. The second stage sampling frame, which contained personnel assigned to the units in the first stage sampling frame, was stratified according to pay grade. The six strata were E1-E4, E5-E6, E7-E9, W1-W4, O1-O3 and O4-O10 (8:Ch 2, 3). The "W1-W4" strata represents warrant officers; ranks not currently used by the USAF. To meet precision requirements within budget constraints, Bray selected 63 primary sampling units from the first stage sampling frame using probability proportional to size and minimum replacement (8:Ch 2, 3). This selection technique, as described by Chromy, allows researchers to select with exact probability proportional to size, a sample from stratified sampling units of unequal size (11:329-347). This technique is applicable because of the large differences in size between the sampling units making up the first stage sampling frame (8:App A, 6). From the primary sampling units and within the second stage strata, Bray selected the survey participants with equal probability and without replacement (8:Ch 2, 3). This selection technique produces a self-weighting sample within both the second and first stage strata which, according to Raj, simplifies the calculations of the population estimates (8:App A, 12; 47:65-67).

In the second phase, Bray attempted to survey all non respondents from the first phase. Bray mailed each non respondent a survey and answer sheet with a letter explaining the purpose and importance of the survey and requesting the non respondents complete the survey anonymously and mail it back to RTI (8:Ch 2, 5-6). Bray used the data from the second phase to adjust the first phase estimates for non response bias (8:Ch 2, 3-6). This design allowed Bray to estimate the population proportions with a coefficient of variation of 0.05 or less for most estimates (8:App A, 1). Coefficient of variation is the standard error of an estimate expressed as a percentage of the true value of

the estimated parameter (14:54). The equations used to estimate population proportions and determine standard errors were derived from those provided by Cochran for stratified subsampling with units of unequal size (14:317-320). Bray provides estimates of the proportion of drug users according to drug type used, frequency of use, service, rank, and several other demographic factors (8:App D, 14-19). Only data specific to the USAF is used for this research. In addition, the 1992 Worldwide Survey questions applicable to this topic are provided in Appendix A.

Survey Validity and Reliability. RTI researchers attempted to ensure the validity and reliability of the data reported in the 1992 Worldwide Survey. Other researchers studying drug abuse using surveys have found that to receive valid self-reporting of drug abuse in a survey, survey administrators must gain the trust of the respondents to convince them of the legitimacy of the survey, the privacy of the survey site and the confidentiality of their responses (30:50-51; 54:232). Therefore, RTI used teams of civilian researchers to administer the survey questionnaires in sessions held at the selected installations worldwide. The RTI researchers rigorously followed procedures to ensure participants answered the survey honestly. In addition, the researchers assured the participants of their privacy and anonymity and convinced them their survey questionnaire would not be revealed to military officials (8:Ch 2, 10).

To improve the reliability of a survey, a pre-test and/or pilot study is one of the researchers' best opportunities to determine weaknesses in the survey instrument, such as confusing questions or instructions (22:185-189, 376-382). To enhance the reliability of the survey, Bray conducted a pilot study of the survey at one installation of each service in the fall of 1991 (8:Ch 2, 9). However, even with the best efforts of the researchers, there is a tendency for non-addicted drug users to minimize or under report their drug use. This tends to occur when non-addicted drug users believe their behavior is socially undesirable and when they have successfully concealed their drug use (28:17-19). Since these

conditions apply to many of the drug users in the USAF, the 1992 Worldwide Survey may underestimate the true prevalence of drug use in the USAF. However, the extent of any underestimation would only lend more support for the findings of this research. The estimate of the prevalence of drug use provided by the 1992 Worldwide Survey was compared to the estimate based on the results of the USAF Drug Testing Program reported in the annual social actions statistical summary.

USAF Social Actions Statistical Summary - Fiscal Year 1992. The Air Force Military Personnel Center (AFMPC) reported the results of the USAF Drug Testing Program for fiscal year 1992 in the 1992 Statistical Summary. The population of interest for the summary and the USAF Drug Testing Program is all active duty USAF personnel because all are eligible to be tested. The only exceptions are personnel temporarily unavailable for testing, such as members working away from their normal duty station, absent without leave (AWOL), or in the process of moving (19:15). The 1992 USAF Social Actions Statistical Summary is provided in Appendix B.

The summary contains information for the entire year about the total number of specimens tested, type of drugs detected, number of drug users identified, and demographic data about the identified drug users (2:4-14). AFMPC consolidates drug testing results reported by each base in the USAF Personnel Data System. The base level drug testing results are based on the reports provided by the USAF Drug Testing Laboratory, the base medical services director's review of the Drug Testing Laboratory reports, and the personnel records of the identified drug users. When the aggregate data provided in the summary lacked the detailed information necessary for this research, the researchers obtained the detailed information by telephone interviews with AFMPC and USAF Drug Testing Laboratory personnel. The USAF Drug Testing Laboratory data describing the drug tests performed in fiscal year 1992 is provided in Appendix C. The

data source for evaluating the costs associated with the USAF Drug Testing Program is discussed next.

Wright-Patterson Air Force Base Social Actions Drug Testing Cost Formula. With the exception of laboratory testing cost, the literature review and this research revealed very little cost data for drug testing in the USAF. Therefore, the researchers used a cost formula and a rough order of magnitude (ROM) unit cost estimate developed by the Wright-Patterson Air Force Base (WPAFB) Social Actions office, Drug and Alcohol Abuse branch, to assess the cost implications of each modification. The formula divides the total program costs into multiple cost elements, grouped into three broad categories: laboratory test costs, supplies and administrative costs, and personnel costs. Laboratory test costs include labor and supply costs, but do not include facilities, utilities and equipment costs. Supplies and administrative costs encompass costs of supplies necessary for collection and transportation of specimens, such as specimen jars, shipping supplies, and postage costs. Personnel costs are an aggregate of costs from six factors: 1) time away from the job; 2) test administrator's cost; 3) observer's pay; 4) Social Actions' program monitoring cost; (5) squadron processing time cost; and 6) specimen processing time cost (45:Atch 2). Each element of cost was evaluated to determine if a potential modification would result in an increase, decrease, or no change to cost. Any unique costs associated with a potential modification that are not captured in one of the categories of the cost formula are discussed individually.

The ROM unit cost estimate was prepared with the assistance of the base Comptroller Squadron's Cost Analysis and Services Branch, and the Medical Urine Test Manager, using the cost formula, fiscal year 1991 testing data, and Military Air Force-Wide Standard Composite Rates. According to the analysis by the WPAFB Social Actions office, Drug and Alcohol Abuse branch, the cost per specimen tested was approximately $83 in fiscal year 1992 dollars (45:Atch 1). The researchers recognize this unit cost

estimate has not been validated and it may not be accurate for every base in the USAF. The researchers further recognize that any modification that results in more drug users being detected will ultimately cause an increase in the administrative costs associated with administrative discharges and the legal costs associated with punishment under the Uniform Code of Military Justice. However, the researchers do not include these cost increases in the analysis.

Legal Interviews. Structured interviews of USAF lawyers responsible for developing policies, administering the legal aspects of the drug testing program, and litigating cases involving drug testing were conducted to identify any legal issues associated with potential modifications to the program. Judgment sampling, a purposive type sampling technique, was used to ensure the lawyers interviewed had experience with, and responsibility for, the legal aspects of USAF Drug Testing Program. Purposive sampling is a non-probability sample that conforms to criteria established by the researcher (22:275). To reduce sampling bias, members from different organizational levels were interviewed including base, Major Command (MAJCOM), and Headquarters USAF. At the base level, the Staff Judge Advocate, and the prosecution and defense attorneys responsible for cases involving military drug testing at Wright-Patterson AFB were interviewed. A MAJCOM perspective was provided by Air Force Materiel Command's office of primary responsibility (OPR) for military drug testing issues in the office of the Command Judge Advocate, also located at Wright-Patterson AFB. A corporate USAF perspective was provided by the OPR for legal policy governing drug testing in the General Law Division, Office of the USAF Judge Advocate General, and the USAF's leading legal expert on drug testing who is assigned as legal counsel to the USAF Drug Testing Laboratory.

Prior to conducting the interviews, a professor of law in the School of Systems and Logistics at the Air Force Institute of Technology, reviewed the questions for proper scope, clarity, and bias. This review served as an informal pre-test to improve reliability of

the questions (22:185-189, 376-382). For the actual interviews, each individual was asked the following questions:

> 1. In your opinion, are there any legal issues associated with increasing the percentage of the Air Force population tested on an annual basis? For example, instead of testing 30 percent of the Air Force population for drugs each year, test 60 percent. If there are legal issues, what are they?
>
> 2. Given a fixed number of total tests, in your opinion, are there any legal issues associated with increasing the proportion of commander-directed tests, at the expense of random (inspection) tests. Increases in commander-directed tests would result from increased emphasis from Air Force senior leadership coupled with improved training for all line supervisors on the symptoms of illegal drug use/abuse, and clear procedures for supervisors to identify potential users to the commanders. If there are legal issues, what are they?
>
> 3. In your opinion, are there any legal issues associated with using weighted random selection, based on historical demographic data on drug use in the Air Force, to select individuals for testing (instead of simple random sampling)? i.e., test a subset of the of the population where you statistically "expect" to find higher levels of drug use at a higher rate. The data on drug use is grouped, and weights would be assigned, based on rank. If there are legal issues, what are they?
>
> 4. In your opinion, are there any legal issues associated with replacing urinalysis testing with hair testing as the standard method for drug testing in the Air Force? If there are legal issues, what are they?

Their expert opinions represent some of the key issues that would need to be addressed before the modification could be implemented.

The interviews were conducted by telephone with two exceptions where the respondents agreed to a personal interview. To reduce any interviewer-induced response error, the questions were provided to the respondents before the interviews. This procedure was followed in all but two cases; one where the respondent felt comfortable having the questions read to him over the phone and the other during a personal interview. Interviews were structured with open ended questions resulting in periods of free flowing dialogue following each question. Respondents were free to ask the interviewer for as

much clarification as they needed to respond to a particular question, or to simply not answer a question if they felt they lacked sufficient information to offer an informed opinion. The complete Legal Issues Questionnaire provided to the interviewees is included in Appendix D.

Statistical Comparison of Survey and Test Results

The 1992 Worldwide Survey provides one estimate for the prevalence or population proportion of drug users in the USAF. The number of drug users detected by random urinalysis and the number of random urinalysis tests performed by the USAF Drug Testing Program are used to determine another estimate of the population proportion of drug users. Both estimates of the population proportion are estimates of a single value, the true proportion of drug users in the USAF. As discussed in the previous section, the estimate provided by the 1992 Worldwide Survey is probably an underestimate of the true value. By demonstrating the estimate based on the results of the random urinalysis portion of the USAF Drug Testing Program is significantly less than the estimate provided by the 1992 Worldwide Survey, the researchers demonstrate the potential to increase the number of drug users detected by USAF Drug Testing Program. The methodology used to demonstrate this potential to improve the program is discussed in the following subsections beginning with the estimates of the population proportion.

Estimates of Population Proportion. The 1992 Worldwide Survey and the 1992 Statistical Summary define a percentage of drug users, either self-reported or detected, for the respective samples. Samples taken in both cases are considered large for statistical purposes--about 5000 USAF members were surveyed and almost 200,000 random urinalysis tests were performed. The number of drug users discovered by both survey and random urinalysis can provide point estimates of the true proportion of drug users in the

USAF population. A point estimate is a number calculated from sample data that can be regarded as the most plausible value of a population parameter of interest (21:231). The random variables of interest, the number of drug users identified by the survey and the testing program, satisfy the requirements given by Devore for a binomial distribution (21:104). The standard error of a point estimate is its standard deviation (21:241).

1992 Worldwide Survey. Bray provides numerous survey based estimates of the proportions of drug users using equations derived from those provided by Cochran for stratified subsampling with units of unequal size (14:317-320). The estimates of proportions include the proportion of total drug users in the USAF, proportion of drug users in pay grade strata, and proportions of users of various types of drugs. With each estimated proportion, Bray provides the standard error (8:App D, 14-17). For this research, Bray's estimate of the population proportion using any drugs in the last 12 months was compared with the estimate of proportion based on fiscal year 1992 drug testing results which is discussed in the next subsection.

USAF Drug Testing Program. The estimate of the population proportion based on the random urinalysis results was derived primarily from the characteristics of the technique used to randomly select personnel to be tested. Generally, the USAF Drug Testing Program uses a stratified random sampling technique to select individuals to provide a specimen for random urinalysis. The sampling technique is stratified because random selection of personnel to be tested occurs at the base level. Officials at each base randomly select a sample of personnel according to a base level random urinalysis quota assigned by the responsible major command (MAJCOM) in support of the USAF quota assigned by the DOD. Since those personnel who have been tested previously are not excluded from the current sampling frame, random sampling occurs with replacement from month to month. Occasionally, all the personnel assigned to a single unit might be tested during a unit sweep. However, according to an inquiry of 11 bases from three USAF

MAJCOMs, unit sweeps occur infrequently and represent a negligible percentage of the total tested. Also, drug users detected by means other than random selection for urinalysis, e.g., commander-directed, arrest or investigation, or medical testing, are excluded from the estimate of the population proportion for this research.

The population proportion can be estimated using the equation for stratified random sampling without replacement shown in Equation (1) (14:107).

$$p_{pop} = \sum \frac{N_{st}}{N_{pop}} \times \frac{a_{st}}{n_{st}} \tag{1}$$

where

p_{pop} = estimate of the population proportion

N_{pop} = total population size

N_{St} = stratum population size

a_{St} = number of drug users detected in a random sample

n_{St} = random sample size

However, Equation (1) was not used because the data are not available for each of the samples selected at each base. The data available from the 1992 Statistical Summary and the USAF Drug Testing Laboratory is limited to the total number of random urinalysis tests performed and the total number of drug users identified by random urinalysis for fiscal year 1992. In addition, the total USAF population and each base's population change frequently. To accommodate these limitations, approximations were made that still yield a useful estimate of the population proportion. First, the average level of testing can be found by dividing the total number of random urinalysis tests performed, n_{total}, by the total population, N_{pop}. The USAF population at the end of fiscal year 1992 was used for the total population, N_{pop}. The resulting average level of random urinalysis provides an estimate of the level of random urinalysis performed at the base or stratum level. This average level of random urinalysis is applicable to all bases since all bases are required to

support the overall USAF quota. The inverse of the average level of random urinalysis provides a constant value for the N_{St}/n_{St} term in Equation (1). When the N_{St}/n_{St} term becomes a constant, the only variable term left to sum is a_{St}, the number of drug users detected in each random sample. The sum of a_{St} is the total number of drug users detected by random urinalysis for the period of interest.

As a result of the simplifications just discussed, the equation for estimating the population proportion reduces conveniently and logically from the case for stratified random sampling to the case for simple random sampling as shown in Equation (2).

$$p_{pop} = \frac{a_{total}}{n_{total}} \tag{2}$$

where

p_{pop} = estimate of the population proportion

a_{total} = total number of drug users detected annually by random urinalysis

n_{total} = total number of random urinalysis tests performed annually

Equation (2) provides an unbiased estimate of population proportion because the random variable, in this case, the number of drug users, has a binomial distribution (21:234). Once the estimates of the population proportions are calculated, the hypothesis testing can be conducted.

Test of Hypothesis for Population Proportion Estimates. The results of both the 1992 Worldwide Survey and the fiscal year 1992 random urinalysis provide point estimates of the proportion of drug users in the active duty USAF population. The distribution of the random variables of interest, the number of drug users identified by the survey and the random urinalysis program, can be approximated with the binomial distribution. The binomial probability distribution is applicable when the experiment has fixed, independent, and identical trials with only two possible outcomes and a constant probability of success (21:104). The applicable test of significance for the large sample estimates of the

population proportions is the z-test. The z-test was used because the sample sizes for the survey and random urinalysis program are both large enough for the test statistic to have an approximately standard normal distribution (21:356-7). The null hypothesis is that the two estimates of the population proportion are equal. The alternative hypothesis is that the proportion estimate from survey data is larger than the proportion estimate from random urinalysis data. The z-test statistic, as given by Devore, is shown in Equation (3) (21:256-7).

$$z = \frac{p_{survey} - p_{test}}{\sqrt{p_{pool} \times q_{pool} \times (\frac{1}{n} + \frac{1}{m})}} \tag{3}$$

where

p_{survey} = the estimate of the population proportion based on survey results

p_{test} = the estimate of the population proportion based on random urinalysis results

n = the total number of random urinalysis specimens tested in one year

m = the number of USAF personnel completing the survey

$q_{pool} = 1 - p_{pool}$

and p_{pool} is an estimator of proportion based on both estimates of proportion as follows.

$$p_{pool} = p_{survey} \times \frac{m}{m+n} + p_{test} \times \frac{n}{m+n} \tag{4}$$

The level of significance, or α, is the probability of rejecting the null hypothesis when it is true (21:286). For this test, the level of significance selected is 0.01. The z_α value corresponding to an α of 0.01 is found in a Standard Normal Curve table to be 2.33 (21:673). If the value of the test statistic given in Equation (4) is greater than 2.33, the null hypothesis is rejected with at most a 1% chance of error. Rejection of the null hypothesis would demonstrate that the current random urinalysis program identifies a proportion of the drug users that is significantly less than the proportion of self-reported drug users and would indicate the current USAF Drug Testing Program is capable of

being improved. The methodology to answer the four research questions which evaluate the proposed improvements to the program follows.

Research Question 1 **What effect would increasing the percentage of the USAF population randomly tested have on the number of users detected?**

In mid-1992, the USAF was directed to increase the percentage of the population it randomly tests each year from 30 to 60 percent and may be directed to increase testing even more in the future. Any change in percent tested would not affect the process of randomly selecting or testing personnel. It would only affected the number of personnel tested. The following methodology describes how the researchers determined the expected impact of an increase in the annual percentage of the USAF population randomly tested if other factors, such as drug screening thresholds, are held constant.

Drug Users Detected. Since this potential modification does not change either the process of selecting personnel for testing or the test process, the proportion of drug users detected in a sample of personnel should be approximately the same for the modified program as for the standard program. The random urinalysis detection rate is the number of drug users identified by random urinalysis divided by the number of random urinalysis specimens tested. As defined, the random urinalysis detection rate is the sample proportion and the unbiased estimator of the probability of success for the binomial random variable, which is the number of drug users in the population (21:234). The product of the estimate of the probability of success and the sample size is the expected value of the binomial random variable (21:110). The expected number of drug users identified is the estimated success rate multiplied by the anticipated total number of specimens tested. For this research, the estimated success rate is the random urinalysis detection rate achieved in fiscal year 1992. The anticipated total number of specimens

randomly tested was based on the total number of USAF personnel on active duty at the end of fiscal year 1992 and a range of values for the annual percentage of the population tested. The results of random testing at levels of 40.7, 60, and 100 percent of the USAF population annually were evaluated. Testing at a level of 100 percent does not mean that each person is tested once in a year. The random selection method used results in some personnel being tested more than once and some personnel not being tested at all. Testing at 100 percent level does mean that the number of specimens tested should be equal to the size of the population. Arithmetic analysis is used to compare the expected number of drug users identified by the random urinalysis before and after the percentage tested was increased. The methodology used to determine the impact of the potential modification on cost is discussed next.

Cost. Costs for this potential modification are evaluated at the level achieved in fiscal year 1992, which was 40.7 percent, and at 60 and 100 percent of the USAF population. The percent tested is multiplied by the total fiscal year 1992 year end population to determine the number of specimens tested. Next, the number of specimens tested is multiplied by the unit cost for testing to arrive at the cost of testing the USAF population at the different levels.

Legal. To determine the legal issues associated with this research question, six USAF lawyers with experience with the drug testing program were asked: In your opinion, are there any legal issues associated with increasing the percentage of the USAF population tested on an annual basis? If there are legal issues, what are they? The methodology used to answer the second research question is provided next.

Research Question 2 **What effect would increasing the proportion of commander-directed tests have on the number of users detected?**

Commanders can direct USAF personnel suspected of possible drug use, to provide a urine specimen for drug testing (19:27). Because the commanders base their order on observed deviant behavior or performance, as opposed to random sampling, their rate of success in identifying drug users has historically been much higher than the detection rate for random urinalysis. However, USAF regulations explicitly state that inspection testing (random urinalysis) should be the most prominent method used because it best achieves deterrence (19:26). The following methodology evaluates the benefit of increasing commander-directed drug testing.

Drug Users Detected. In this potential modification to the drug testing program, an increase in the proportion of commander-directed drug tests is offset by a reciprocal decrease in the proportion of random urinalysis tests so that the total number of drug tests performed remains constant. Fiscal year 1992 detection rates of commander-directed testing and random urinalysis are used to estimate the effect of increasing the proportion of commander-directed tests. The detection rates for both commander-directed and random urinalysis tests were calculated by dividing the number of drug users identified by the number of specimens tested for each selection method.

The commander-directed testing detection rate and the random urinalysis detection rate were used to determine the change in expected number of drug users identified for different proportions of commander-directed tests. The impact of a range of increases in the proportion of commander-directed tests were evaluated for this research. The increased proportions investigated were 3.75, 5.0, 7.5 and 10 percent of the total number of commander-directed tests conducted in fiscal year 1992. The total amount of random urinalysis and commander-directed testing and the amount of USAF personnel used for

this research were set to the total amounts for fiscal year 1992. Using the expected value equation for a binomial random variable, the expected number of drug users detected is sum of the commander-directed testing detection rate multiplied by the number of commander-directed tests performed and the random urinalysis detection rate multiplied by the number of tests performed on randomly selected personnel (21:110). The expected number of drug users detected was then compared in a tabular format to the actual results from fiscal year 1992 testing. The methodology used to determine the impact of the potential modification on cost defined in Research Question 2 is discussed next.

Cost. Because the total number of test remains constant, the total costs identified by the cost formula for the modified program would be the same for the standard program. However, relevant costs not accounted for in the model are discussed in Chapter IV.

Legal. To determine the legal issues associated with this research question, six USAF lawyers with experience with the drug testing program were given the following scenario and asked: Given a fixed number of total tests, in your opinion, are there any legal issues associated with increasing the proportion of commander-directed tests, at the expense of random (inspection) tests? If there are legal issues, what are they? Their opinions are presented in Chapter IV. The methodology used to answer the third research question is provided next.

Research Question 3 **What effect would weighted random selection, based on data from the prior fiscal year and surveys on the prevalence of drug use in the officer and enlisted ranks, have on the number of users detected?**

With weighted random selection, only the selection process for random urinalysis is changed. Instead of each individual having an equally likely chance of being selected at random from a base level sampling frame, the probability of selection is dependent on the

individual's rank. Five rank strata are proposed: E1-E3, E4-E6, E7-E9, O1-O3 and O4-O10. These correspond to the data reported by strata in the 1992 Worldwide Survey (8:App D, 14).

Description of Weighted Random Selection Techniques. Two weighted random selection techniques that retain random sampling within each stratum were evaluated. With both techniques, the number of personnel selected for testing from each rank stratum depends on the results of either the 1992 Worldwide Survey or the drug users identified in fiscal year 1992. Both techniques cause the members of the rank stratum with the largest number of estimated (by survey) or identified drug users to be selected for testing more frequently than the members of the rank strata with fewer estimated or identified drug users. This is accomplished by weighting the proportion of personnel selected from a stratum according to the number of estimated or identified drug users in that stratum. Once the proportion of personnel to be selected is known, the estimated number of drug users selected for testing can be determined with the methodology described next.

Drug Users Detected. The methodology to estimate the number of drug users detected requires data from several sources and the following assumptions about the modified program. For this research, the 1992 Statistical Summary provides the number of drug users identified in each stratum for the rank strata weighting. The 1992 Worldwide Survey provides estimates of the proportion of drug users in each rank stratum used for both rank strata weighting and determining the expected number of drug users selected for testing. The anticipated total number of tests conducted is the number of random urinalysis tests conducted in fiscal year 1992. In addition, the total population and the population of each rank stratum are taken to be constant for the year and equal to the fiscal year 1992 end strengths. Finally, the researchers assume that selecting more drug users to be tested than would be selected by the standard program, results in a

proportional increase in the number of drug users detected. The methodology used to estimate the number of drug users detected with each selection technique is provided next.

Random Sampling Technique. The current technique used in the USAF Drug Testing Program is a random sampling technique. With random sampling, each element of a set should be equally likely to be selected and in this case, the expected number of personnel selected from a stratum should be directly proportional to the proportion of personnel in that strata relative to the total population (14:18). In other words, if the E4-E6 strata contained 20 percent of the USAF population, then approximately 20 percent of a random sample of the entire USAF population should be E4-E6 personnel. Once the likely proportion of personnel selected from each stratum is determined, the total number of personnel selected from a stratum is found by multiplying the proportion by the total number of random tests. For this research, the expected number of drug users randomly selected in each stratum is given by the product of the estimated proportion of drug users in the stratum (as given by survey data) and the number of personnel selected to be tested from the stratum (36:178). Once the expected number of drug users selected for testing is determined for each stratum, the total expected number of drug users selected is the sum of the expected number of drug users selected from each stratum. Using this information, the expected number of drug users selected for testing by the current random sampling technique can be determined and compared to the expected number of drug users selected using the methodology for the two weighted random selection techniques given next.

Survey-Based Technique. The survey-based weighted random selection technique uses the survey estimate of the number of drug users in each stratum to determine the proportion of personnel selected for testing. The proportion of personnel selected for testing equals the estimated number of drug users in the stratum divided by the estimated total number of drug users in the USAF. The total number of personnel selected for testing for a stratum is the proportion of personnel selected for testing multiplied by the

total number of random tests performed. Finally, the expected number of drug users selected to be tested is the number of personnel selected to be tested multiplied by the estimate of the proportion of drug users provided by the 1992 Worldwide Survey.

Identification-Based Technique. The identification-based weighted random selection technique uses the total number of drug users identified in each stratum in fiscal year 1992 to determine the proportion of personnel selected for testing. The proportion of personnel selected for testing equals the number of drug users identified in the stratum divided by the total number of drug users identified in the USAF for fiscal year 1992. The total number of personnel selected for testing for a stratum is the proportion of personnel selected for testing multiplied by the total number of random tests performed. Finally, the expected number of drug users selected to be tested is the number of personnel selected to be tested multiplied by the estimate of the proportion of drug users provided by the 1992 Worldwide Survey.

The ratio of the expected number of drug users selected using the weighted random selection techniques and the expected number of drug users selected for testing by the current, random sampling technique, provides the proportional advantage for each weighted random selection technique in selecting drug users for testing. The proportional advantage ratio equals the expected total number of drug users selected for testing by a weighted random selection technique divided by the expected total number of drug users selected for testing using the random sampling technique. To find the increase in the expected number of drug users detected, the number of drug users detected by random urinalysis in fiscal year 1992 was multiplied by the ratio for each weighted random selection technique. Then, the actual random urinalysis results for fiscal year 1992 were compared to the expected results of weighted random selection techniques. The methodology used to determine the impact of the potential modification defined in Research Question 3 on cost is discussed next.

Cost. Under this modification the total number of tests conducted would remain the same; however, the makeup of the population tested would change thus affecting the personnel cost element of the cost formula. The impact of testing a more junior population than the population tested in fiscal year 1992 is assessed by evaluating the impact on the time away from the job cost factor. Costs not accounted for by the formula are also discussed in Chapter IV.

Legal. To determine the legal issues associated with this research question, six USAF lawyers with experience with the drug testing program were asked: In your opinion, are there any legal issues associated with using weighted random selection, based on historical demographic data on drug use in the USAF, to select individuals for testing (instead of simple random sampling)? If there are legal issues, what are they? They were told the data on drug use is grouped, and weights would be assigned, based on rank. Their opinions are presented in Chapter IV. A discussion of the methodology used to answer the fourth research question follows.

Research Question 4 **What effect would changing the test method from urinalysis to hair testing have on the number of users detected?**

Urinalysis and hair testing techniques both employ similar assay techniques to detect drugs in a specimen. The primary difference between the two test methods is the specimen needed for the test. The hair testing potential modification to the standard USAF Drug Testing Program would only affect the testing portion of the program. The researchers assumed the process of selecting personnel to be tested was unaffected by the potential modification. The most important difference between the two methods is the longer timeframe in which hair testing can detect drugs.

Drug Users Detected. To focus on just the differences between the two testing methodologies, only the detection capability of the two test methods was evaluated. The selection process was assumed to be the same for either test method and thus a negligible portion of the process for this evaluation. Four steps were required to evaluate the difference in effectiveness between hair testing and urinalysis. In each step, only the drug types commonly used by USAF personnel, as reported in the 1992 Statistical Summary of drug testing and the 1992 Worldwide Survey, were considered.

The first step in the evaluation was to estimate the number of personnel using drug types only urinalysis can detect. Initially, the common drug types detected by urinalysis and not detected by hair testing were determined through a review of literature. Then, the estimated number of users of these drug types was determined using the estimate of the proportion in the 1992 Worldwide Survey. This process produced an estimate of the number of drug users that could be detected by urinalysis, but not hair testing.

The second step used the same process described in the first step to determine the number of personnel using drug types only hair testing can detect.

The third step determined the drug types for which hair testing and urinalysis have approximately the same size window of detection. "Window of detection" is the period of time following drug use, that a drug test, using hair or urine, can detect the presence of the drug. For the drug types where hair testing and urinalysis have a similar size window of detection, both tests should identify the same number of drug users which would not affect the evaluation of the modification. For this reason, these drug types were ignored.

The fourth step evaluates the remaining common drug types for which the urinalysis window of detection is different from the hair testing window of detection. For each drug type and both test techniques, the researchers determined the probability of detection, which is the probability that a drug user would be detected by a drug testing within a period of one month. The researchers defined the probability of detection as the likeliness

that a drug user would be selected to provide a specimen within the window of detection after they had used a drug. To determine the probability of detection using the methodology described next, the researchers made the following assumptions. First, drug use and drug testing were both equally likely to occur on any of the 30 days in a month. Second, urinalysis and hair testing were equally accurate since both use assay techniques. Third, the majority of USAF drug users were infrequent users who used drugs no more than three times per month (8:Ch 5, 17).

The probability of detection, or likeliness that a drug user would be selected to provide a specimen within the window of detection after they had used a drug, was calculated using the frequency of drug use typical for USAF personnel and the window of detection for the test method evaluated. The probability the specimen was provided within the window of detection is the probability of selecting the individual on any of the days within the window of detection following each instance of drug use. The researchers examined two cases for the frequency of drug use. The worst case for detection was drug use only once per month. The best case considered was three instances of drug use evenly distributed in one month, i.e., one instance of drug use every ten days. (The chances of detection are greater if the window of detection for each instance of drug use, does not overlap another.) Since the researchers assumed testing was equally likely on any day, the probability of selection within the window of detection following a single drug use is the window size, in number of days, divided by the time period of consideration, 30 days. For the case of three instances of drug use, the probability of selection is the sum of the number of the days in each window of detection, less any days of overlap, divided by the 30 days in a month.

For each drug type and test type, the probabilities of detection were determined for the best and worst cases. Once the probabilities of detection were determined, the data was summarized in a tabular format according to drug type. Finally, the researchers calculated

an estimate of the number of personnel using the drug types considered in the fourth step. The methodology to determine the impact of the potential modification defined in Research Question 4 on cost is discussed next.

Cost. Each element of the cost formula was evaluated to determine whether or not the implementation of hair testing would cause an increase or decrease in that portion of the total testing cost. Cost data for hair testing from the literature was used where available. Where no detailed cost data was available, the researchers provided their analysis of the anticipated impact. Costs not covered by the cost formula are discussed in Chapter IV.

Legal. To determine the legal issues associated with this research question, six USAF lawyers with experience with the drug testing program were asked: In your opinion, are there any legal issues associated with replacing urinalysis testing with hair testing as the standard method for drug testing in the Air Force? If there are legal issues, what are they? Their expert opinions were collected and are presented in Chapter IV.

Summary

In summary, potential modifications to the standard drug testing program can be evaluated using simple probability and mathematical methods to estimate the effects on the number of drug users selected for testing, the number of users detected and/or the change in the probability of detection. These numbers can be compared to the standard USAF Drug Testing Program results to determine if the potential modification might improve the program. In addition, a methodology to assess the impact to current program cost for each modification was developed to determine if a modification would significantly change the current cost. Finally, a methodology was developed to identify any legal issues associated with the implementation of the potential modifications.

IV. Analysis and Results

This chapter begins with the calculation of the estimates of population proportions of drug users in the USAF based on the 1992 Worldwide Survey and random urinalysis results. The estimates of the population proportion of drug users are then statistically compared using a test of hypothesis. Following the test of hypothesis, the cost impact, legal issues, and the expected change in the identification of drug users are provided for each of the potential modifications to the standard USAF Drug Testing Program.

Population Proportion Estimates

The estimates of population proportion of drug users are derived from two different sources of data. The first source discussed is self-reported data obtained in the 1992 Worldwide Survey. The second source is the USAF Drug Testing Program results principally documented in the 1992 Statistical Summary.

Survey Based Estimates. Of the 25,000 DOD personnel selected to participate in the 1992 Worldwide Survey of Substance Abuse and Health Behaviors Among Military Personnel, 5,880 were USAF personnel. Of the USAF personnel, 85.0 percent or 4,998, correctly completed the survey in either the first or second phase (8:Ch 2, 7). The survey participants were questioned about their use of the following drugs: marijuana; LSD or other hallucinogens; amphetamines and other stimulants; PCP; heroin and other opiates; barbiturates and other sedatives; cocaine; anabolic steroids; tranquilizers and other depressants; inhalants; analgesics and other narcotics; and "designer" drugs. "Designer" drugs, with names such as "Ecstasy" and "Adam," are mood or perception altering drugs made from combinations of other drugs or chemicals (8:App G, 13). The 1992 Worldwide Survey provided the estimates in Table 1 for the USAF population proportion

having any nonmedical use of the drugs listed previously except anabolic steroids. The 1992 Worldwide Survey does not include anabolic steroids in the estimate of the personnel using "any drug" to remain consistent with previous surveys. The 1992 Worldwide Survey estimate of the population proportion of USAF personnel using anabolic steroids is 0.2 percent with 0.1 standard error for both the last 30 days and the last 12 months.

TABLE 1

ESTIMATES OF THE PROPORTION (AND STANDARD ERRORS) OF USAF PERSONNEL THAT HAVE USED ANY DRUG EXCEPT STEROIDS

Rank/Total	Past 30 Days	Past 12 Months
E1-E3	1.8 (0.8)	4.3 (1.5)
E3-E6	1.5 (0.2)	2.7 (0.2)
E7-E9	1.0 (0.2)	1.4 (0.2)
O1-O3	0.3 (0.2)	0.6 (0.4)
O4-O10	0.1 (0.1)	0.4 (0.3)
Total USAF	1.2 (0.2)	2.3 (0.3)

(8:App D, 14)

There are two methods available to the researchers to estimate the proportion of personnel using any drug, including anabolic steroids. For the first method, the researchers could assume the users of anabolic steroids are different from those users included in the "any drug" proportion. With this assumption, the estimates would be combined by adding the two estimates together. In the other method of estimating the proportion of personnel using any drug including anabolic steroids, the researchers would assume the anabolic steroid users are not different from those personnel included in the

"any drug" use proportion. With this method, the estimate of the proportion of "any drug" users in Table 1 would be the estimate of the total drug user proportion of the USAF population. The second, more conservative, method is appropriate for the hypothesis testing performed for this research. The survey-based estimate of the proportion of personnel using any drugs in the past 12 months was compared by hypothesis testing to the estimate of the population proportion based on the fiscal year 1992 USAF Drug Testing Program results.

USAF Drug Testing Program-Based Estimates. In fiscal year 1992, the 189,699 random urinalysis specimens tested resulted in 195 drug users being identified (40; 56). This research focuses on the random urinalysis portion of the USAF Drug Testing Program because random urinalysis represents about 97 percent of the total drug testing performed annually and provides an unbiased estimate of the population proportion of drug users. Using Equation (2) defined in the Chapter III, the point estimate of the proportion of users in the USAF is calculated as follows:

$$p_{pop} = \frac{a_{total}}{n_{total}} = \frac{195}{189,699} = 0.00103$$

where

p_{pop} = estimate of the population proportion of drug users

a_{total} = total of 195 drug users detected by random urinalysis in fiscal year 1992

n_{total} = total of 189,699 random urinalysis tests performed in fiscal year 1992

The unbiased estimate of population proportion based on the fiscal year 1992 results of random urinalysis is 0.00103 or about 0.1 percent. The estimates of the population proportions provided by the survey and based on random urinalysis results are compared by the test of hypothesis method next.

Test of Hypothesis for Population Proportion Estimates

The applicable test of hypothesis for the large sample estimates of the population proportions is the *z* test. The null hypothesis was that the two estimates of the population proportion are equal. The alternative hypothesis was that the proportion estimate from survey data is larger than the proportion estimate from random urinalysis data. Before the *z* test statistic was calculated, the pooled estimator (p_{pool}) of the proportion, based on both estimates of proportion, was calculated. That calculation was performed using Equation (4).

$$p_{pool} = p_{survey} \times \frac{m}{m+n} + p_{test} \times \frac{n}{m+n}$$

where

p_{survey} = 0.023, the population proportion estimate based on survey results

p_{test} = 0.00103, the population proportion estimate based on random urinalysis

n = 189,699, the number of random urinalysis tests performed in one year

m = 4,998, the number of USAF personnel completing the survey

The value for p_{pool} was calculated as follows:

$$p_{pool} = 0.023 \times \frac{4,998}{189,699+4,998} + 0.00103 \times \frac{189,699}{189,699+4,998} = 0.0016$$

The *z* test statistic, was calculated using Equation (3) defined in Chapter III.

$$z = \frac{p_{survey} - p_{test}}{\sqrt{p_{pool} \times q_{pool} \times (\frac{1}{n} + \frac{1}{m})}}$$

where

q_{pool} = 1-p_{pool} = 1- 0.0016 = 0.9984

and the same values of the variables used to determine p_{pool} were used again to find the value of the z statistic.

$$z = \frac{0.023 - 0.00103}{\sqrt{0.0016 \times 0.9984 \times (\frac{1}{189,699} + \frac{1}{4,998})}} = 38.4$$

For this test, the level of significance is 0.01 with a corresponding z_α of 2.33 which defines a null hypothesis rejection region that starts at 2.33 and continues to positive infinity. Since the value of the test statistic, $z = 38.4$, was greater than 2.33, the null hypothesis was rejected with at most a 1% chance of error. Rejection of the null hypothesis demonstrated the current random urinalysis program identifies a proportion of drug users in the USAF population that is significantly less than the proportion of self-reported drug users. Rejection of the null hypothesis also indicated the current drug testing program could be improved to detect more drug users. In the following sections, data for potential modifications to increase the number of drug users detected is provided according to the thesis research questions.

Research Question 1 **What effect would increasing the percentage of the USAF population randomly tested for drug use have on the number of users detected?**

When the percentage of the USAF population that is randomly tested annually is changed, only the quantity of people selected for random urinalysis changes. How people are selected or tested does not change. For this reason, the researchers assumed the rate of detection of drug users by random urinalysis did not change. As developed in Chapter III, the detection rate is the point estimate of the sample proportion and was found by dividing the number of drug users detected by random urinalysis in fiscal year 1992 by the total number of random urinalysis tests conducted in fiscal year 1992. The USAF Military Personnel Center provided data from the USAF Personnel Data System which showed

that 195 members were initially identified as drug users by random urinalysis in fiscal year 1992 (56). The USAF Drug Testing Laboratory records, provided in Appendix C, document that 189,699 random urinalysis tests were performed in fiscal year (FY) 1992 (40).

$$\text{FY 1992 Random Urinalysis Detection Rate} = \frac{195}{189,699} = 0.00103$$

As developed in Chapter III, the expected number of drug users detected annually was estimated by the random urinalysis detection rate multiplied by the number of random urinalysis specimens tested annually. For this modification, the number of specimens randomly tested annually depended on two factors. The first was the total number of personnel on active duty. For this estimate, the researchers assumed the USAF population was constant and equal to 466,060, the population at the end of fiscal year 1992 (39:29). The second factor was the percentage of specimens required to be randomly tested each year. For this potential modification, the percentage was varied from 60 to 100 percent. Table 2 provides the expected number of drug users detected by random urinalysis if the level of random testing were increased above the 40.7 percent level of testing in fiscal year 1992.

TABLE 2

THE EXPECTED NUMBER OF DRUG USERS DETECTED WHEN RANDOMLY TESTING DIFFERENT PERCENTAGES OF THE POPULATION

PERCENTAGE OF PERSONNEL TESTED ANNUALLY	NUMBER OF SPECIMENS TESTED ANNUALLY	EXPECTED NUMBER OF DRUG USERS DETECTED
40.7	189,699	195
60	279,636	288.0
100	466,060	480.0

The information in Table 2 corresponding to the 40.7 percent level of random testing reflects actual testing in fiscal year 1992. In fiscal year 1993, the USAF should achieve the mandated 60 percent level of random urinalysis and should detect about 288 drug users through random urinalysis based on fiscal year 1992 results. If the random testing level is further increased to the 100 percent level, random urinalysis should detect about 480 drug users annually. The next subsection provides the impact to costs for these increased levels of random urinalysis.

Cost Impact. The rough order of magnitude costs of testing 40.7 percent of the USAF population in fiscal year 1992 and potential increases to 60 and 100 percent of the USAF population were estimated using the following formula described in Chapter III:

$$\text{total cost} = \text{unit cost} \times \text{number of units tested}$$

where

unit cost = $83 per test (45:Atch 1)

number of units tested = percent of the population tested × total population

total population = 466,060, the USAF active-duty population at the end of FY 1992

The rough order of magnitude costs of testing are presented in Table 3 in fiscal year 1992 dollars. No additional costs are associated with randomly testing at the different levels.

TABLE 3

THE EXPECTED COSTS WHEN RANDOMLY TESTING
DIFFERENT PERCENTAGES OF THE POPULATION

PERCENTAGE OF PERSONNEL TESTED ANNUALLY	NUMBER OF SPECIMENS TESTED ANNUALLY	EXPECTED COSTS ($)
40.7	189,699	15,745,017
60	279,636	23,209,788
100	466,060	38,682,980

Legal Issues. When asked about the legal issues associated with increasing the percentage of the population randomly tested, the lawyers unanimously agreed that there were none.

Research Question 2 **What effect would increasing the proportion of commander-directed tests have on the number of users detected?**

For the evaluation of this potential modification, the researchers assume the testing methodology, urinalysis, and the total number of tests performed annually remain the same as in fiscal year 1992 when a total of 194,364 commander-directed and random urinalysis tests were performed. Of these 194,374 tests, 4,675 tests, or 2.405 percent, were commander-directed tests (40). To evaluate this proposal, the researchers assumed a total of 194,364 tests were performed, but the percentage of commander-directed tests is increased above the fiscal year 1992 level. Since the testing methodology, urinalysis, was unchanged by this potential modification, the researchers again assumed the random urinalysis detection rate was the same as for fiscal year 1992 and calculated by dividing the

number of drug users detected via random urinalysis in fiscal year 1992 by the total number of random urinalysis tests conducted in fiscal year 1992.

$$\text{FY 1992 Random Urinalysis Detection Rate} = \frac{195}{189,699} = 0.00103.$$

The annual detection rate for commander-directed testing was found by dividing the total number of drug users identified by commander-directed testing in fiscal year 1992 by the total number of commander-directed tests performed in fiscal year 1992. The Air Force Military Personnel Center provided data from the USAF Personnel Data System which showed that 39 members were initially identified as drug users by commander-directed testing in fiscal year 1992 (56).

$$\text{FY 1992 Commander-Directed Testing Detection Rate} = \frac{39}{4,675} = 0.0083.$$

For the evaluation of this potential modification, the detection rate for random urinalysis and commander-directed testing are 0.00103 and 0.0083 respectively.

Once the detection rates for random urinalysis and commander-directed testing were determined, the effect of increasing the percentage of commander-directed testing was determined using the expected value equation developed in Chapter III. The researchers calculated the expected number of drug users detected by commander-directed testing by multiplying the fiscal year 1992 detection rate for commander-directed testing by the number of commander-directed tests performed. The researchers calculated the expected number of drug users detected by random urinalysis by multiplying the random urinalysis detection rate by the number of tests performed on randomly selected personnel. The expected total number of drug users detected is the sum of the expected number of drug users detected by either method.

Table 4 documents the effect of increasing the proportion of commander-directed tests on the number of tests performed and the expected number of drug users detected by

commander-directed testing and random urinalysis. For each increase in commander-directed testing, the researchers kept the total number of tests equal to the fiscal year 1992 total number of tests by reducing the number of random urinalysis tests. In Table 4, "Directed" refers to commander-directed tests and "Random" refers to random urinalysis tests.

TABLE 4

RESULTS OF INCREASING THE PROPORTION OF COMMANDER-DIRECTED TESTS

PROPORTION OF TESTS (%)		NUMBER OF TESTS PERFORMED		EXPECTED NUMBER OF DRUG USERS DETECTED		
Directed	Random	Directed	Random	Directed	Random	Total
2.41	97.59	4,675	189,699	39	195	234
3.75	96.25	7,289	187,075	61	193	254
5.00	95.00	9,718	184,646	81	190	271
7.50	92.50	14,577	179,787	121	185	306
10.00	90.00	19,436	174,928	161	180	341

In fiscal year 1992, 2.41 percent of the total number of commander-directed and random urinalysis tests were commander-directed and resulted in 39 drug users identified while random urinalysis tests detected 195 drug users. If commanders approximately doubled the number of personnel directed to take the drug test (to five percent) and the same detection rate was maintained , approximately 37 additional drug users could be identified annually through random urinalysis and commander-directed testing. If commanders could increase by approximately fourfold the number of personnel directed to take the drug test (to ten percent) and the same detection rate was maintained,

approximately 107 additional drug users could be identified annually through random urinalysis and commander-directed testing. The impact to cost of the increased commander-directed tests would be minimal as discussed in the next paragraph.

Cost Impact. Increasing the proportion of commander-directed tests relative to random test while holding the total number of tests constant would result in no change in the costs estimated by the cost formula for the standard program. However, in order to implement this proposed modification, a substance abuse training module would have to be developed and inserted into the existing supervisory courses taught throughout the USAF. Many of the training materials that would be required already exist and are being used in some of the USAF professional education programs (46). However, implicit in this modification are the non-recurring costs of developing and implementing a standardized block of instruction for all USAF supervisory courses. The lesson would focus on teaching supervisors and commanders to recognize the symptoms of drug abuse, and familiarizing them with the process for having employees tested for drugs. These added training costs would cause a short-term net increase in the program's cost relative to the standard program.

Legal Issues. The legal community interviewed for this research expressed three major concerns related to increased emphasis on commander-directed tests. First, Colonel Giovagnoni, the Wright-Patterson Air Force Base (WPAFB) Judge Advocate, Lieutenant Colonel Fahey, USAF OPR for military drug testing, Major Coacher, Legal Advisor to the Air Force Drug Testing Lab, and Captain Kinlin, Assistant Judge Advocate at WPAFB, all expressed concerns that encouraging more commander-directed tests at the expense of random tests would reduce the program's deterrent effect because the USAF loses the option of judicial or nonjudicial punishment in cases where members test positive after being directed to test. In those cases, the USAF would be limited to separating the member from service with an honorable discharge. The four legal experts believed that

the principal reason the program has been such an effective deterrent is the fact that the USAF has emphasized holding the drug abuser accountable. They agreed that simply putting the drug users out of the USAF without punishment, i.e., with an honorable discharge, was not sufficient to deter drug use (27; 23; 13; 33). Captain Wiste, the former Area Defense Counsel, also expressed reservations that such an approach would probably not send the same strong message as the current program (55). A second concern, expressed by Lieutenant Colonel Fahey, would be the need for the USAF to exercise extreme care that commanders not view a policy of encouraging more commander-directed testing as direction to "find" more users (23). The researchers' expectations would be to provide commanders and line supervisors with training that would help them correctly identify potential users. Third, according to Major Coacher, Legal Advisor to the USAF Drug Testing Laboratory, any attempt to increase proportion of commander-directed tests would definitely need to be accompanied by a training program that emphasized the symptoms of drug abuse and provided information on the windows of detection for various drugs so that supervisors and commanders would understand the necessity of a timely decision on whether a particular employee should be tested. Given the narrow urinalysis window of detection for many drugs, recognizing the symptoms of drug abuse, and then waiting several days before directing the employee to test would significantly reduce the probability of the employee testing positive (13).

Research Question 3 **What effect would weighted random selection, based on data from prior tests and surveys on the prevalence of drug use in the officer and enlisted ranks, have on the number of users detected?**

The weighted random selection process would select personnel for random urinalysis using five rank strata: E1-E3, E4-E6, E7-E9, O1-O3 and O4-O10. Unlike random

sampling, where each individual is equally likely to be selected, the two weighted random selection techniques make the probability of selection dependent on the individual's rank and the estimated or identified proportion of drug users in each stratum. With the weighted random selection techniques, personnel in the stratum with the largest estimated or identified proportion of drug users have the highest probabiiity of being selected for random testing. The calculations to determine the expected number of drug users selected for random urinalysis using the current, random sample, technique and the weighted random selection techniques are provided next.

Drug Users Detected. To determine the expected number of drug users selected and detected, the following fiscal year 1992 data were needed: strata population, number of drug users identified in fiscal year 1992, and the survey-based estimate of the proportion of drug users in each rank strata. For this research, the population in each stratum was taken as the population at the end of fiscal year 1992. The 1992 Statistical Summary provided the number of drug users in each stratum identified in fiscal year 1992. The 1992 Worldwide Survey provided the estimates of the proportion of personnel who have used any drugs in the past 12 months for each rank stratum. The researchers assumed the same number of random urinalysis specimens tested in fiscal year 1992, which was 189,699 tests, would be tested annually in this evaluation (40). The stratum population, number (and percentages) of drug users identified in fiscal year (FY) 1992, and the estimate of the number (and proportion) of drug users in each stratum are given in Table 5.

TABLE 5

RANK STRATUM POPULATION, DRUG USERS IDENTIFIED AND ESTIMATE OF THE NUMBER OF DRUG USERS FOR FY 1992

RANK STRATA	POPULATION	NUMBER OF DRUG USERS IDENTIFIED (%)	SURVEY-BASED ESTIMATE OF NUMBER OF DRUG USERS (%)
E1-E3	80,444	254 (.32)	3,459 (4.3)
E4-E6	245,769	275 (.11)	6,636 (2.7)
E7-E9	49,471	16 (.03)	693 (1.4)
O1-O3	56,181	12 (.02)	337 (0.6)
O4-O10	34,195	5 (.01)	137 (0.4)
TOTAL	466,060	562 (.12)	11,262 (2.4)

(39:29; 2:4; 8:App D, 14)

To evaluate this potential modification to the current program, the researchers compared the potential number of drug users selected for testing by random sampling to the potential numbers of drug users selected by the two weighted random selection techniques. The expected number of drug users selected for testing by the current process, which uses random sampling, was evaluated first.

Random Sampling Technique. The proportion of personnel randomly selected from each stratum equals the population proportion of each stratum relative to the total USAF population. The population proportion of each stratum relative to the total USAF population was found by dividing the stratum population by the total USAF population. For example, the population proportion of the E1-E3 stratum is 80,444/466,060=0.172604. The expected number of personnel selected to be tested is the stratum population proportion multiplied by the total number of random tests. Continuing the previous example, the number of personnel selected to be tested from the E1-E3

stratum is $0.172604 \times 189,699 = 32,743$. Finally, the expected number of drug users selected to be tested is the number of personnel selected to be tested multiplied by the estimate of the proportion of drug users provided by the 1992 Worldwide Survey. Continuing the previous example again, the expected number of drug users selected to take the test is $32,743 \times 0.043 = 1,408$. The values for the all the strata were calculated with the method JUST described using the data in Table 5. The results are shown in Table 6 in the columns labeled "RANDOM". Calculations for the weighted random selection techniques are provided next.

Weighted Random Selection Techniques. The expected number of drug users selected to be tested by the two weighted random selection methods were found by the same method as used for random selection. The weighted random selection techniques are only different in the method of determining the proportion of personnel selected from each stratum. For the first method, the survey-based technique, the proportion of personnel selected for testing was calculated by dividing the estimated number of drug users in the stratum by the estimated total number of drug users. For example, with the E1-E3 stratum, the proportion of personnel selected for testing would be 3,459/11,260=0.3072. For the second method, the identification-based technique, the proportion of personnel selected for testing was calculated by dividing the number of drug users identified in the stratum in fiscal year 1992 by the total number of drug users identified. For example, with the E4-E6 stratum and the data from Table 5, the proportion of personnel selected for testing would be 275/562=0.4893. Once the proportion of personnel selected for testing in each stratum was known, the same method used to calculate the number of personnel and drug users selected for testing by random selection, was used again for both weighted random selection techniques. The results of the calculations are found in Table 6 below in the columns labeled "SURVEY" for the survey-based technique and "IDENT" for the identification-based technique.

TABLE 6

ESTIMATED NUMBER OF PERSONNEL AND DRUG USERS SELECTED TO BE TESTED

RANK STRATA	NUMBER OF PERSONNEL SELECTED FOR TEST			EXPECTED NUMBER OF DRUG USERS SELECTED FOR TEST		
	RANDOM	SURVEY	IDENT	RANDOM	SURVEY	IDENT
E1-E3	32,743	58,264	85,736	1,408	2,505	3,687
E4-E6	100,035	111,778	92,824	2,701	3,018	2,506
E7-E9	20,136	11,673	5,401	282	163	76
O1-O3	22,867	5,676	4,050	137	34	24
O4-O10	13,918	2,308	1,688	56	9	7
TOTAL	189,699	189,699	189,699	4,584	5,729	6,300

Expected Number of Drug Users Identified. The researchers used a ratio to determine the expected number of drug users identified if weighted random selection techniques were used. The ratio was the expected number of drug users selected for testing by a weighted random selection technique divided by the expected number of drug users selected by the current technique, random sampling. The survey-based technique ratio was 5,729/4,584=1.25. The identification-based technique ratio was 6,300/4,584=1.374. Multiplying the two ratios by the number of drug users identified by random urinalysis in fiscal year 1992, which was 195, gave the expected number of drug users that would have been detected had either weighted random selection technique been used. For the survey-based technique, the expected number of drug users detected is $195 \times 1.25 = 243.8$. For the identification-based technique, the expected number of drug users detected is $195 \times 1.374 = 268$. If the survey-based technique or the identification-

based technique had been implemented, the expected increase in the number of drug users detected would be 49 and 73 respectively. These results indicate that either technique would increase the number of users detected over random urinalysis. The next section defines the effect on cost of the weighted random selection techniques.

Cost Impact. Under this modification the laboratory test costs and supplies and administrative costs would remain the same since the total number of tests is unchanged. However, personnel costs would be affected because weighted sampling results in fewer senior enlisted members and officers being selected for testing, driving a change in the personnel cost factor for time away from the job. The lower the average rank of the members being tested, the lower the personnel costs associated with lost time from the job. Lost time is a function of the time consumed traveling to and from the testing site, and time spent at the site preparing to give and giving a urine specimen. The average time away from the primary job in the Wright-Patterson AFB analysis was one-and-a-half hours per person at a rate of $35.19 for officers and $15.59 for enlisted personnel (45). The other personnel cost factors would remain unchanged for this option. Adopting weighted random selection would drive down the cost of time spent away from the primary job, thus reducing personnel costs and subsequently driving a net reduction in the cost of the program relative to the base program.

However, before this modification could be implemented, a standard software program should be developed for USAF-wide use that would select a weighted random sample for each test date from a base's manpower data base based on pre-programmed weights. The cost of developing a weighted random selection software program and the administrative cost of distributing it throughout the USAF would tend to cause an increase in the program's total cost though perhaps not enough to offset the decrease in cost associated with lower personnel cost.

A final, nonpecuniary cost that would need to be evaluated is the potential negative impact that weighted random selection might have on morale within the force. Many people, especially junior enlisted members, might perceive weighted testing as a policy developed by officers that unfairly singles out junior enlisted members for punishment, regardless of the historical survey and test data supporting the weighting. At a minimum, the reasons for adopting weighted random selection would have to be explained and the historical survey and test data shared with the affected members for the program to be successfully implemented.

Legal Issues. The concept of weighted random selection was the most controversial, with the legal community almost evenly divided on both sides of the issue. First, Captain Wiste and Mr. Krueger questioned whether or not weighted random sampling would withstand a challenge in court as to whether it was truly random. They each believed that a good defense attorney would argue that weighted random sampling unfairly focused too heavily on her client and in fact violated the client's 14th Amendment rights to the equal protection of the laws (55; 35). If the argument proved successful, every other conviction based on weighted selections made prior to the ruling would be in jeopardy of being overturned on appeal and the USAF could face a number of costly suits alleging discrimination (55). On the other side of the issue, Colonel Giovagnoni, Lieutenant Colonel Fahey, and Major Coacher argued that there was no legal reason why the USAF could not implement weighted random selections so long as there was a rational basis for the weightings (27; 23; 13). Specifically, Colonel Fahey and Major Coacher pointed to Military Rule of Evidence 313 (MRE 313), Inspections and Inventories in the Armed Forces, in the Manual for Courts Martial which governs inspection of all types including what we commonly refer to as random urinalysis. MRE 313 states:

> An inspection is an examination of the whole or part of a unit, organization, installation, vessel, aircraft, or vehicle, including an examination conducted at entrance

> and exit points, conducted incident of command the primary purpose of which is to determine and ensure the security, military fitness, or good order and discipline of the unit, organization, installation, vessel, aircraft, or vehicle. An inspection may include but is not limited to an examination to determine and ensure that any or all of the following requirements are met: that the command is properly equipped, functioning property, maintaining proper standards of readiness, sea or air worthiness, sanitation and cleanliness, and that the personnel are present, fit, and ready for duty. An inspection also includes an examination to locate and confiscate unlawful weapons or contraband. An order to produce body fluids, such as urine, is permissible under this rule (52:Ch 3, 11).

Fahey and Coacher further argue that MRE 313 does not require random inspections. In fact, it does not even mention random inspections (23; 13). According to Lieutenant Colonel Fahey, the purpose of having random testing is to compensate for the fact that probable cause does not exist for testing a particular group or individual. In his opinion, if the groups are weighted on a logical basis and individuals are selected from within the groups at random, there is no legal reason why weighted random sampling could not be used (23). Major Coacher, the USAF's legal expert on drug testing, noted that "random" has been interpreted in the military courts to mean the test cannot be a subterfuge for a search. Simply stated, you cannot use an inspection to target an individual because you think he may have committed a crime. Random selection is a means of ensuring that an inspection is not a subterfuge for a search (13). In spite of strong arguments in support of the legality of weighted random selection, Colonel Giovagnoni and Major Coacher noted that the issue has never been raised before the United States Court of Military Appeals or the Service Courts of Review. All the parties agree that implementing this proposed modification would probably result in a legal challenge that would ultimately cause the issue to be resolved in the courts.

Research Question 4 **What effect would changing the test method from urinalysis to hair testing have on the number of users detected?**

Urinalysis and hair testing both employ assay techniques to detect drugs in a specimen. The primary differences between the two test methods is the specimen needed for the test and the resulting difference in windows of detection. The principle data sources, the 1992 Worldwide Survey and the USAF Drug Testing Program, provided the data discussed next.

The 1992 Worldwide Survey provided estimates of the prevalence of use of various types of drugs. The standard errors of the estimates were also provided (8:Ch 5, 12). Using the standard errors and the estimates, confidence intervals were constructed. Assuming a large random sample, a 95 percent confidence interval was calculated in a two step process. First, the standard error was divided by the square root of the sample size and multiplied by 1.96. Then, the result of the first step was added to and subtracted from the estimate of the prevalence (or proportion of drug users) to form the confidence interval (21:269). The estimates (and standard errors) of the proportions of USAF personnel that had used various drugs within 30 days and 12 months of completing the 1992 Worldwide Survey are provided in Table 7. Also provided in Table 7 are the 95 percent confidence intervals (CI) for each estimate of proportion in terms of actual numbers of personnel, based on 466,060 personnel on active duty at the end of fiscal year 1992. Finally, Table 7 reflects the fact that drug users may use more than one type of drug and a single individual could have reported in the 1992 Worldwide Survey, the use of many different types of drugs. Thus, the estimated proportion of personnel using marijuana may include personnel also counted as using cocaine.

TABLE 7

ESTIMATES OF PREVALENCE OF DRUG USE BY TYPE OF DRUGS
FOR THE USAF POPULATION

DRUG TYPE	ILLICIT DRUG USE IN THE LAST 30 DAYS		ILLICIT DRUG USE IN THE LAST 12 MONTHS	
	PERCENT	95 % C. I.	PERCENT	95 % C. I.
Marijuana	0.3 (0.1)	1,385 - 1,411	0.8 (0.1)	3,716 - 3,741
Cocaine	0.1 (0.0)	466	0.2 (0.1)	919 - 945
PCP	0.1 (0.1)	453 - 479	0.1 (0.1)	453 - 479
LSD/Hallucinogens	0.1 (0.1)	453 - 479	0.2 (0.1)	919 - 945
Amphetamines/Stimulants	0.2 (0.1)	919 - 945	0.2 (0.1)	919 - 945
Tranquilizers	0.2 (0.1)	919 - 945	0.3 (0.1)	1,385 - 1,411
Barbiturates/Sedatives	0.1 (0.1)	453 - 479	0.1 (0.1)	453 - 479
Heroin/Other Opiates	0.1 (0.0)	466	0.1 (0.0)	466
Analgesics	0.7 (0.2)	3,237 - 3,288	1.0 (0.2)	4,635 - 4,686
Inhalants	0.2 (0.1)	919 - 945	0.2 (0.1)	919 - 945
Designer Drugs	0.1 (0.1)	453 - 479	0.1 (0.1)	453 - 479
Anabolic Steroids	0.2 (0.1)	919 - 945	0.2 (0.1)	919 - 945
Any Drug (except Steroids)	1.2 (0.2)	5,567 - 5,619	2.3 (0.3)	10,681 - 10,758

(8:Ch 5, 12)

In fiscal year 1992, urine specimens collected for the USAF Drug Testing Program were tested for the following drugs: Cannabis (Marijuana), Cocaine, Amphetamine, Barbiturates, PCP, Opiates, LSD, and Methamphetamines. Of the 569,041 tests performed on 196,476 specimens, only 20 tests were performed to detect drugs different

from those listed above (40). Since the eight drugs listed previously represent the overwhelming majority of the drug tests performed, they were the focus of the evaluation comparing urinalysis and hair testing provided next. The number of tests, positive tests, specimens and positive specimens for fiscal year 1992 drug testing is provided in Table 8 and Appendix C.

TABLE 8

FISCAL YEAR 1992 DRUG TESTING PROGRAM RESULTS

DRUG	NUMBER OF TESTS	POSITIVE TESTS
Cannabis (Marijuana)	191,254	320
Cocaine	180,339	242
Barbiturates	50,756	31
Amphetamine	40,823	23
PCP	34,115	1
Opiates	31,890	101
LSD	29,879	0
Methamphetamines	9,965	0
Other drugs	20	2
TOTAL	569,041	720
SPECIMENS TESTED	196,476	696

(40)

Drug Users Detected. The methodology to evaluate the effect on the number of drug users detected by a modified program using hair testing focuses on the detection capability of the two test methods. The selection process to choose personnel to be tested was

assumed to be the same for either test method and thus a negligible portion of the process for this evaluation. Four steps were used to evaluate the difference in effectiveness between hair testing and urinalysis. In each step, only the drug types commonly used by USAF personnel, as reported in the 1992 Statistical Summary and the 1992 Worldwide Survey, were considered.

In the first step of the evaluation, the researchers attempted to determine the types of drugs that can be detected by urinalysis, but not hair testing. The researchers found urinalysis and hair testing can detect similar drugs because both testing methods use similar assay techniques (25:266). However, of the few research papers dealing with marijuana, two indicated hair testing is less effective than random urinalysis in detecting infrequent marijuana use (5:8; 42:3). Hair testing may be less able to detect marijuana because marijuana tends to bond with fat cells in the body, while hair is largely a protein matrix (53:83; 49:26). Also, the researchers failed to locate any research demonstrating the ability of hair testing to detect LSD. However, urinalysis is also a poor detector of LSD because the drug does not remain in the system at detectable levels for more that 12 to 24 hours (50). The data in Table 8 shows no positive tests in 29,879 urinalysis tests for LSD and the 1992 Statistical Summary reported only 25 cases of LSD abuse (2:9) which suggests urinalysis is a poor detector of LSD. For these reasons, the researchers found urinalysis was better than hair testing in detecting casual marijuana use. In fiscal year 1992, the urinalysis program found 320 specimens positive for marijuana while the 1992 Statistical Summary reported 278 cases of marijuana abuse (40; 2:9). The estimated number of USAF personnel using marijuana was calculated by multiplying the estimated proportion of users provided in Table 7 by the number of USAF active-duty personnel at the end of fiscal year 1992. For this step, the researchers found urinalysis could potentially detect approximately 1,398 monthly users of marijuana that hair testing could

not detect because the researchers assume the overwhelming majority of drug users are casual drug users based on the 1992 Worldwide Survey results (8:Ch 5, 17).

In the second step of the evaluation, the researchers attempted to determine the types of drugs that can be detected by hair testing, but not urinalysis. Because hair testing and urinalysis both use assay techniques, both detect similar drugs within the constraints imposed by the specimen used. The researchers found no drugs commonly used by USAF personnel that were detectable by hair testing, but not urinalysis.

In the third step, the researchers examined the windows of detection for urinalysis and hair testing to determine those drugs that have similar windows of detection for either test method. The window of detection for hair testing is about one month for each one half inch of hair (25:266). No urinalysis windows of detection, except for marijuana, were close to the hair testing window of detection. Urinalysis windows of detection are discussed completely in the next paragraph.

In the fourth step, the researchers determined the urinalysis and hair testing windows of detection for drugs commonly used by USAF personnel. As previously mentioned, the hair testing window of detection depends of the length of the hair; one half inch equates to about one month. With urinalysis, the window of detection depends on the drug. Table 9 provides estimates of some windows of detection for urinalysis.

TABLE 9

URINALYSIS WINDOWS OF DETECTION

DRUG	WINDOW OF DETECTION
Marijuana	5 - 10 days (moderate use)
Cocaine	3 - 4 days
Barbiturates	2 - 4 days
Amphetamines	2 - 4 days
PCP	3 days
Opiates	2 - 3 days
LSD	12 - 24 hours
Methamphetamines	2 - 4 days

(25:273-4; 32:176-177; 31:87-92)

Next, the researchers determined the monthly probabilities of detection based on the windows of detection and the assumed best and worst cases for frequency of drug use. Since the researchers assume testing is equally likely on any day, the probability of selection within the window of detection following a single drug use is the window size in number of days divided by the time period of consideration, 30 days. For the case of three instances of drug use, the probability of selection is the sum of the number of the days in each window of detection, less any days of overlap, divided by 30 days. Table 10 provides the probabilities of detection for urinalysis using the upper limits of the estimated windows of detection from Table 9 and excludes those drugs already discussed, LSD and marijuana.

TABLE 10

URINALYSIS PROBABILITIES OF DETECTION

DRUG	PROBABILITIES OF DETECTION	
	DETECTION BEST CASE (3 instances of drug use)	DETECTION WORST CASE (1 instance of drug use)
Cocaine	12/30	4/30
Barbiturates	12/30	4/30
Amphetamines	12/30	4/30
Methamphetamines	12/30	4/30
PCP	9/30	3/30
Opiates	9/30	3/30

For hair testing, the window of detection for all the drugs in Table 10 is one month for a one half inch hair specimen. The probability of detection then is 1.0, or 30/30, for hair testing. Use of hair testing would at least double the probability of the best case detection of personnel using the drugs listed in Table 10. In the worst case situation, hair testing improves the probability of detecting the users 7 to 10 times the probability of detection using urinalysis. In fiscal year 1992, there were 398 positive urinalysis tests and at least 174 cases of drug abuse reported in the 1992 Statistical Summary for the six drugs listed in Table 10 (40; 2:9). There may be more cases of abuse of these six drugs, but 85 of the cases are grouped in a single category called "Other," which includes barbiturates, opiates, PCP, and stimulants (2:9). Using Table 7, the researchers found an estimate of the number of personnel using the drugs listed in Table 10 by summing the expected number of users for each drug for the "past 30 days" and "past 12 months" categories. Estimates

of the number of personnel using the drugs listed in Table 10 in the last 30 days and in the last 12 months are 2,796 and 3,262 respectively.

In summary, urinalysis appears better able to detect the casual or infrequent user of marijuana than hair testing. From Table 7, the estimated numbers of USAF personnel that have used marijuana within the last 30 days and the last 12 months are 1,400 and 3,725 respectively. The 1992 Statistical Summary reported 278 cases of marijuana abuse (2:9). Hair testing appears to be much more capable of detecting the six drugs listed in Table 10. From Table 7, the estimated numbers of USAF personnel that have used these six drugs within the last 30 days and the last 12 months are 2,796 and 3,262 respectively. However, the 1992 Statistical Summary reported only 174 cases of abuse of the six drugs in Table 10 (2:9).

Cost Impact. The true cost impact of adopting hair testing was very difficult to assess because of the lack of detailed cost data for hair testing and urinalysis. One of the two known laboratories conducting hair testing reported charging approximately $50 to test a specimen for five drugs (43:242). The other laboratory charges approximately $100 to test a specimen for four drugs (50). These figures include facilities, utilities, and equipment costs and supplies. They do not cover the costs in the personnel element of the cost formula. On the other hand, it costs the USAF $83 to test a urine specimen (45:Atch 1). This cost includes the personnel element, but not include facilities, utilities, and equipment costs. Nevertheless, evaluating the impact of the change on specific cost elements provides some idea of what we could expect to happen to total cost. We started our evaluation with the test element.

One of the few differences between hair testing and urinalysis is that the laboratory techniques for hair testing are significantly more labor intensive than urinalysis. In the laboratory, urinalysis is a highly automated process (50). The higher laboratory labor utilization for hair testing increases the test element costs.

Of the six factors that contribute to the personnel cost element, three would be affected: time away from job, processing time, and supplies and administration. The researchers speculate that the costs associated with time away from the job would decrease because there would no longer be a need to wait until the body was ready to produce a urine sample. This is especially true for those people who have difficulty urinating while someone watches them. Also, the time delay caused by an individual not producing a large enough specimen would be eliminated. Processing time, or the time required for collection administration, could increase if the administrator also took on the task of collecting the specimens, i.e., clipping the hair. However, allowing the administrator to collect the specimens would also result in a decrease in observer costs. The third cost factor affected would be supplies and administration. Because hair is easier to collect and handle, and because it weighs less and takes up less space than urine, shipping costs should be much lower. Costs not covered in the cost formula are discussed next.

One of the largest cost impacts not covered in the cost formula is training. Laboratory technicians would have to be trained on new test procedures and specimen collectors would also need training on the proper techniques for clipping hair samples. In addition to training, there would be a large administrative cost associated with adopting new policies and procedures for testing. New policies, regulations, and instructions would have to written and distributed throughout the USAF. Finally, we would see a rise in the cost of laboratory equipment, because equipment needed for hair testing that is not already being used for urinalysis, would need to be purchased (50).

Legal Issues. Most of the lawyers interviewed as part of this research were not very familiar with the latest developments in hair testing, though all had at least heard something about it. Based on their knowledge of hair testing, they generally agreed that hair testing was not ready for widespread use in the USAF (13; 23; 33; 55). Specific

concerns were related to the reliability of hair testing and its infancy in the courts. Reliability concerns stemmed from unresolved issues in the scientific community on what constitutes a positive test, and the impacts of environmental contamination. Until there is greater agreement in the scientific community on what the appropriate cut off levels are for various drugs, and well established procedures for ruling out the possibility of environmental contamination, Lieutenant Colonel Fahey and Major Coacher both felt that the results of a hair test should not be used as primary evidence. However, they noted that the results of a hair test had been use in at least one USAF case as corroborative evidence (23; 13). An overriding concern was that hair testing had not been tested in the courts to the extent that urinalysis has (23; 33). Captain Kinlin believed that if the USAF were to adopt hair testing, cases involving hair testing would be subject to many of the same kinds of challenges raised in the early days of urinalysis, including chain of custody and accuracy. And if adopted now, it could take another 10 to 15 years to re-build the USAF Drug Testing Program's credibility (33).

Summary

The comparison of the survey-based estimate and random urinalysis-based estimate of the population proportion of drug users demonstrated the potential for improving the USAF Drug Testing Program. With that accomplished, the researchers evaluated the four potential modifications defined in the four research questions. Each potential modification was assessed for the expected change in the number of drug users detected or the probability of detecting drug users. In addition, the researchers determined the cost of each potential modification for comparison to the current USAF Drug Testing Program. Finally, the legal issues associated with implementing each potential modification were determined and documented.

V. Conclusions and Recommendations

This chapter provides the researchers' conclusions and recommendations after examining each research question. In the first section of the chapter, the significant advantages and disadvantages of each potential modification defined by the research questions are discussed in terms of the number of users detected, cost impacts and legal issues. The second section of this chapter provides four recommendations based on the research effort. The recommendations identify efforts that should aid the advancement of hair testing and enhance the effectiveness and management of the USAF Drug Testing Program.

Conclusions

More drug users are detected when random urinalysis is increased; however, the percentage of total users detected remains low. For research question 1, the researchers investigated the effects of increasing the amount of random urinalysis testing performed annually. In fiscal year 1992, only 195 drug users out of the estimated 10,000 drug users in the USAF were identified through random urinalysis. When random urinalysis increases from 40.7 percent to 60 percent of the USAF population tested annually, the number of drug users detected annually should increase to approximately 288 drug users detected. If the amount of random urinalysis testing were increased from 60 to 100 percent of the USAF population, the number of drug users detected should increase to approximately 479 drug users detected. These increased numbers of drug users detected, 288 and 479, represent 2.9 and 4.8 percent of the estimated population of drug users in the USAF. With each increase in the amount of random urinalysis testing, there is

a proportional increase in annual cost of the USAF Drug Testing Program. The annual costs are expected to increase at least 7.5 million dollars when random urinalysis testing increases from 40.7 to 60 percent of the USAF population. Increasing the amount of testing from 60 to 100 percent of the USAF population would cause annual costs to increase by at least 15.4 million dollars. Since neither the method of selecting personnel to be tested nor the method of testing would change this potential modification to the program, there are no legal issues associated with increasing the amount of random urinalysis performed.

More drug users would be detected if the percentage of commander-directed testing were increased; however, the percentage of total users detected remains low. If the level of commander-directed testing were increased from the present 2.41 percent to five percent of the total random urinalysis and commander-directed testing performed, the total number of drug users detected annually by the two tests should increase above the fiscal year 1992 results by about 40 personnel, to a total of about 270. If the level of commander-directed testing were to increase a substantial amount, from 2.41 percent to ten percent, the total number of drug users detected by random urinalysis and commander-directed testing should increase from about 230 personnel to about 340 personnel. These increased numbers of drug users detected, 270 and 340, represent only 2.7 and 3.4 percent of the population of drug users in the USAF. Because this modification does not increase the total number of tests, the financial costs associated with implementing the modification are small. The primary cost would be associated with developing a block of training for inclusion in all USAF supervisory courses to teach supervisors to be aware of drug abuse and its symptoms. An alternative, less costly, and perhaps more effective approach to increasing the proportion of commander-directed tests would be to establish a policy requiring all personnel in alcohol abuse programs take a monthly, commander-directed drug test (46). Researchers have found that "alcohol dependence and abuse are often

associated with use and abuse of other psychoactive drugs, including cannabis, heron, amphetamines and various sedatives and hypnotics" (4:173). This potential modification would change the method of selecting personnel for testing, in a manner that causes concern in the legal community. The principle concern is that the loss of the ability to punish drug users would decrease the deterrence value of the program because no punitive actions may be taken against the drug user ordered (forced) to provide an incriminating specimen. The only recourse available to the commander is to place the identified user in a rehabilitation program or to give the individual an honorable discharge. These non-punitive options would provide little awareness in the USAF population that another drug user had been apprehended and dealt with in manner to discourage others from using drugs.

More drug users could be detected by using weighted random selection, but not a significant number. Employing either weighted random selection technique to select personnel from groups most likely to use drugs gives drug users a greater chance of being selected for random urinalysis. If the survey-based technique had been used in fiscal year 1992, an additional 50 drug users might have been detected by random urinalysis, bringing the total number of drug users detected to 245. The identification-based technique might have resulted in an additional 75 drug users or a total of 270 drug users being detected in fiscal year 1992. These increased numbers of drug users detected, 245 and 270, represent 2.5 and 2.7 percent of the population of drug users in the USAF.

With either technique, the groups with the highest historical prevalence of drug use, generally the most junior personnel, would be tested most frequently. This would lead to some savings in personnel cost because fewer senior noncommissioned officers (NCOs) and officers would spend time away from their primary jobs for drug testing. This cost savings would probably be offset by the cost of developing and maintaining a software program to randomly select personnel according to the weighting assigned to each rank

stratum. The weights would be based on the survey results or the previous year's tests results and could be written in read only code. Each year or after each survey, new floppy disks could be distributed to each base with new weights assigned to each rank stratum. This process would allow the USAF to take advantage of benefits of weighted sampling while simultaneously ensuring that the same weights are applied throughout the USAF and that the weighs are based on survey or test data. The software program could be developed in-house, for example by an AFIT graduate student studying computer science, or a software engineer at the Computer Systems at Gunter AFB, for a relative small amount of money. The cost of developing a weighted random selection software program and the administrative cost of distributing it throughout the USAF would increase the program's total cost though perhaps not enough to offset the decrease in cost associated with lower personnel cost.

More significant is the non-quantifiable cost of the anticipated loss of morale in the junior enlisted members where the bulk of random testing would occur. Historical evidence of the highest prevalence of drug use may not satisfy the members of the junior rank strata that the weighted random selection techniques are fair. Fairness is also a major concern for the legal community. Although the majority agreed that weighted random selection techniques could be used if the weightings had a rational basis, there was also agreement that the fairness of the techniques would be challenged in the courts.

Hair testing greatly increases the probability of detecting many drug users. Hair testing provides at least twice and up ten times the urinalysis probability of detection for the estimated 2,800 to 3,200 users of cocaine, barbiturates, amphetamines, methamphetamines, PCP, and opiates. However, urinalysis provides better detection of the estimated 1,400 to 3,700 casual marijuana users in the USAF. Neither test technique provides good detection of infrequent LSD use. Because hair testing has not been widely used for drug testing programs, hair testing does not provide the benefits of economies of

scale or the more than 20 years of experience provided by urinalysis. Some assays and automatic laboratory equipment for detecting drugs are available for urine testing, but not hair testing. Because current hair testing laboratory techniques are very labor intensive, hair testing appears too expensive to implement in place of urinalysis in the USAF Drug Testing Program. In addition, the debate in the scientific community over several aspects of hair testing technology has influenced the USAF legal community to believe that if hair testing were used as the primary evidence of drug abuse, the legal challenges mounted by identified drug users would diminish the current credibility of the USAF Drug Testing Program.

Summary of Conclusions. The USAF Drug Testing Program is an effective deterrent despite the fact that this research indicates the program detects less than 2.9 percent of the estimated 10,000 drug users in the service. This study examined four modifications to the current program aimed at increasing the program's effectiveness by increasing the number of users detected. Three of the potential modifications; increasing the amount of random testing; increasing the proportion of commander-directed tests; and using weighted random selection techniques based on the historical prevalence of use by rank strata, could result in more drug users being detected. However, none of the modifications significantly increases the percentage of the total users detected. In addition, each modification comes with some added cost.

Increasing the level of random testing from 40.7 to 100 percent of the USAF population, causes an increase in cost of over $23 million and results in only 284 additional drug users detected. Increasing the proportion of commander-directed tests would likely cost the USAF decreased deterrence because punitive measures would be prohibited for a greater portion of the identified drug users. Weighted random selection techniques would most likely cause a loss in morale among junior enlisted members and be challenged in courts.

The fourth modification, adopting hair testing instead of urinalysis, significantly increases the probability of detecting many drug users. However, there are several reasons hair testing is not currently suitable to replace urinalysis. First, hair testing cannot currently detect casual marijuana use. Also, hair testing is an expensive laboratory procedure relative to urinalysis. Finally, the scientific community has not fully resolved the issue of exogenous contamination. For these reasons, hair testing is not a viable option for widespread use in the USAF today.

Recommendations

Use Hair Testing to Corroborate Positive Urinalysis Specimens. Using hair testing to corroborate the positive urinalysis results of the USAF Drug Testing Program would serve two purposes. First, hair testing could provide, information not available from urinalysis results, to the commanders of the identified drug users. The information provided by hair testing would be an indication of the amount and frequency of drug use over a period of several weeks up to three months The second purpose of using hair testing to corroborate positive urinalysis results would be to facilitate the continued development of hair testing methodology. The large windows of detection provided by hair testing offers significant increases in the probability of detection for many drugs. With additional research, more sensitive assay techniques may be developed for hair testing of marijuana like they were for urinalysis in the 1970's. Also, continued interest in hair testing may stimulate the development of the automated laboratory equipment necessary to reduce the unit costs of hair testing. The cost to implement this recommendation should be minimal. The commercial laboratory cost to corroborate the 696 positive test specimens in fiscal year 1992 is estimated at less than $100,000.

Use Survey Results to Tailor the Drug Testing Program. In fiscal year 1992, the USAF Drug Testing Program performed over 500,000 individual drug tests on almost 200,000 specimens to detect the estimated 10,000 drug users in the USAF. However, according to the USAF Military Personnel Center, random urinalysis was the primary means of detection for only 195 drug users (56). If random urinalysis tested for different drugs, it might detect more drug users. The USAF Drug Testing Program most frequently tests specimens for the eight drugs listed in Table 8. In order of the frequency of testing, they are marijuana, cocaine, barbiturates, amphetamine, PCP, opiates, LSD, and methamphetamines. According to the best source of information on undetected drug users, the 1992 Worldwide Survey, the most frequently abused drugs are analgesics, followed by marijuana, tranquilizers, amphetamines/stimulants, inhalants, and anabolic steroids. (The specific drugs included in each category are defined by the survey included in Appendix A.) The 1992 Worldwide Survey estimated that over 4,800 USAF personnel had abused analgesics in the 12 months prior to the survey, almost 1,000 more than had used marijuana. Although the USAF Drug Testing Program is capable of detecting some of the analgesics, e.g., Darvon, Demerol and Codeine, these tests are not routinely performed.

In fiscal year 1992, the USAF Drug Testing Program tested almost 30,000 specimens for LSD, with no positive test results. No positive results from 30,000 tests can partially be explained by the very narrow, 24 hours or less, window of detection for LSD. Another explanation is the limited number of USAF personnel using LSD. The 1992 Worldwide Survey estimated that less than 1,000 personnel had used LSD within the previous 12 months. If the level of testing for various drugs were assigned according to the survey results, there would have been far fewer tests for LSD and many more tests for analgesics. The researchers recommend the personnel responsible for the USAF Drug Testing Program use the estimates of the prevalence of drug use in the 1992 Worldwide Survey to

tailor the program to test for the drugs that are reported as being most frequently abused. Since some survey categories, e.g., the analgesics category, include several different drugs, the researchers recommend the next DOD worldwide survey of substance abuse be modified to differentiate between the drugs in the categories. This would allow the USAF Drug Testing Program to be further tailored to the self-reported preferences of the USAF drug user.

Develop A Good Estimate of the Total Costs of Drug Testing. The USAF should conduct a study to determine a good estimate of the total cost of the USAF Drug Testing Program. As previously noted, the researchers relied almost exclusively on a rough order of magnitude cost estimate prepared by the Social Actions Office at Wright-Patterson AFB (WPAFB) to estimate the financial cost of testing because a search for drug testing cost estimates at Office of the Secretary of Defense, Headquarters USAF, Headquarters Military Personnel Center and 12 Social Actions Offices at bases assigned to three Major Commands revealed that very little cost data existed. In fact the only cost estimate, besides the one performed by the WPAFB Social Actions Office, the researchers were able to find was an estimate of the laboratory cost per specimen tested, and it did not include all of the laboratory costs. A reliable, rough order of magnitude cost estimate is needed because it shows the financial impact of policy decisions involving drug testing. In this era of reduced budgets, the USAF can no longer afford to assume that benefits of testing always outweigh the costs. Without a reliable estimate, we could easily wind up spending millions of dollars in testing that does not significantly increase the deterrence provided by the program or significantly increase the percentage of drug users detected. An analogy in the defense acquisition business is spending 90 percent of a budget to achieve the last ten percent of performance when the 90 percent level of performance may be sufficient to accomplish the mission.

Determine the Deterrence Provided by the USAF Drug Testing Program. In order to fully assess the effectiveness of the USAF Drug Testing Program and to properly manage the program, two pieces of information appear essential. The first is a good estimate of the total cost of the program which the researchers recommend be determined. The second is the level of deterrence provided by the program. It is naive to assume that every specimen that tests negative represents a member deterred from using drugs. There are several reasons for drug users not testing positive which have already been discussed in this thesis. In addition, the 1992 Worldwide Survey estimates that 86.3 percent of the USAF population would not use drugs even if there were no testing (8:Ch 9, 24). Since at least 2.3 percent of the USAF population (the self-reported drug users) are not deterred from abusing drugs, the true percentage of USAF personnel deterred by the USAF Drug Testing Program may be less than 12 percent. While some people may be deterred when personnel who would not use drugs are tested, it may be possible that the number of tests conducted could be reduced without a negative effect on deterrence. The researchers recommend additional research be conducted to determine the current level of deterrence provided by the program and how the level of deterrence is affected by changes in the level of testing, number of drug users prosecuted, and other factors specific to the current methods of selection and testing. Once a good estimate of the total cost and deterrence of the USAF Drug Testing Program are determined, a thorough analysis of the effectiveness of the program, and any potential modifications, could be accomplished. In addition, the program could be managed more effectively and efficiently.

Appendix A:

RCS #DD-HA(AR)1785

1992 DEPARTMENT OF DEFENSE SURVEY OF SUBSTANCE ABUSE AND HEALTH BEHAVIORS AMONG MILITARY PERSONNEL

HEALTH AFFAIRS

INTRODUCTION

Who are we? We are from Research Triangle Institute, a not-for-profit research company under contract to the Assistant Secretary of Defense—Health Affairs.

How were you selected? You were randomly selected to participate in this important survey.

Must you participate? Your participation in this survey is voluntary. We encourage you to answer all of the questions honestly, but you are not required to answer any question to which you object.

What are the questions about? Mainly about alcohol and drug abuse. There are a few other questions about tobacco use, health attitudes and behavior, and gambling behavior.

Who will see your answers? Only civilian researchers. No military personnel will see your answers. Your answers will be combined with those from other military personnel to prepare a statistical report. This questionnaire will be anonymous if you DO NOT WRITE YOUR NAME OR SOCIAL SECURITY NUMBER ANYWHERE ON THIS BOOKLET.

INSTRUCTIONS FOR COMPLETING THE QUESTIONNAIRE

- Most questions provide a set of answers. Read all the printed answers before marking your choice. If none of the printed answers exactly applies to you, mark the circle for the one answer that best fits your situation.

- Use only the pencil you were given.
- Make heavy black marks that fill the circle for your answer.

CORRECT MARK ● INCORRECT MARKS ⊘ ⊗ ◐ ◭

- Erase cleanly any answer you wish to change.
- Do not make stray marks of any kind anywhere in this booklet.
- For many questions, you should mark only one circle for your answer in the column below the question, as shown here:

EXAMPLE: How would you describe your health?

- ○ Excellent
- ● Good
- ○ Fair
- ○ Poor

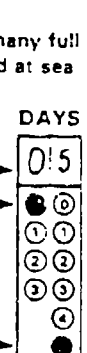
- If you are asked to give numbers for your answer, please complete the grid as shown below.

EXAMPLE: During the past 30 days, how many full 24-hour days were you deployed at sea or in the field?

- *First, write your answer in the boxes. Use both boxes. Write ONE number in each box.*
- *Always write the last number in the right-hand box. Fill in any unused boxes with zeros.*

For example, an answer of "5 days" would be written as "05."

- *Then, darken the matching circle below each box.*



- Sometimes you will be asked to *"Darken one circle on each line."* For these questions, record an answer for each part of the question, as shown here:

EXAMPLE: How often do you do each of the following?

(Darken one circle on each line)	Often	Sometimes	Never
Swim	●	○	○
Bowl	○	○	●
Play tennis	○	●	○

NOW PLEASE TURN THE PAGE AND BEGIN WITH QUESTION 1.

60. The following list includes some of the reasons people give for smoking cigarettes. Please tell us how important each reason is to you, for your smoking.

(Darken one circle on each line)	Very Important	Fairly Important	Slightly Important	Not at All Important	Don't Smoke
To fit in with the group					
To help me relax					
To keep my weight down					
To show that I'm "cool"					
To show that I'm tough					
To look and feel like an adult					
To help me when I'm bored					
To help me concentrate					
To satisfy a craving					
To help me handle stress					
For the taste					
For the enjoyment of it					

61. Please indicate how much you agree or disagree with each of the following statements.

(Darken one circle on each line)	Strongly Agree	Agree	Disagree	Strongly Disagree	Don't Know/No Opinion
Smoking will harm my health or physical fitness					
The number of places to buy cigarettes at this installation makes it easy to smoke					
Disciplinary action will be taken against any person violating my Service's tobacco use policy					
Use of tobacco is against my religious beliefs					
There are times at work when I could use a cigarette					
Most of my friends smoke					
Smoking is part of being in the military					
My spouse or the person I date disapproves of my smoking (or would disapprove if I did smoke)					
I don't like being around people when they're smoking					
Smoking is a good way to relieve tension					
Being around people who are smoking will harm my health					

The following question refers to the use of anabolic steroids. Anabolic steroids are sometimes prescribed by doctors to promote healing from certain types of injuries. Some athletes, and others, use them to try to increase muscle development.

62. How important has each of the following reasons been for your using anabolic steroids on your own, that is, without a doctor's orders?

(Darken one circle on each line)	Very Important	Fairly Important	Slightly Important	Not at All Important	Don't Use Steroids
To speed up my recovery from an injury					
To help prevent injury					
To improve my athletic performance					
To improve my physical appearance, such as to "bulk up"					
To make me more aggressive					
To make me stronger					

The next set of questions is about use of drugs for non-medical purposes. First, we list the types of drugs we are interested in, along with some of their most common trade and clinical names.

DRUG TYPES	COMMON TRADE/CLINICAL NAMES
Marijuana or Hashish	Cannabis, THC
PCP (alone or combined with other drugs)	Phencyclidine (PCP)
LSD and Other Hallucinogens	LSD, Mescaline, Peyote, DMT, Psilocybin
Cocaine	Cocaine (including "crack")
Amphetamines, Methamphetamines, and Other Stimulants	Ice, crystal meth, Preludin, Benzedrine, Biphetamine, Cylert, Desoxyn, Dextroamphetamine, Dexamyl, Dexedrine, Didrex, Eskatrol, Ionamin, Methedrine, Obedrin-LA, Plegine, Pondimin, Pre-Sate, Ritalin, Sanorex, Tenuate, Tepanil, Voranil
Tranquilizers and Other Depressants	Ativan, Meprobamate, Librium, Valium, Atarax, Benadryl, Equanil, Libritabs, Meprospan, Miltown, Serax, SK-Lygen, Thorazine, Tranxene, Verstran, Vistaril, Xanax
Barbiturates and Other Sedatives	Seconal, Alurate, Amobarbital, Amytal, Buticaps, Butisol, Carbrital, Dalmane, Doriden, Eskabarb, Luminal, Mebaral, Methaqualone, Nembutal, Noctec, Noludar, Optimil, Parest, Pentobarbital, Phenobarbital, Placidyl, Quaalude, Secobarbital, Sopor, Tuinal
Heroin and Other Opiates	Heroin, Morphine, Opium
Analgesics and Other Narcotics	Darvon, Demerol, Percodan, Tylenol with codeine, codeine, cough syrups with codeine, Dilaudid, Dolene, Dolophine, Leritine, Levo-Dromoran, Methadone, Propoxyphene, SK-65, Talwin
Inhalants	Lighter fluids, aerosol sprays like Pam, glue, toluene, amyl nitrite, gasoline, poppers, locker room odorizers, spray paints, paint thinner, halothane, ether or other anesthetics, nitrous oxide ("laughing gas"), correction fluids, cleaning fluids, degreasers
"Designer" drugs	These drugs, with names like "Ecstasy," "Adam," "Eve," are made by combining two or more, often legal, drugs or chemicals to produce drugs specifically for their mood-altering or psychoactive effects
Anabolic Steroids	Testosterone, Methyltestosterone, or other drugs taken to improve physical strength

Although some of the drugs listed above may be prescribed for medical reasons, the questions that follow refer to use of these drugs *for non-medical purposes*. By *non-medical purposes*, we mean *any use of these drugs on your own* — that is, either without a doctor's prescription,

- or in greater amounts or more often than prescribed,
- or for any reasons other than a doctor said you should take them, such as to get high, for thrills or kicks, to relax, to give insight, for pleasure, or curiosity about the drug's effect.

Please take your time and answer the questions as accurately as possible. Remember, *NO ONE will ever link your answers with your identity.*

63. During the past 30 days, on about how many days did you use each of the following drugs for non-medical purposes?

(Darken one circle on each line)	28-30 Days	20-27 Days	11-19 Days	4-10 Days	1-3 Days	Never in Past 30 Days
Marijuana or hashish	○	○	○	○	○	○
PCP	○	○	○	○	○	○
LSD or other hallucinogens	○	○	○	○	○	○
Cocaine	○	○	○	○	○	○
Amphetamines or other stimulants	○	○	○	○	○	○
Tranquilizers or other depressants	○	○	○	○	○	○
Barbiturates or other sedatives	○	○	○	○	○	○
Heroin or other opiates	○	○	○	○	○	○
Analgesics or other narcotics	○	○	○	○	○	○
Inhalants	○	○	○	○	○	○
"Designer" drugs ("Ecstasy," etc.)	○	○	○	○	○	○
Anabolic steroids	○	○	○	○	○	○

64. The following statements describe some things connected with using drugs that affect people [illegible]. Please indicate on how many work days in the past 12 months these things ever happened to you.

(Darken one circle on each line)	NUMBER OF WORKS DAYS IN PAST 12 MONTHS								
	40 or More	21-39	12-20	7-11	4-6	3	2	1	None / Don't Use Drugs
I was late for work or left work early because of my drug use	○	○	○	○	○	○	○	○	○
I was hurt in an on-the-job accident because of my drug use	○	○	○	○	○	○	○	○	○
I worked below my normal level of performance because of my drug use	○	○	○	○	○	○	○	○	○
I did not come to work at all because of the aftereffects, an illness, or a personal accident caused by my drug use	○	○	○	○	○	○	○	○	○
I was "high" or "strung out" while working because of my drug use	○	○	○	○	○	○	○	○	○
I was called in during off-duty hours and reported to work feeling "high" or "strung out" from my drug use	○	○	○	○	○	○	○	○	○

65. Please indicate how much you agree or disagree with each of the following statements.

(Darken one circle on each line)	Strongly Agree	Agree	Disagree	Strongly Disagree	Don't Know/No Opinion
At parties or social functions at this installation, it's easy to get away with using drugs	○	○	○	○	○
There's always a party somewhere at or near this installation where drugs are being used	○	○	○	○	○
Education about drugs at this installation helps keep people from using drugs	○	○	○	○	○
The personnel at this installation sincerely try to help people who have a drug problem	○	○	○	○	○
Using drugs is just about the only recreation available at this installation	○	○	○	○	○

66. On the average, how often in the past 12 months have you taken each of the following drugs for non-medical purposes?

(Darken one circle on each line)	USED THIS TYPE OF DRUG IN PAST 12 MONTHS								
	Daily	3-6 Days a Week	1-2 Days a Week	25-51 Days Total	12-24 Days Total	6-11 Days Total	3-5 Days Total	1-2 Days Total	Never in Past Year
Marijuana or hashish	○	○	○	○	○	○	○	○	○
PCP	○	○	○	○	○	○	○	○	○
LSD or other hallucinogens	○	○	○	○	○	○	○	○	○
Cocaine	○	○	○	○	○	○	○	○	○
Amphetamines or other stimulants	○	○	○	○	○	○	○	○	○
Tranquilizers or other depressants	○	○	○	○	○	○	○	○	○
Barbiturates or other sedatives	○	○	○	○	○	○	○	○	○
Heroin or other opiates	○	○	○	○	○	○	○	○	○
Analgesics or other narcotics	○	○	○	○	○	○	○	○	○
Inhalants	○	○	○	○	○	○	○	○	○
"Designer" drugs ("Ecstasy," etc.)	○	○	○	○	○	○	○	○	○
Anabolic steroids	○	○	○	○	○	○	○	○	○

67. Here are some statements about things that happen to people while or after using drugs or because of using drugs. How many times in the past 12 months did each of the following happen to you?

(Darken one circle on each line)	NUMBER OF TIMES IN PAST 12 MONTHS				
	3 or More	2	1	Never	Don't Use Drugs
I was arrested for driving under the influence of drugs	○	○	○	○	○
I didn't get promoted because of my use of drugs	○	○	○	○	○
I received UCMJ punishment (Court Martial, Article 15, Captain's Mast, Office Hours) because of my use of drugs	○	○	○	○	○
I had an illness connected with my use of drugs that kept me from duty for a week or longer	○	○	○	○	○
I was arrested for a drug incident not related to driving	○	○	○	○	○
I spent time in jail, stockade, or brig because of my use of drugs	○	○	○	○	○
I was hurt in any kind of accident caused by my use of drugs	○	○	○	○	○
I got into a fight where I hit someone when I was using drugs	○	○	○	○	○
My wife or husband left me because of my use of drugs	○	○	○	○	○
I had to be detoxified because of my use of drugs	○	○	○	○	○
I came up positive on a drug urinalysis test	○	○	○	○	○

68. Please indicate how much you agree or disagree with each of the following statements.

(Darken one circle on each line)	Strongly Agree	Agree	Disagree	Strongly Disagree	Don't Know/No Opinion
The emphasis on detection and discipline in my Service's drug program hurts morale	○	○	○	○	○
Anyone detected using marijuana should be discharged	○	○	○	○	○
I am opposed to personnel in my Service using marijuana:					
At any time anywhere	○	○	○	○	○
Only if it affects their performance	○	○	○	○	○
Some people get away with using certain drugs because the urinalysis tests won't detect those drugs	○	○	○	○	○
The people I associate with off-duty think that I should not use marijuana (or would disapprove if I did use marijuana)	○	○	○	○	○
Some drug users I know stop or cut down their use when they think they may be selected for urinalysis testing	○	○	○	○	○
I would not use drugs even if there were no urinalysis testing	○	○	○	○	○
The military's urinalysis tests for drugs are reliable	○	○	○	○	○
I would be more inclined to use drugs if the military did not have urinalysis testing	○	○	○	○	○
People in my unit would be more inclined to use drugs if the military did not have urinalysis testing	○	○	○	○	○
Disciplinary action will be taken against any person identified as having a drug problem, even if no drugs are found	○	○	○	○	○
Seeking help for a drug problem will damage one's military career	○	○	○	○	○
I might use (more) marijuana if it were easier to get	○	○	○	○	○

69. The statements below are about some other things that happen to people because of using drugs for non-medical purposes. How many times in the past 12 months did each of the following happen to you?

(Darken one circle on each line)	NUMBER OF TIMES IN PAST 12 MONTHS: 3 or More	2	1	Never	Don't Use Drugs
I had trouble on the job because of my use of drugs	○	○	○	○	○
I had heated arguments with family or friends because of my use of drugs	○	○	○	○	○
I was involved in a motor vehicle accident while I was driving after using drugs (regardless of who was responsible)	○	○	○	○	○
I had health problems because of my use of drugs	○	○	○	○	○
I drove unsafely because of my use of drugs	○	○	○	○	○
My using drugs interfered with my family responsibilities	○	○	○	○	○
I had serious money problems because of my use of drugs	○	○	○	○	○
I had trouble with the police (civilian or military) because of my use of drugs	○	○	○	○	○
I found it harder to handle my problems because of my use of drugs	○	○	○	○	○
I got into a loud argument in public because of my use of drugs	○	○	○	○	○
A relative or friend told me that I should cut down on my use of drugs	○	○	○	○	○

70. When did you last use each type of drug listed below for non-medical purposes?

(Darken one circle on each line)	LAST USED THIS TYPE OF DRUG: Today	1-30 Days Ago	5-8 Weeks Ago	2-3 Months Ago	4-6 Months Ago	7-12 Months Ago	More Than 1 Year Ago	Never Used
Marijuana or hashish	○	○	○	○	○	○	○	○
PCP	○	○	○	○	○	○	○	○
LSD or other hallucinogens	○	○	○	○	○	○	○	○
Cocaine	○	○	○	○	○	○	○	○
Amphetamines or other stimulants	○	○	○	○	○	○	○	○
Tranquilizers or other depressants	○	○	○	○	○	○	○	○
Barbiturates or other sedatives	○	○	○	○	○	○	○	○
Heroin or other opiates	○	○	○	○	○	○	○	○
Analgesics or other narcotics	○	○	○	○	○	○	○	○
Inhalants	○	○	○	○	○	○	○	○
"Designer" drugs ("Ecstasy," etc.)	○	○	○	○	○	○	○	○
Anabolic steroids	○	○	○	○	○	○	○	○

71. Which one of these statements best reflects your use of drugs for non-medical purposes while you were serving in the Middle East as part of Operation Desert Shield/Desert Storm?

- ○ My use of drugs increased
- ○ My use of drugs stayed about the same
- ○ My use of drugs decreased
- ○ Did not use drugs before or during service in Operation Desert Shield/Desert Storm
- ○ Did not serve in Operation Desert Shield/Desert Storm

72. Are you now using drugs more, about the same, or less than you did before you served in the Middle East as part of Operation Desert Shield/Desert Storm?

- ○ Using drugs more now
- ○ Using drugs about the same
- ○ Using drugs less now
- ○ Did not use drugs before or during service in Operation Desert Shield/Desert Storm
- ○ Did not serve in Operation Desert Shield/Desert Storm

73. Since you joined the Service, have you received professional counseling or treatment for a drug-related problem from any of the following sources?

(Darken one circle on each line)	Yes	No	Have Had No Problem	Don't Use Drugs
Through a military clinic, hospital, or other military medical facility	○	○	○	○
Through a military drug counseling center or other military drug treatment or rehabilitation program	○	○	○	○
Through a civilian doctor, clinic, hospital, or other civilian medical facility	○	○	○	○
Through a civilian drug counselor, mental health center, or other civilian drug treatment or rehabilitation program	○	○	○	○

74. Please indicate how much you agree or disagree with each of the following statements.

(Darken one circle on each line)	Strongly Agree	Agree	Disagree	Strongly Disagree	Don't Know/No Opinion
Most of my friends use drugs, at least marijuana	○	○	○	○	○
There are some times at work when I could use an "upper"	○	○	○	○	○
Using drugs would interfere with my health or physical fitness	○	○	○	○	○
Using drugs would mess up my mind	○	○	○	○	○
Persons who try to get treatment for drug problems will later experience surprise searches of themselves, their auto, or their quarters	○	○	○	○	○
My spouse or the person I date disapproves of my using drugs (or would disapprove if I did use drugs)	○	○	○	○	○
Persons who want treatment for their drug problems have difficulty getting off-duty to attend counseling sessions	○	○	○	○	○
Using drugs would interfere with my work	○	○	○	○	○
There is no way to get help for a drug problem without one's commander finding out	○	○	○	○	○
I favor being able to use marijuana when I'm off-duty	○	○	○	○	○

The next set of questions deals mainly with your use of health services, your health attitudes, and your health behavior.

75. During the <u>past 12 months</u>, how much stress did you experience <u>at work</u> or while carrying out your military duties?

- ○ A great deal
- ○ A fairly large amount
- ○ Some
- ○ A little
- ○ None at all

76. During the <u>past 12 months</u>, how much stress did you experience <u>in your family life</u> or in a relationship with a person you live with or date seriously?

- ○ A great deal
- ○ A fairly large amount
- ○ Some
- ○ A little
- ○ None at all

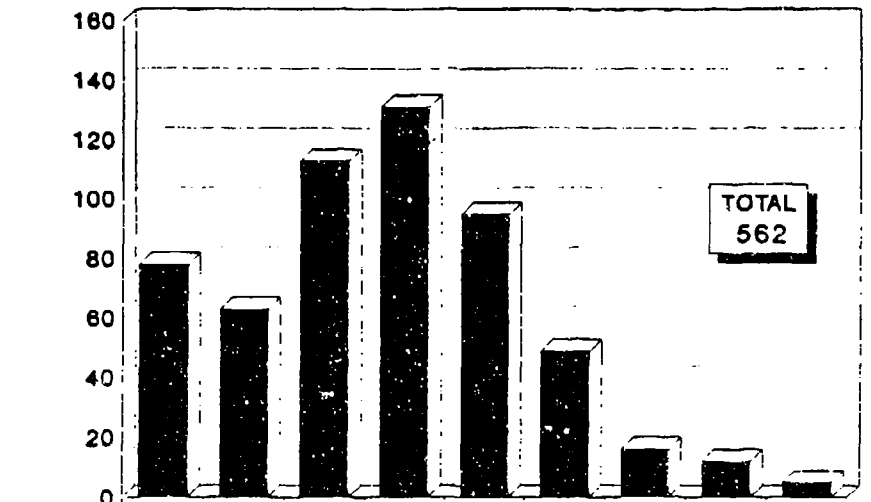
Appendix B:

Statistical Summary
Fiscal Year 1992

United States Air Force
Social Actions Program

OPR: HQ AFMPC/DPMYS, Social Actions Operations Division

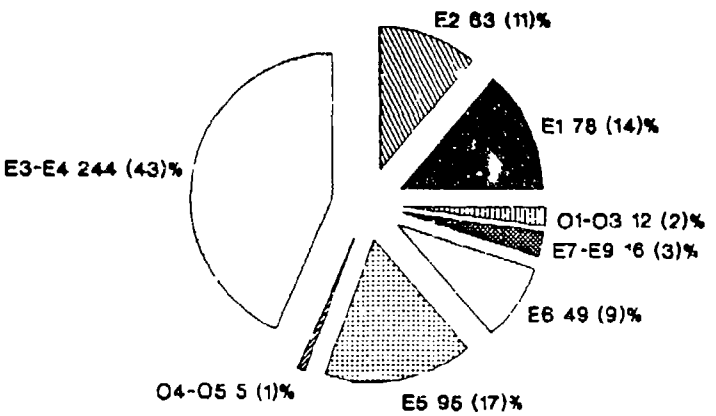
DRUG IDs BY GRADE - FY92



- Most identifications to the SART Program for drug evaluations were enlisted personnel in the grades of E3 and E4.

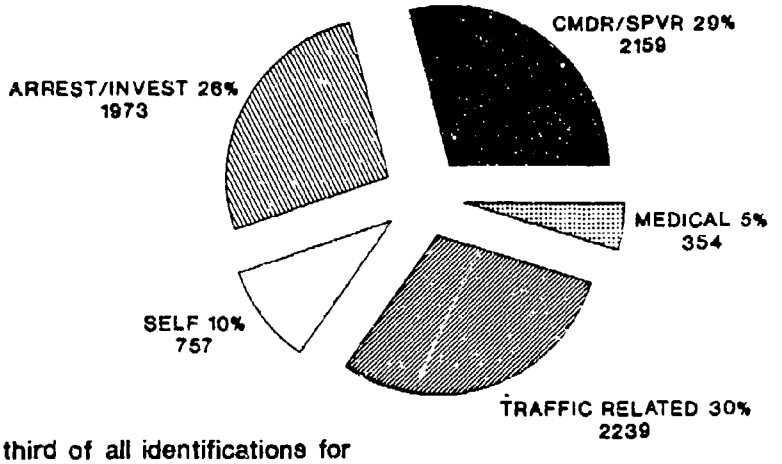
- E3s and E4s make up 25 percent of the total Air Force population and were 43 percent of the drug identifications.

DRUG ABUSE IDs - FY92
GRADES BY PERCENT OF TOTAL



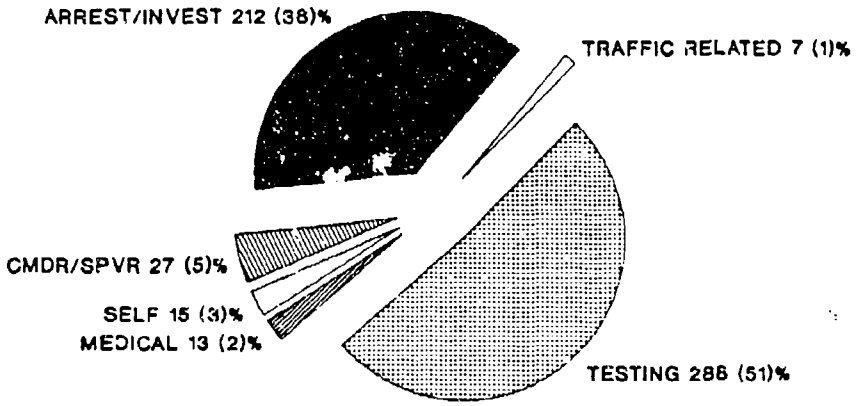
SUBSTANCE ABUSE SOURCES - FY92

ALCOHOL ABUSE



- About one third of all identifications for alcohol abuse were due to traffic-related arrests.

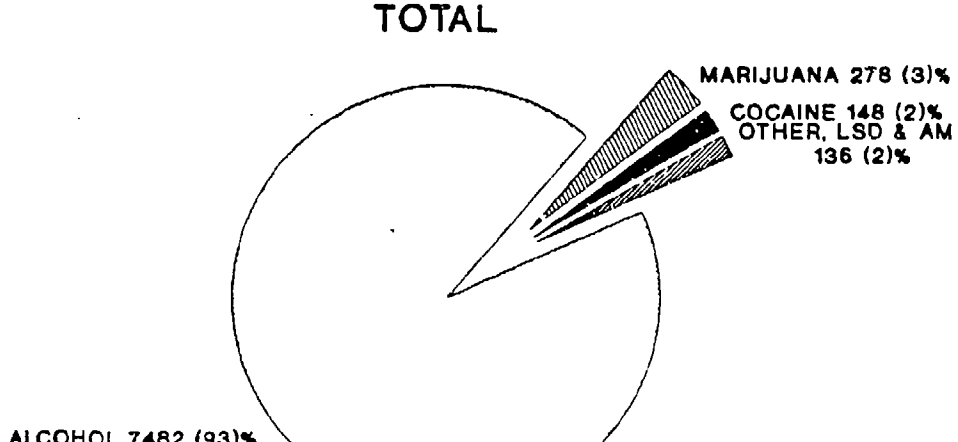
DRUG ABUSE



- One half of all drug identifications were due to drug testing.

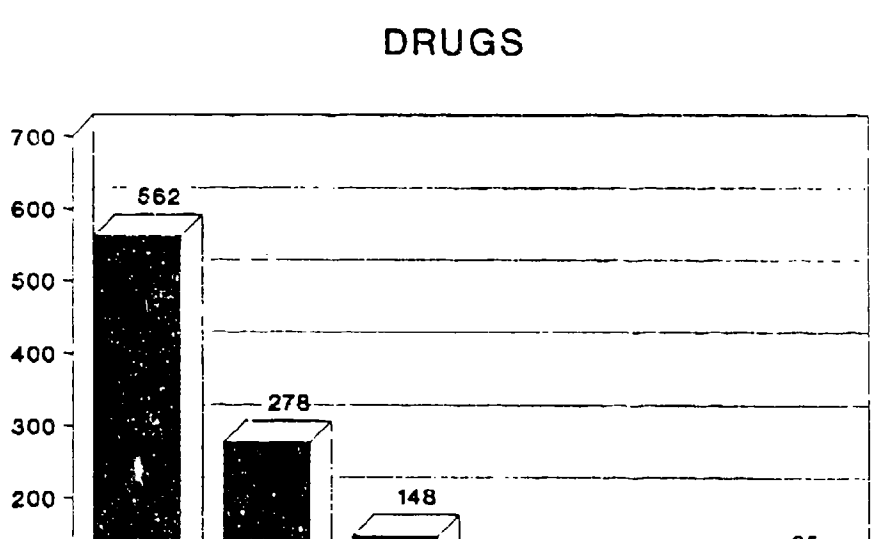
TYPES OF SUBSTANCES - FY92

TOTAL



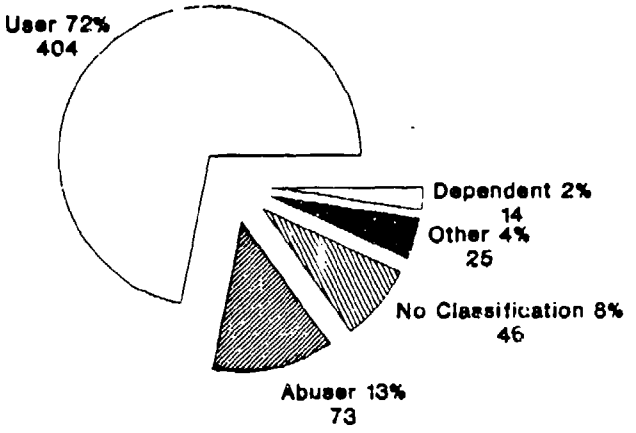
- Alcohol abuse continues to be the most commonly abused substance followed by marijuana, cocaine, and other (LSD & AMPH).

DRUGS



- The "other" category includes hallucinogens barbituates, methaqualone, opiates, PCP, tranquilizers, other depressants, steroids and stimulants.

LEVEL OF DRUG ABUSE - FY92

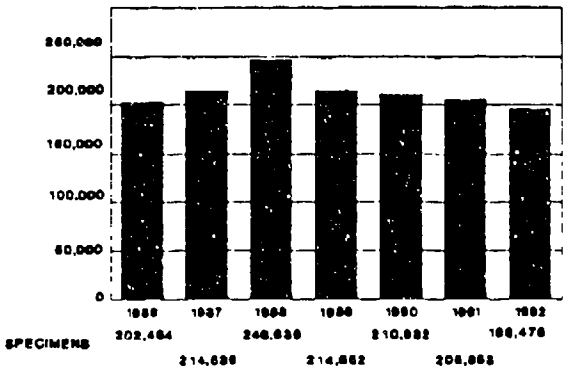


"No classification" denotes Track 1-2 entries. The "other" category includes those identified as drug possessors, manufacturers, and distributors.

- DRUG USER
  Nonpathological drug use which does not meet the criteria of drug abuse in the Diagnostic and Statistical Manual (DSM-III-R). Can be an experimental or legal drug misuser.
- DRUG ABUSER
  Maladaptive pattern of drug use which meet the diagnostic criteria of psychoactive substance abuse in the DSM-III-R.
- DRUG DEPENDENT
  Patterns of drug use that meet the diagnostic criteria of psychoactive substance dependence in the DSM-III-R.

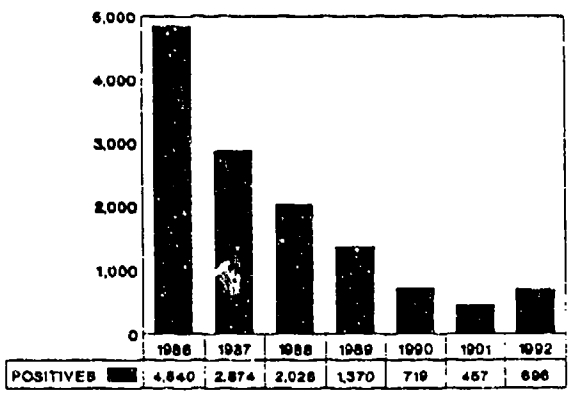
DRUG TESTING PROGRAM

Number of Specimens



- The number of specimens tested in FY92 decreased by 5 percent from FY91.
- Pulse testing, or 10 percent selection of one additional DOD listed drug is conducted monthly.

Amounts Positive



- The number of positive drug tests reported increased in FY92 (6 percent) partly because DOD lowered the cut-off levels for positive drug tests on 1 Jan 92; however, the total number of SART drug identifications decreased in FY92.

Appendix C: USAF Drug Testing Laboratory Record of Tests for Fiscal Year 1992

Definitions: INSP - Inspection (Random Urinalysis) CD - Commander Directed
OT - Probable Cause, Directed Rehab (Rehabilitation), Medical

NUMBER OF DRUG TESTS AND POSITIVE RESULTS

DRUG	INSP TESTS/ POSITIVES	CD TESTS/ POSITIVES	OT TESTS/ POSITIVES	TOTAL TESTS/ POSITIVES
Marijuana	185,975 / 198	3,255 / 48	2,024 / 74	191,254 / 320
Cocaine	175,102 / 114	3,234 / 57	2,003 / 71	180,339 / 242
Barbiturates	48,575 / 27	1,203 / 1	978 / 3	50,756 / 31
Amphetamine	39,075 / 10	1,000 / 8	748 / 5	40,823 / 23
PCP	32,632 / 0	864 / 0	619 / 1	34,115 / 1
Opiates	30,327 / 97	878 / 3	685 / 1	31,890 / 101
LSD	28,472 / 0	803 / 0	604 / 0	29,879 / 0
Methamphetamines	9,765 / 0	181 / 0	19 / 0	9,965 / 0
Steroids	0 / 0	5 / 0	5 / 0	10 / 0
Benzodiazepine	0 / 0	5 / 0	2 / 1	7 / 1
Demerol	0 / 0	0 / 0	1 / 1	1 / 1
Ecstasy	0 / 0	0 / 0	1 / 0	1 / 0
Orphendrine	0 / 0	0 / 0	1 / 0	1 / 0
TOTAL	549,923 / 446	11,428 / 117	7,690 / 157	569,041 / 720

NUMBER OF SPECIMENS TESTED AND POSITIVE RESULTS

SPECIMENS TESTED	INSP/ POSITIVES	CD / POSITIVES	OT/ POSITIVES	TOTAL/ POSITIVES
NUMBER	189,699 / 431	4,675 / 118	2,162 / 147	196,476 / 696

This data provided by Mr John Mellman, Biostatistician,
USAF Office of Medical Support, Brooks AFB TX (40).

Appendix D: Legal Issues Questionnaire

Background: Each year the Air Force tests up to 60 percent of its military population for illegal drug use. The majority of those tested at each base are randomly selected from the population of military members serviced by the Consolidated Base Personnel Office. Tests are also conducted in conjunction with criminal investigations, accidents, and when commanders direct them due to unexplained changes in an individual's performance or behavior.

Our thesis evaluates program modifications aimed at improving the effectiveness of the current USAF Drug Testing Program by increasing the number of drug users that testing identifies. The thesis looks at modifications to the selection process for determining who will be tested, and also examines a change in the testing method.

Questionnaire Objective: To identify and address all of the legal issues associated with proposed modifications to the current Air Force Drug Testing Program.

Questions:

1. In your opinion, are there any legal issues associated with increasing the percentage of the AF population tested on an annual basis? For example, instead of testing 30 percent of the Air Force population for drugs each year, test 60 percent.

If so, what are they?

Are there any precedent setting cases related to this alternative/issue of which we should be aware?

2. Given a fixed number of total tests, in your opinion, are there any legal issues associated with increasing the proportion of commander-directed tests, at the expense of

random (inspection) tests. Increases in commander-directed tests would result from increased emphasis from AF senior leadership coupled with improved training for all line supervisors on the symptoms of illegal drug use/abuse, and clear procedures for supervisors to identify potential users to the commanders.

If so, what are they?

Are there any precedent setting cases related to this alternative/issue of which we should be aware?

3. In your opinion, are there any legal issues associated with using weighted random sampling, based on historical demographic data on drug use in the Air Force, to select individuals for testing (instead of simple random sampling)? i.e. test a subset of the of the population where you statistically "expect" to find higher levels of drug use at a higher rate. The data on drug use is grouped, and weights would be assigned, based on rank.

If so, what are they?

Are there any precedent setting cases related to this alternative/issue of which we should be aware?

4. In your opinion, are there any legal issues associated with replacing urinalysis testing with hair testing as the standard method for drug testing in the Air Force?

If so, what are they?

Are there any precedent setting cases related to this alternative/issue of which we should be aware?

Bibliography

1. Ackerman, Deborah L. "A History of Drug Testing," in Drug Testing: Issues and Options. Eds. Robert H Coombs and Louis J. West. Oxford NY: Oxford University Press, 1991.

2. Air Force Military Personnel Center. USAF Social Actions Programs Statistical Summary - FY92. Randolph AFB TX, (December 1992).

3. Air Force Military Personnel Center. USAF Social Actions Programs Statistical Summary - FY91. Randolph AFB TX, (December 1991).

4. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders (Third Edition, Revised). Washington: American Psychiatric Association, 1987.

5. Baer, James D., Werner A. Baumgartner, Virginia A. Hill, and William H. Blahd. "Hair Analysis for the Detection of Drug Use in Pretrial, Probation, and Parole Populations," Federal Probation, 55: 3-10 (March 1991).

6. Biegel, Mark M. and James F. Holcomb. A Study Of Department of Defense Drug Abuse Prevention and Control Programs. Contract DAHC 15-73-C-304. Cambridge MA: Arthur D. Little, Inc., January 1975 (AD-A017576).

7. Bray, Robert M., Mary Ellen Marsden, John R. Herbold and Michael R. Peterson. "Progress Toward Eliminating Drug and Alcohol Abuse among U.S. Military Personnel," Armed Forces & Society, 18: 476-496 (Summer 1992).

8. Bray, Robert M. and others. 1992 Worldwide Survey of Substance Abuse and Health Behaviors Among Military Personnel. Contract MDA 903-91-C-0220. Research Triangle Park NC: Research Triangle Institute. (RTI/5154/06-16FR).

9. Brittingham, James H. Mobilization Studies Program Report Drugs in the USAF. Research Paper. Industrial College of the Armed Forces (NDU), Fort McNair, Washington DC, May 1985 (AD-B093693).

10. Brookler, Rob. "Industry Standards in Workplace Drug Testing," Personnel Journal, 71: 128-132 (April 1992).

11. Chromy, James R. "Variance Estimators for a Sequential Sample Selection Procedure," in Current Topics in Survey Sampling. Eds. Daniel Krewski, R. Platek and J. N. K. Rao. New York: Academic Press, 1981.

12. Clausen, Perrin. "EA-6B Crash on Nimitz Attributed to Pilot Error," Aviation Week & Space Technology, 117: 22-23 (16 August 1982).

13. Coacher, Le Ellen, Major. Law Advisor to the Air Force Drug Testing Program, Air Force Drug Testing Laboratory, Brooks AFB TX. Telephone interview. 16 July 1993.

14. Cochran, William G. Sampling Techniques (Third Edition). New York: John Wiley & Sons, 1977.

15. Covill, Bruce. "Court Affirms Right to Refuse Drug Test," Air Force Times, 24 July 1974: 3.

16. Department of Defense. Alcohol and Drug Abuse by DOD Personnel. DOD Directive 1010.4. Washington: GPO, 25 August 1980.

17. Department of Defense. Drug Abuse Testing Program. DOD Directive 1010.1. Washington: GPO, 28 December 1984.

18. Department of Defense. xperience in Drug Abuse Programs. Washington: Office of the Deputy Assistant Secretary of Defense (Drug and Alcohol Abuse), June 1973.

19. Department of the Air Force. Personnel: Social Actions Programs. AFR 30-2. Washington: HQ USAF, 18 April 1986.

20. Department of the Air Force. Medical Service: Drug Abuse Testing Program. AFR 160-23. Washington: HQ USAF, 31 July 1986.

21. Devore, Jay L. Probability and Statistics for Engineering and the Sciences. Pacific Grove CA: Brooks/Cole Publishing Company, 1991.

22. Emory, William C. and Donald R. Cooper. Business Research Methods (Fourth Edition). Homewood IL: Richard D. Irwin, Inc., 1991.

23. Fahey, David A., Lieutenant Colonel. Chief of Personnel Actions Law Branch, General Law Division, Office of the Air Force Judge Advocate General, Pentagon, Washington DC. Telephone Interview. July 1993.

24. Fanigliette, Len. "DOD Renews Drug Urinalysis," Air Force Times, 29 January 1975: 4.

25. Fay, John J. Drug Testing. Boston: Butterworth-Heinemann, 1991.

26. Fritch, Dean, Yvette Groce and Fredric Rieders. "Cocaine and Some of its Products in Hair by RIA and GC/MS," Journal of Analytical Toxicology, 16: 112-114 (March/April 1992).

27. Giovagnoni, Robert E., Colonel, Staff Judge Advocate, Wright-Patterson AFB OH. Personal Interview. 30 July 1993.

28. Harrell, Adele V. "Validation of the Self-Report: The Research Record," in Self-report Methods of Estimating Drug Use: Meeting Current Challenges to Validity. Eds. Beatrice A. Rouse, Nicholas J. Kozel and Louise G. Richards. (DHHS Publication ADM 85-1402.) Rockville MD: National Institute on Drug Abuse, 1985.

29. Inciardi, James A. "The Evolution of Drug Abuse in America," in Handbook of Drug Control in the United States. Ed. James A. Inciardi. New York: Greenwood Press, 1990.

30. Johnston, Lloyd D. and Patrick M. O'Malley. "Issues of Validity and Population Coverage in Student Surveys of Drug Abuse," in Self-report Methods of Estimating Drug Use: Meeting Current Challenges to Validity. Eds. Beatrice A. Rouse, Nicholas J. Kozel and Louise G. Richards. DHHS Publication ADM 85-1402. Rockville MD: National Institute on Drug Abuse, 1985.

31. Jones, Alan B. and Michael S. Peat. "Forensic Laboratory Drug Testing" in The Medical Review Officer's Guide to Drug Testing. Ed. Robert B. Swotinsky. New York: Van Nostrand Reinhold, 1992.

32. Kelly, Raymond C. "Urine Drug Testing," in Drug Testing: A Workplace Guide to Designing Practical Policies and Winning Arbitrations. Ed. Lloyd Loomis. Washington: The Bureau of National Affairs, Inc., 1990.

33. Kinlin, Joseph P., Captain. Assistant Staff Judge Advocate, Wright-Patterson AFB OH. Telephone interview. 23 July 1993.

34. Kintz, Pascal, Bertrand Ludes and Patrice Mangin. "Detection of Drugs in Human Hair Using the Abbot ADx, with Confirmation by Gas Chromatography/Mass Spectrometry," Journal of Forensic Sciences, 37: 328-331 (1991).

35. Krueger, William P. Attorney Advisor, Directorate of General Law, Office of the Staff Judge Advocate, HQ AFMC, Wright-Patterson AFB OH. Personal Interview. 29 June 1993.

36. Larson, Harold J. Introduction to Probability Theory and Statistical Inference (Third Edition). New York: John Wiley & Sons, 1982.

37. Marshall, Eliot. "Testing Urine for Drugs," Science, 241: 150-152 (8 July 1988).

38. Martz, Roger, Brian Donnelly, Dean Fetterolf, Lynn Lasswell, George W. Hime and W. Lee Hearn. "The Use of Hair Analysis to Document a Cocaine Overdose Following a Sustained Survival Period Before Death," Journal of Analytical Toxicology, 15: 279-281 (September/October 1991).

39. Mehuron, Tamar A. Editor. "The US Air Force in Facts and Figures," Air Force Magazine, 76: 27-56 (May 1993).

40. Mellman, John. Biostatistician, Air Force Office of Medical Support, Brooks AFB TX. Personal Correspondence. 16 July 1993.

41. Mieczkowski, Tom. "New Approaches in Drug Testing: A Review of Hair Analysis," Annals of the American Academy of Political and Social Science, 521: 132-150 (May 1992).

42. Mieczkowski, Tom, Harvey J. Landress, Richard Newel, and Shirley D. Coletti. "Testing Hair for Illicit Drug Use." U.S. Department of Justice, National Institute of Justice Report Number NC. 138539. Washington: GPO, January 1993.

43. Mieczkowski, Tom, David Barzelay, Bernard Gropper, and Eric Wish. "Concordance of Three Measures of Cocaine Use in an Arrestee Population: Hair, Urine, and Self-report," Journal of Psychoactive Drugs, 23: 241-249.

44. "New Drug Test Seen Signaling Pot Crackdown," Air Force Times, 3 August 1981: 18.

45. Orellena, William B., Colonel. Commander, 2750th Air Base Wing, Wright-Patterson AFB OH. Official Correspondence to Chief of Staff, Headquarters Air Force Logistics Command. 21 April 1992.

46. Peterson, James J., Captain. Chief of Social Actions Program Development, Social Actions Operations Division, HQ AFMPC, Randolph AFB TX. Telephone Interview. 12 Aug 1993.

47. Raj, Des. Sampling Theory. New York: McGraw-Hill Book Company, 1968.

48. Reaser, Joel M., John A. Richards and Steven L. Hartsock. The Prevalence of Drug Abuse in the Army: A Comparison of Urinalysis and Survey Rates. Contract DAHC 19-73-C-0004. National Resources Research Organization. June 1975 (AD-A012683).

49. Ritchie, Donald D. and Robert Carola. Biology. Reading MA: Addison-Wesley Publishing Company, 1979.

50. Selavka, Carl M., Ph.D. Director of Forensic Operations, National Medical Services, Inc. Willow Grove PA. Telephone interview. 13 July 1993.

51. Ward, Edward A. "Employee Drug Testing: Aalberts and Walker Revisited," Journal of Small Business Management, 29: 77-83 (January 1991).

52. White House. Manual for Courts-Martial, United States 1984. Executive Order 12473. Washington: GPO, 24 July 1984.

53. Willette, Robert E. "Techniques of Reliable Drug Testing" in Drug Testing: Issues and Options. Eds. Robert H. Coombs and Louis Jolyon West. New York: Oxford University Press, 1992.

54. Wish, Eric D. "Drug Testing and Identification of Drug-Abusing Criminals," in Handbook of Drug Control in the United States. Ed. James A. Inciardi. New York: Greenwood Press, 1990.

55. Wiste, Christina C., Captain. Area Defense Counsel, Wright-Patterson AFB OH. Telephone interview. 28 June 1993.

56. Wygle, Mary Jane, Major. Chief, Substance Abuse Control Branch, Social Actions Operations Division, HQ AFMPC, Randolph AFB TX. Telephone Interview. 23 July 1993.

Vita

Captain Thomas R. Doster was born on 17 October 1962 in Charlotte, North Carolina. After graduating from high school in Union County, North Carolina in 1980, he studied psychology at the University of North Carolina at Charlotte for one year. Following a year in the commercial construction industry as a welder and sheet metal worker, he enlisted in the United States Air Force and entered Basic Military Training School at Lackland AFB, Texas in June 1982. After graduation, he attended the six month, Instrumentation Mechanic course at Lowry AFB, Colorado. Following graduation, in January 1983, he was assigned to the Special Devices Unit of the 475th Test Squadron, at Tyndall AFB, Florida where he operated a computer circuit board production facility in support of various aircraft modification and test projects. After being selected for the Airman Education and Commissioning Program, he attended the Ohio State University from September 1984 until September 1987 when he graduated with a Bachelor of Science in Electrical Engineering. Following graduation, he attended Officer Training School and received a commission in December 1987. His first assignment was to the C-17 System Program Office as a controls and displays, recorders, and air data systems engineer. In November 1990, he was selected to serve in the F-22 System Program Office. There he was responsible for the cost, schedule, performance, maintainability and supportability of the F-22 controls and displays systems developed by the Controls and Displays Integrated Product Team until entering the Graduate School of Logistics and Acquisition Management, Air Force Institute of Technology, in May 1992.

Permanent Address: 2616 Hamiltons Crossroads
Marshville NC 28103

Vita

Captain Hubert A. Ross was born on 14 March 1962 in Atlanta, Georgia. He graduated from Atlanta's D.M. Therrell High School in 1980 and attended the United States Air Force Academy, graduating with a Bachelor of Science in May 1984. Upon graduation, he received a regular commission in the USAF and was assigned as an Acquisition Project Officer to Hanscom AFB, Massachusetts. He first served in the Joint Surveillance Target Attack Radar System , Joint Program Office(JPO), as an Operational Requirements Manager where he worked with the Army and Air Force users to define operational requirements and external interfaces for the system. Next, he served as International Programs Officer where he was responsible for laying the groundwork for international cooperation on Joint STARS with NATO member nations. After his first 2 1/2 years in the JPO, he was chosen to serve as the Program Director's Executive Officer. In February 1989, Captain Ross was reassigned to Headquarters Air Force Systems Command (AFSC) at Andrews AFB, Maryland. There he served a one year tour as a Protocol Officer where he planned ceremonies and official social functions for the senior staff, and briefed distinguished visitors on the Command's mission. In May 1990, he was selected to serve as the AFSC Chief of Staff's Executive Officer where he managed operations in the Office of the Chief of Staff and participated in the integration of Air Force Logistics Command and Air Force Systems Command into Air Force Materiel Command. He remained in this position until entering the Graduate School of Logistics and Acquisition Management, Air Force Institute of Technology, in May 1992.

Permanent Address: 133 Chartley Court

Beavercreek OH 45440-3600

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This study evaluated the 1992 USAF Drug Testing Program and potential improvements, based on the number of drug users detected, cost, and legal issues. Four potential improvements were examined: 1) increasing the annual amount of random urinalysis, 2) increasing the proportion of commander-directed testing, 3) using a weighted selection technique; and 4) replacing urinalysis with hair testing. For each improvement, the researchers used test and survey results to estimate the number of drug users detected, a cost formula to estimate any changes in cost, and interviews with legal experts to identify any legal issues associated with implementing the modification. Researchers found the proportion of drug users detected by the testing program was significantly less than the proportion estimated by a 1992 survey of military personnel. In addition, the researchers found the potential modifications should each increase the number of drug users detected. However, the percentage of drug users detected would remain small and implementation of each modification would result in increased costs or legal challenges or decreased deterrence. Researchers found hair testing has the greatest potential for significantly increasing the number of drug users detected. However, widespread use is not recommended because of technical issues and higher costs.

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a. Highly Significant b. Significant c. Slightly Significant d. Of No Significance

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