Operator Drug- and Alcohol-Testing Across Modes

DETAILS

47 pages | | PAPERBACK
ISBN 978-0-309-22344-7 | DOI 10.17226/14635

AUTHORS

Gene Bergoffen; Dary Fiorentino; Randi Shannahan; Transportation Research Board

CTBSSP
SYNTHESIS 23

COMMERCIAL TRUCK AND BUS SAFETY

Operator Drug- and Alcohol-Testing Across Modes

Sponsored by
the Federal Motor Carrier Safety Administration

A Synthesis of Safety Practice

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

TRANSPORTATION RESEARCH BOARD 2011 EXECUTIVE COMMITTEE*

OFFICERS

Chair: *Neil J. Pedersen, Consultant, Silver Spring, MD*
Vice Chair: *Sandra Rosenbloom, Professor of Planning, University of Arizona, Tucson*
Executive Director: *Robert E. Skinner, Jr., Transportation Research Board*

MEMBERS

J. BARRY BARKER, *Executive Director, Transit Authority of River City, Louisville, KY*
DEBORAH H. BUTLER, *Executive Vice President, Planning, and CIO, Norfolk Southern Corporation, Norfolk, VA*
WILLIAM A.V. CLARK, *Professor, Department of Geography, University of California, Los Angeles*
EUGENE A. CONTI, JR., *Secretary of Transportation, North Carolina DOT, Raleigh*
JAMES M. CRITES, *Executive Vice President of Operations, Dallas-Fort Worth International Airport, TX*
PAULA J. HAMMOND, *Secretary, Washington State DOT, Olympia*
MICHAEL W. HANCOCK, *Secretary, Kentucky Transportation Cabinet, Frankfort*
ADIB K. KANAFANI, *Cahill Professor of Civil Engineering, University of California, Berkeley*
MICHAEL P. LEWIS, *Director, Rhode Island DOT, Providence*
SUSAN MARTINOVICH, *Director, Nevada DOT, Carson City*
JOAN McDONALD, *Commissioner, New York State DOT, Albany*
MICHAEL R. MORRIS, *Director of Transportation, North Central Texas Council of Governments, Arlington*
TRACY L. ROSSER, *Vice President, Regional General Manager, Wal-Mart Stores, Inc., Mandeville, LA*
STEVEN T. SCALZO, *Chief Operating Officer, Marine Resources Group, Seattle, WA*
HENRY G. (GERRY) SCHWARTZ, JR., *Chairman (retired), Jacobs/Sverdrup Civil, Inc., St. Louis, MO*
BEVERLY A. SCOTT, *General Manager and CEO, Metropolitan Atlanta Rapid Transit Authority, Atlanta, GA*
DAVID SELTZER, *Principal, Mercator Advisors LLC, Philadelphia, PA*
LAWRENCE A. SELZER, *President and CEO, The Conservation Fund, Arlington, VA*
KUMARES C. SINHA, *Olson Distinguished Professor of Civil Engineering, Purdue University, West Lafayette, IN*
THOMAS K. SOREL, *Commissioner, Minnesota DOT, St. Paul*
DANIEL SPERLING, *Professor of Civil Engineering and Environmental Science and Policy; Director, Institute of Transportation Studies; and Interim Director, Energy Efficiency Center, University of California, Davis*
KIRK T. STEUDLE, *Director, Michigan DOT, Lansing*
DOUGLAS W. STOTLAR, *President and CEO, Con-Way, Inc., Ann Arbor, MI*
C. MICHAEL WALTON, *Ernest H. Cockrell Centennial Chair in Engineering, University of Texas, Austin*

EX OFFICIO MEMBERS

J. RANDOLPH BABBITT, *Administrator, Federal Aviation Administration, U.S.DOT*
REBECCA M. BREWSTER, *President and COO, American Transportation Research Institute, Smyrna, GA*
ANNE S. FERRO, *Administrator, Federal Motor Carrier Safety Administration, U.S.DOT*
LEROY GISHI, *Chief, Division of Transportation, Bureau of Indian Affairs, U.S. Department of the Interior, Washington, DC*
JOHN T. GRAY, *Senior Vice President, Policy and Economics, Association of American Railroads, Washington, DC*
JOHN C. HORSLEY, *Executive Director, American Association of State Highway and Transportation Officials, Washington, DC*
DAVID T. MATSUDA, *Deputy Administrator, Maritime Administration, U.S.DOT*
MICHAEL P. MELANIPHY, *President, American Public Transportation Association, Washington, DC*
VICTOR M. MENDEZ, *Administrator, Federal Highway Administration, U.S.DOT*
TARA O'TOOLE, *Under Secretary for Science and Technology, U.S. Department of Homeland Security, Washington, DC*
ROBERT J. PAPP (Adm., U.S. Coast Guard), *Commandant, U.S. Coast Guard, U.S. Department of Homeland Security, Washington, DC*
CYNTHIA L. QUARTERMAN, *Administrator, Pipeline and Hazardous Materials Safety Administration, U.S.DOT*
PETER M. ROGOFF, *Administrator, Federal Transit Administration, U.S.DOT*
DAVID L. STRICKLAND, *Administrator, National Highway Traffic Safety Administration, U.S.DOT*
JOSEPH C. SZABO, *Administrator, Federal Railroad Administration, U.S.DOT*
POLLY TROTTENBERG, *Assistant Secretary for Transportation Policy, U.S.DOT*
ROBERT L. VAN ANTWERP (Lt. Gen., U.S. Army), *Chief of Engineers and Commanding General, U.S. Army Corps of Engineers, Washington, DC*
BARRY R. WALLERSTEIN, *Executive Officer, South Coast Air Quality Management District, Diamond Bar, CA*
GREGORY D. WINFREE, *Acting Administrator, Research and Innovative Technology Administration, U.S.DOT*

---

*Membership as of November 2011.

COMMERCIAL TRUCK AND BUS SAFETY SYNTHESIS PROGRAM

CTBSSP **SYNTHESIS 23**

Operator Drug- and Alcohol-Testing Across Modes

A Synthesis of Safety Practice

Consultants
DARY FIORENTINO
and
RANDI SHANNAHAN
DF Consulting
Van Nuys, California

With the support of
GENE BERGOFFEN
MaineWay Services, Inc.
Fryeburg, Maine

Subscriber Categories
Motor Carriers • Safety and Human Factors

Research Sponsored by the Federal Motor Carrier Safety Administration

TRANSPORTATION RESEARCH BOARD

WASHINGTON, D.C.
2011
www.TRB.org

COMMERCIAL TRUCK AND BUS SAFETY SYNTHESIS PROGRAM

Safety is a principal focus of government agencies and private-sector organizations concerned with transportation. The Federal Motor Carrier Safety Administration (FMCSA) was established within the Department of Transportation on January 1, 2000, pursuant to the Motor Carrier Safety Improvement Act of 1999. Formerly a part of the Federal Highway Administration, the FMCSA's primary mission is to prevent commercial motor vehicle-related fatalities and injuries. Administration activities contribute to ensuring safety in motor carrier operations through strong enforcement of safety regulations, targeting high-risk carriers and commercial motor vehicle drivers; improving safety information systems and commercial motor vehicle technologies; strengthening commercial motor vehicle equipment and operating standards; and increasing safety awareness. To accomplish these activities, the Administration works with federal, state, and local enforcement agencies, the motor carrier industry, labor, safety interest groups, and others. In addition to safety, security-related issues are also receiving significant attention in light of the terrorist events of September 11, 2001.

Administrators, commercial truck and bus carriers, government regulators, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and underevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information available on nearly every subject of concern to commercial truck and bus safety. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the commercial truck and bus industry, the Commercial Truck and Bus Safety Synthesis Program (CTBSSP) was established by the FMCSA to undertake a series of studies to search out and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern. Reports from this endeavor constitute the CTBSSP Synthesis series, which collects and assembles the various forms of information into single concise documents pertaining to specific commercial truck and bus safety problems or sets of closely related problems

The CTBSSP, administered by the Transportation Research Board, began in early 2002 in support of the FMCSA's safety research programs. The program initiates three to four synthesis studies annually that address concerns in the area of commercial truck and bus safety. A synthesis report is a document that summarizes existing practice in a specific technical area based typically on a literature search and a survey of relevant organizations (e.g., state DOTs, enforcement agencies, commercial truck and bus companies, or other organizations appropriate for the specific topic). The primary users of the syntheses are practitioners who work on issues or problems using diverse approaches in their individual settings. The program is modeled after the successful synthesis programs currently operated as part of the National Cooperative Highway Research Program (NCHRP) and the Transit Cooperative Research Program (TCRP).

This synthesis series reports on various practices, making recommendations where appropriate. Each document is a compendium of the best knowledge available on measures found to be successful in resolving specific problems. To develop these syntheses in a comprehensive manner and to ensure inclusion of significant knowledge, available information assembled from numerous sources, including a large number of relevant organizations, is analyzed.

For each topic, the project objectives are (1) to locate and assemble documented information (2) to learn what practice has been used for solving or alleviating problems; (3) to identify all ongoing research; (4) to learn what problems remain largely unsolved; and (5) to organize, evaluate, and document the useful information that is acquired. Each synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation.

The CTBSSP is governed by a Program Oversight Panel consisting of individuals knowledgeable in the area of commercial truck and bus safety from a number of perspectives—commercial truck and bus carriers, key industry trade associations, state regulatory agencies, safety organizations, academia, and related federal agencies. Major responsibilities of the panel are to (1) provide general oversight of the CTBSSP and its procedures, (2) annually select synthesis topics, (3) refine synthesis scopes, (4) select researchers to prepare each synthesis, (5) review products, and (6) make publication recommendations.

Each year, potential synthesis topics are solicited through a broad industry-wide process. Based on the topics received, the Program Oversight Panel selects new synthesis topics based on the level of funding provided by the FMCSA. In late 2002, the Program Oversight Panel selected two task-order contractor teams through a competitive process to conduct syntheses for Fiscal Years 2003 through 2005.

CTBSSP SYNTHESIS 23

Project MC-20
ISSN 1544-6808
ISBN: 978-0-309-22344-7
Library of Congress Control Number 2011943708

COPYRIGHT INFORMATION

NOTICE

The project that is the subject of this report was a part of the Commercial Truck and Bus Safety Synthesis Program conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council. Such approval reflects the Governing Board's judgment that the program concerned is appropriate with respect to both the purposes and resources of the National Research Council.

The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and, while they have been accepted as appropriate by the technical panel, they are not necessarily those of the Transportation Research Board, the National Research Council, or the Federal Motor Carrier Safety Administration of the U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical panel according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

The Transportation Research Board, the National Research Council, and the Federal Motor Carrier Safety Administration (sponsor of the Commercial Truck and Bus Safety Synthesis Program) do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the clarity and completeness of the project reporting.

Published reports of the

COMMERCIAL TRUCK AND BUS SAFETY SYNTHESIS PROGRAM

are available from:

Transportation Research Board
Business Office
500 Fifth Street, NW
Washington, DC 20001

and can be ordered through the Internet at:
http://www.national-academies.org/trb/bookstore

Printed in the United States of America

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. On the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Ralph J. Cicerone is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. Charles M. Vest is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, on its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Ralph J. Cicerone and Dr. Charles M. Vest are chair and vice chair, respectively, of the National Research Council.

The **Transportation Research Board** is one of six major divisions of the National Research Council. The mission of the Transportation Research Board is to provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. The Board's varied activities annually engage about 7,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation. **www.TRB.org**

www.national-academies.org

FOREWORD

Administrators, commercial truck and bus carriers, government regulators, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and underevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information available on nearly every subject of concern to commercial truck and bus safety. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day jobs. To provide a systematic means for assembling and evaluating such useful information and to make it available to the commercial truck and bus industry, the Commercial Truck and Bus Safety Synthesis Program (CTBSSP) was established by the Federal Motor Carrier Safety Administration (FMCSA) to undertake a series of studies to search out and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern. Reports from this endeavor constitute the CTBSSP Synthesis series, which collects and assembles information into single concise documents pertaining to specific commercial truck and bus safety problems.

The CTBSSP, administered by the Transportation Research Board, was authorized in late 2001 and began in 2002 in support of the FMCSA's safety research programs. The program initiates several synthesis studies annually that address issues in the area of commercial truck and bus safety. A synthesis report is a document that summarizes existing practice in a specific technical area based typically on a literature search and a survey of relevant organizations (e.g., state DOTs, enforcement agencies, commercial truck and bus companies, or other organizations appropriate for the specific topic). The primary users of the syntheses are practitioners who work on issues or problems using diverse approaches in their individual settings.

This synthesis series reports on various practices; each document is a compendium of the best knowledge available on measures found to be successful in resolving specific problems. To develop these syntheses in a comprehensive manner and to ensure inclusion of significant knowledge, available information assembled from numerous sources is analyzed.

For each topic, the project objectives are (1) to locate and assemble documented information; (2) to learn what practices have been used for solving or alleviating problems; (3) to identify relevant, ongoing research; (4) to learn what problems remain largely unsolved; and (5) to organize, evaluate, and document the useful information that is acquired. Each synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation.

CONTENTS

OPERATOR DRUG- AND ALCOHOL-TESTING ACROSS MODES

PREFACE

The primary objective of this synthesis is to identify the current practices used to deter drug and alcohol use among operators within the U.S.DOT's regulated community. The intended target audience is broad, including DOT staff, various DOT agencies, companies of all sizes in the regulated industries, drug- and alcohol-testing organizations, and the research community.

The document begins with a brief history of the transportation workplace drug- and alcohol-testing program, the general approach, the reasons for testing, some of the issues that impact the validity of the tests, and an outline of the specific regulations by mode. Some alcohol- and drug-testing statistics are also presented to give the reader a sense of the scope of the program and of the prevalence of illegal alcohol and drug use among safety-sensitive employees.

Next, the findings of inquiries to companies in the regulated community are reported with an emphasis on alternative strategies aimed at deterring illegal alcohol and drug use among employees. Unfortunately, participation on the part of the companies in the regulated community was limited, resulting in a small sample. Moreover, it is possible that the companies that responded to requests for information may not be representative of their entire industry. This is an important caveat.

The structure and content of the section on alternative strategies reflect what the companies in the regulated community reported. The synthesis is not intended to provide an organic and comprehensive review of the scientific literature on alcohol testing, drug testing, and related topics, but rather to provide the minimum necessary information for most readers to understand and evaluate the actions of the regulated community. On the sensitive issue of alternative specimens, for example, considerably more space was devoted to the scientific issues associated with some matrices than others, because the regulated community has made certain decisions and those decisions are what the reader must understand and evaluate, not because of the inherent interest in one matrix over the other.

An attempt was made to provide the minimum necessary information in a scholarly fashion, with the hope of striking a delicate balance between brevity and thoroughness. It is hoped that readers find the balance useful, and they are asked to refer to the sources credited throughout the document for additional information.

Finally, some general recommendations for new research are included. They are offered with the strong belief that data obtained through methodologically sound research can help clarify some of the lingering issues associated with alcohol and drug testing in the transportation workplace.

Dary Fiorentino and Randi Shannahan, DF Consulting, Van Nuys, California, collected and synthesized the information and wrote the report. The Commercial Truck and Bus Safety Synthesis Program Oversight Committee members are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

CHAPTER ONE

OBJECTIVES

The U.S. Department of Transportation (DOT) oversees the largest drug and alcohol testing program in the United States. The program is managed and coordinated by the Office of the Secretary of Transportation. DOT regulations are codified in Title 49 of the Code of Federal Regulations (49 CFR Part 40), which concerns the activities of transportation employers, safety-sensitive transportation employees (including self-employed individuals, contractors, and volunteers), and service agents.

Compliance and enforcement within the different transportation modes are the responsibility of the agency that has regulatory authority over that particular industry. The Omnibus Transportation Employee Testing Act of 1991 promulgated the elimination of abuse of alcohol and the use of illegal drugs, whether on duty or off duty, by those individuals who are involved in the operation of aircraft, train, trucks, and buses.

This project had the following objectives:

- Synthesize the general DOT procedures for the transportation workplace drug and alcohol testing programs.
- Synthesize the specific regulations by mode.
- Provide DOT alcohol and drug testing statistics.
- Identify alternative strategies currently considered or implemented by the regulated community to deter illegal drug and alcohol use among safety-sensitive employees.
- Provide suggestions for future research.

CHAPTER TWO

BACKGROUND

President Ronald Reagan initiated a program by executive order (Executive Order No. 12564, 1986) toward achieving drug-free workplaces in the federal government by offering drug users a helping hand and, at the same time, demonstrating to drug users and potential drug users that drugs would not be tolerated in the federal workplace. The program required federal employees to refrain from the use of illegal drugs, on duty or off duty. It assigned the responsibilities for developing specific plans for achieving a drug-free workplace to each executive agency. Each agency's plan had to include a statement of policy, an employee assistance program (EAP), supervisory training, provisions for self-referrals, and provisions for identifying illegal drug users.

The head of each executive agency was to allow four types of testing programs for (1) detection of illegal drug use by employees in sensitive positions; (2) voluntary employee drug testing; (3) suspicion of illegal drug use following an accident or unsafe practice, or as part of a follow-up for counseling or rehabilitation for illegal drug use; and (4) the detection of illegal drug use by federal job applicants.

A general outline was provided for drug-testing procedures, including the need to inform the employee to be tested of the opportunity to submit medical documentation that may support a legitimate use for a specific drug; the need for retention of records and specimens, retesting, and employee confidentiality; procedures for providing a balance between safeguarding the privacy of the individual being tested and the need to obtain a valid specimen, without alteration or substitution; and authorized the Secretary of the Department of Health and Human Services (DHHS) to promulgate scientific and technical guidelines for drug-testing programs.

The outline also specified personnel actions in the event that an employee was found to use illegal drugs, including referrals to treatment and rehabilitation, temporary removal from sensitive positions, and termination. It required that positive test results be confirmed by a second analysis of the same sample, and it defined the administrative and legal ramifications of drug testing.

The coordination of agency programs was delegated to the director of the Office of Personnel Management, who was held responsible for implementing the executive order, ensuring that appropriate coverage for drug abuse was maintained for employees and their families, developing a model EAP for federal agencies, developing training programs for federal supervisors on illegal drug use, and mounting an intensive drug awareness campaign throughout the federal workforce.

In 1988, the Secretary of DHHS, as required by Executive Order 12564, published the mandatory guidelines for federal workplace drug testing, which set scientific and technical standards for drug testing of federal employees and for certification of drug-testing laboratories (DHHS Mandatory Guidelines for Federal Workplace Drug-Testing Programs, 53 *Fed. Reg.* 11,970, proposed Apr. 11, 1988). Those mandatory guidelines have since been updated and revised (DHHS Mandatory Guidelines for Federal Workplace Drug-Testing Programs, 59 *Fed. Reg.* 29,908, proposed June 9, 1994; 63 *Fed. Reg.* 63,483, proposed Nov. 14, 1998; 69 *Fed. Reg.* 19,644, proposed Apr. 13, 2004; 73 *Fed. Reg.* 71,858, proposed Nov. 25, 2008). The 2008 guidelines went into effect October 1, 2010 (75 *Fed. Reg.* 22,809).

The mandatory guidelines establish workplace drug testing as an education and deterrent program and do not include alcohol and prescription drugs (Bush 2007). Components of a comprehensive drug-free program are a formal written policy, employee assistance, supervisor training, employee education, and drug testing for detecting illicit drug users. In general, the guidelines address the collection and testing of urine specimens, the requirements for certification of the testing facilities, and the role and standards for collectors and medical review officers. Six major changes occurred from the 2004 to 2008 guidelines: revised requirements for specimen collection, standards for collectors and collection sites, revised laboratory testing requirements, new technologies for confirmatory drug testing, new types of testing facilities, and revised standards for medical review officers. As discussed later, the Office of the Secretary of Transportation (OST) amended certain provisions of its current drug-testing procedures to create consistency with the new DHHS mandatory guidelines.

The DHHS guidelines require that each specimen be tested twice. The initial test is used to differentiate a negative specimen from one that requires further testing for drugs or drug metabolites. The confirmatory drug test is performed

on a different aliquot of the original specimen to identify and quantify the presence of a specific drug or drug metabolite. The two tests are based on different analytical techniques.

In the 2004 proposed guidelines, DHHS proposed the use of alternative specimens (hair, oral fluid, sweat) for federal employee drug testing. In the 2008 guidelines, DHHS recognized that the addition of alternative specimens would be useful in complementing urine drug testing but that important areas of concern remained and that additional study and analyses were required, effectively postponing the use of alternative specimens.

The U.S.DOT implemented its own drug-testing program (DOT Procedures for Transportation Workplace Drug and Alcohol Testing Programs, 40 CFR, Part 40, 1989). The DOT drug-testing program is based exclusively on urine testing. It incorporates the DHHS scientific and technical guidelines. The DOT alcohol-testing program is based on breath and saliva testing. For each transportation mode (i.e., aviation, maritime, motor carriers, pipelines, public transit), DOT has an agency required to define which classes of employees are subject to testing.

CHAPTER THREE

TRANSPORTATION WORKPLACE DRUG- AND ALCOHOL-TESTING PROGRAM

Under 49 CFR Part 40, there is an important distinction between drug testing and alcohol testing. The drug-testing program is aimed at deterring use of illegal drugs, regardless of the pattern and frequency of use in relationship to the job. The alcohol-testing program, in contrast, is a fitness-for-duty program aimed at preventing prohibited use of a legal substance while the employee is at work.

REASONS FOR TESTING

Pre-employment

Drug and alcohol testing must be conducted before an employee's first-time performance in a safety-sensitive position, either because of a transfer from a non–safety-sensitive position or because of a new job offer. The employee must pass the tests before safety-sensitive work can begin. Not all administrations require pre-employment alcohol testing.

Postaccident

The definition of "accident" varies by mode, but it is generally interpreted as a series of connected events that result in death, injury, or damage to property. All administrations require that specimens for alcohol postaccident tests be collected within 8 h of the occurrence of the accident, and that specimens for drugs postaccident tests be collected within 32 h of the occurrence of the accident.

Random

Drug and alcohol testing must be conducted at random and without prior notification at predetermined rates, determined by the individual administrations on the basis of the random positive rates for the previous year. In general, the minimum annual percentage rate for random drug testing is 50% of covered employees; the random alcohol testing rate is 10%. These rates, however, are subject to review by the administrators of each DOT agency. The administrator's decision to increase or decrease the minimum annual percentage rate for random drug and alcohol testing is based, respectively, on the reported positive drug and alcohol violation rates for the entire industry.

For drugs, when the minimum annual percentage rate for random drug testing is 50%, the administrator may lower this rate to 25% of all covered employees if the administrator determines that the data for the two preceding consecutive calendar years indicate that the reported positive rate is less than 1.0%. When the minimum annual percentage rate for random drug testing is 25%, and the data for the calendar year indicate that the reported positive rate is equal to or greater than 1.0%, the administrator will increase the minimum annual percentage rate for random drug or random alcohol testing to 50% of all covered employees.

For alcohol, when the minimum annual percentage rate for random alcohol testing is 25% or more, the administrator may lower this rate to 10% of all covered employees if the administrator determines that the data for two consecutive calendar years indicate that the violation rate is less than 0.5%. When the minimum annual percentage rate for random alcohol testing is 50%, the administrator may lower this rate to 25% of all covered employees if the administrator determines that the data for two consecutive calendar years indicate that the violation rate is less than 1.0% but equal to or greater than 0.5%. When the minimum annual percentage rate for random alcohol testing is 10%, and the data for that calendar year indicate that the violation rate is equal to or greater than 0.5%, but less than 1.0%, the administrator will increase the minimum annual percentage rate for random alcohol testing to 25% of all covered employees. When the minimum annual percentage rate for random alcohol testing is 25% or less, and the data for that calendar year indicate that the violation rate is equal to or greater than 1.0%, the administrator will increase the minimum annual percentage rate for random alcohol testing to 50% of all covered employees. Note that not all DOT agencies are required to apply random alcohol testing regulations to the workforces they regulate.

Reasonable Suspicion

Drug and alcohol testing must be conducted when a properly trained supervisor observes specific clues in an employee's behavior and appearance that are associated with drug or alcohol abuse.

Return-to-duty

Drug and alcohol testing (alone or in combination) must be conducted prior to an employee's return to a safety-sensitive position following a positive test.

Follow-up

Drug and alcohol testing (alone or in combination) must be conducted at unannounced bases at least six times in the first 12 months following the return to a safety-sensitive position after a positive test.

DRUG TESTING

Specimen Collection

Subpart E of 49 CFR Part 40 is dedicated to the collection of specimens. It is a detailed set of instructions, from the preliminary steps in the collection process to the shipping of the specimen to the laboratory.

A urine specimen must be collected using chain of custody procedures documented with the Federal Drug Testing Custody and Control Form (CCF). Specimen collection must be conducted by a trained individual using a standard collection kit.

The collection begins with the collector completing Step 1 of the CCF. Precautions the collector must take to prevent tampering include dyeing the toilet water and asking the employee to show the contents of his or her pockets. The collector then instructs the employee to wash and dry his or her hands. The employee is not allowed to wash his or her hands again until after delivering the specimen. Employees are not allowed access to water or to materials that can be used to adulterate or dilute a specimen. A sealed or wrapped collection container is selected with both the employee and the collector present. The employee is then directed to go to the room used for urination and provide a specimen of at least 45 ml, not flush the toilet, and return the specimen as soon as he or she has completed the void. The collector must pay careful attention to signs that the employee is attempting to tamper with the specimen. To prevent substitution, the room used for urination has a toilet tank with a blue dye in it.

The collector inspects the specimen to ensure that it is of sufficient volume and acceptable temperature range (32°C–38°C or 90°F–100°F). The collector also checks for signs of tampering, such as unusual color, appearance, and odor of the specimen. If the collector suspects tampering, he or she may request that the employee provide a new specimen under direct observation. Follow-up and return-to-duty tests require direct observation.

Before sending the specimen for analyses, the collector divides the specimen into two bottles, the first containing at least 30 ml of urine, the second containing at least 15 ml of urine. The two bottles are then sealed, dated, and sent to the laboratory for analyses with a copy of the completed CCF.

Initial Test and Confirmation Test

On arrival at the laboratory, each urine specimen must be tested twice. The initial immunoassay test is used to eliminate negative urine specimens from further consideration and to identify the presumptively positive specimens that require confirmation or further testing. The confirmatory test uses gas chromatography/mass spectrometry (GC/MS) or liquid chromatography interfaced to (tandem) mass spectrometry (LC/MS or LC/MS/MS) to identify and quantify the presence of a specific drug or metabolite.

Common Methods Used to Defeat the Drug-Testing Program

As discussed earlier, the DOT drug-testing program has measures to determine whether the specimen is urine and whether the urine presents normal characteristics or has been adulterated. At the collection site, the urine is checked for proper temperature and unusual appearance. In some cases, direct observation of the specimen collection is required. At the laboratory, specimen validity testing is conducted to determine whether the specimen is consistent with normal human urine.

In spite of these precautions, however, products aimed at "beating the test" continue to proliferate. In August 2010, a Google search on the phrase "beat a drug test" yielded 1,500,000 results. As of May 2005, the National Laboratory Certification Program identified more than 400 products that are marketed to beat a drug test.

Earlier methods of beating the tests were crude and often ineffective. Over time, however, methods improved and a cottage industry developed, especially through the Internet. In general, many new products work when first introduced, but as they are detected, identified, and ultimately tested for, their use wanes, and they are replaced with newer formulations, repeating the cycle.

Drug users can use three general approaches to beat the urine test: dilution, adulteration, and substitution. Each is discussed in the following sections, which, unless otherwise noted, are based in large part on the following publications: Jambor (2000), Caplan (2007), Dasgupta (2007), Bush (2008), and Jaffee et al. (2008). The reader is encouraged to refer to these publications for additional material.

Dilution

The dilution and cleansing products are aimed at diluting the urine in the bladder (in vivo) to such an extent that the concentrations of tested illicit drugs fall below the established cutoffs. Dilution and cleansing products are available through various Internet sites, and even large retailers sell them, usually with product descriptions that tout the products' purported abilities without mentioning their likely purposes. These products—sold as teas, pills, gel caps, drinks, and chewable tablets—are usually to be consumed with large amounts of water 1 to 5 h before providing a urine specimen.

In addition to selling products, some Internet sites also provide advice on how to beat the test. Drug users are advised to drink as much water as possible before the test and to take high dosages of aspirin, presumably because it may reduce the sensitivity of some urine tests. Donors are advised to never give the first urine of the morning. Taking of vitamin B-2 is advised to color the urine, likely to be clear from drinking the great quantity of water. Taking diuretics is also advised, from weak diuretics such as coffee, cranberry juice, certain health food products, and over-the-counter pills for premenstrual water retention, to potent diuretics like furosemide, which are available only with a prescription in the United States but can be purchased over-the-counter in Mexico. According to some websites, the diuretics can be detected in urine, but analyses of these drugs are rarely included in drug-testing programs not aimed at athletes.

There is evidence that ingestion of large quantities of water can produce false negatives. Cone et al. (1998) examined the effectiveness of two herbal products (Naturally Klean Herbal Tea and golden seal root), a diuretic medication (hydrochlorothiazide), and water (1 gal, 12 oz) as a means of passing a drug test. Subjects smoked a marijuana cigarette and insufflated cocaine and were randomly assigned to one of the treatments. Twenty-two hours after taking the drugs, subjects consumed their respective treatment. The herbal products, the diuretic medication, and the 1 gal of water were served in four 1-qt drinks at 1-h intervals. By the time the subjects drank 2 qt of any fluid, they were generally producing false negatives. The ingestion of large quantities of water produced dilute specimens (creatinine concentration less than 20 mg/dl and specific gravity less than 1.003). Negative marijuana results rarely returned to positive after drinking the 1-gal treatments, but cocaine results reverted to positive after the dilution effects disappeared.

Adulteration

Adulteration additives are chemical compounds that are added to the urine after it is provided in the collection cup (in vitro). Types of additives range from common household items to special formulations purposely developed to increase the probability of false negatives. Some act by interfering with the immunoassay detection scheme, others by converting the target drug to compounds that do not bind to the antibodies used in the immunoassay or that produce negative results in confirmation testing (Wu et al. 1999).

The first type of adulterants were common household items such as bleach, vinegar, hand soap, drain cleaner, eye drops, lemon juice, table salt, and golden seal tea. Mikkelsen and Ash (1988) set up an experiment to determine how these common household items affected urine drug tests. Solutions of several illegal and medicinal drugs were added to urine from a healthy drug-free individual. The results indicated that with the exception of lemon juice, all adulterants produced some false negatives, depending on the type of drug and adulterant concentrations. With the exception of eye drops, however, all adulterants could be detected because they shifted urine characteristics outside of normal human range. Salt produced specific gravity values greater than 1.035; drain cleaner, bleach, and vinegar shifted pH values; golden seal caused a dark appearance in the urine; and hand soap produced cloudiness in the specimen.

The effects of eye drops on urine drug tests were further examined by Pearson et al. (1989). Solutions of several illegal and medicinal drugs in isotonic saline were added to drug-free urine. Eye drop solution was added in various concentrations to each specimen before analyses. Eye drop solution produced false negatives only for marijuana and only in some concentrations, and it was not detectable by routine urine analyses. The lowering of tetrahydrocannabinol (THC) in the specimen could be accounted for by two components, benzalkonium chloride and borate, which reduced the availability of the drug to be tested by increasing the attraction of 9-carboxy-THC to the walls of the glass tubes.

Glutaraldehyde was the active ingredient in some of the first commercially available products marketed to beat the urine drug tests (UrinAid, Clear Choice). It interferes with screening immunoassays by producing final absorbance rates readings for amphetamines, cocaine metabolites, cannabinoids, opiates, and phencyclidine that are lower than true negative urine specimens (Goldberger and Caplan 1994; Wu et al. 1994).

Products with hydrochloric acid, such as Amber 13, THC Free, and an early version of Urine Luck, were marketed next. They did interfere with some immunoassays, often resulting in false negatives. However, because of their acidity, they could be easily detected.

In late 1996, products with nitrates became common (Klear, Whizzies, Randy's Clear). Nitrates did not appear to have a large effect on immunoassays, but they did produce false negatives for marijuana in the confirmatory (GC/MS) tests (Tsai et al. 1998; Wu et al. 1999). Nitrates can naturally

occur in human urine, but at much lower levels than those resulting from adulteration (Urry et al. 1998).

Pyridinium chlorochromate (PCC) was the active ingredient of the next generation of adulterants (Urine Luck). Wu et al. (1999) conducted a series of studies to determine the conditions under which PCC interfered with the screening and confirmation analyses of illegal drugs. PCC was added at three concentrations to urine specimens positive for methamphetamine, cocaine, opiates, phencyclidine, and marijuana. The adulterated specimens were tested with two immunoassays and GC/MS. Results indicated that PCC affected response rates as a function of immunoassay, type of drug, and PCC concentration. In general, however, intermediate and high concentrations of PCC resulted in lower detection of opiates and marijuana with both immunoassays and GC/MS.

Urine Luck was reformulated by dropping the pyridinium ion, making chromium (VI) (chromate) the active ingredient. The new formulation had effects similar to the previous one, a positive screen and negative confirmation result for THC. Paul and Jacobs (2002) investigated the effects of chromate and other oxidizing agents on the GC/MS test for tetrahydrocannabinol carboxylic acid (THCA). They found that, when treated with chromate, THCA was lost completely in the specimen. Another chromium-based product is Ultra Kleen.

In 2001, Cody and Valtier reported the effects of Stealth, an adulterant sold in two vials, one containing peroxidase and the other peroxide. The user pours the content of one vial into the collection cup, adds urine, and then adds the contents of the second vial. The combination of the two chemicals creates a strong oxidant in the urine. Stealth was found to cause immunoassay false negatives for marijuana, LSD, and morphine.

The effects of several oxidants, including iodine (a halogen, with fluorine, chlorine, and bromine) were examined by Paul and Jacobs (2005). Iodine was found to destroy morphine and 6-acetylmorphine almost immediately. The effects were less evident on THCA.

Substitution

Some donors substitute their urine, which would presumably result in a positive test, with urine that is clear of drugs and that, if undetected, would result in a negative test. The drug-free urine, natural or synthetic, is sold in containers and can be frozen for up to 1 year. At the time of collection, the drug-free urine must be warmed to body temperature and transferred to the collection cup. To avoid detection even under direct observation, the drug-free urine is transferred through a hose (the Urinator) or fake penis (the Whizzinator), which can be purchased to match the color of the skin of the donor.

The Whizzinator received media coverage in May 2005 after a professional football player was caught with one in an airport. A month later, the player was suspended by the NFL for substance abuse. In October 2008, federal prosecutors won a 19-count indictment against the maker of the Whizzinator for fraud and selling drug paraphernalia. Prosecutors alleged that by manufacturing and selling the Whizzinator, the company's president and vice president conspired to defraud the Substance Abuse and Mental Health Services Administration.

In November 2008, the two individuals pleaded guilty in federal court to one count of conspiracy to defraud the government and one count of conspiracy to sell drug paraphernalia. In April 2010, one man was sentenced to 6 months in federal prison followed by 3 years of supervised release; the other was sentenced to 3 years' probation (Burris 2010). Their company was forced to shut down and the website used to sell the product has been closed. The next generation of the Whizzinator, however, can still be purchased online. It has been marketed as paraphernalia for urolagnia.

It can be noted, however, that to combat substitution under observed collection, the observer gives instructions to the donors to raise their clothing above the waist, lower clothing and underpants, and to turn around to permit the observer to determine the presence of a prosthetic or other device that could be used to interfere with the collection process.

Specimen Validity Testing (SVT)

In the DOT drug-testing program, measures are in place to determine whether a specimen is urine, whether the urine presents normal characteristics, or whether it has been adulterated.

Normal Urine Characteristics

In healthy humans, urine has specific physical characteristics: temperature, color, clarity, odor, and foaming properties. It also has specific chemical characteristics: creatinine, specific gravity, and pH.

Urine temperature is typically 90°F–100°F (32°C–38°C) within 4 min of collection. Temperatures outside this range may be an indication that a substitute sample was used.

The color of urine depends on several factors. A first morning void has a deep yellow color. After hydration, the urine becomes dilute, and it is a pale yellow. Very dilute urine is almost colorless.

A normal urine specimen is clear and transparent. Bacteria, blood, sperm, crystals, or mucus can make urine look cloudy.

Typically, dilute urine has little to no odor. The smell of urine can be affected by the consumption of foods and beverages such as asparagus, curry, alcohol, coffee, turkey, and onion. Abnormal urine odors can be caused by urinary tract disorders, diabetes, and *E. coli* bacteria infection.

Urine foaming can be a sign of protein in the specimen. Normal urine foaming does not have the rainbow appearance that is typical of soap adulteration.

Creatinine is a waste product formed by the breakdown of creatine, a nitrogenous organic acid that helps to supply energy to muscle. Creatinine is filtered out of the blood by the kidneys and then is passed out of the body in urine. Normal creatinine concentrations are greater than 20 mg/dl.

Specific gravity assesses the amount of substances in the urine. The higher the specific gravity, the more solid material is in the urine. Normal values are between 1.0020 and 1.0200 (Caplan 2007), depending on fluid intake and hydration.

pH is a measure of urine acidity or alkalinity. A urine pH of 4 is strongly acidic, 7 is neutral, and 9 is strongly alkaline.

Types of Validity Tests

Laboratories must conduct the following validity testing of the specimen:

- Determine the creatinine concentration on each primary specimen. Determine its specific gravity if the creatinine concentration is less than 20 mg/dl.
- Determine the pH of each primary specimen.
- Perform one or more validity tests for oxidizing adulterants on each primary specimen.
- Perform additional validity tests on the primary specimen when the following conditions are observed:
  - Abnormal physical characteristics,
  - Reactions or responses characteristic of an adulterant obtained during initial or confirmatory drug tests (e.g., nonrecovery of internal standards, unusual response), or
  - Possible unidentified interfering substance or adulterant.
- If it is determined that specimen is invalid, send to a second laboratory for additional analyses.

Validity Tests Criteria

A specimen is dilute when

- The creatinine concentration is greater than or equal to 2 mg/dl but less than 20 mg/dl, and
- The specific gravity is greater than 1.0010 but less than 1.0030 on a single aliquot.

A specimen is substituted when

- The creatinine concentration is less than 2 mg/dl and the specific gravity is less than or equal to 1.0010 on both the initial and confirmatory tests on two separate aliquots, or
- The creatinine concentration is less than 2 mg/dl and the specific gravity is greater than or equal to 1.0200 on both the initial and tests on two separate aliquots.

A specimen is adulterated when

- The pH is less than 3 or equal to or greater than 11;
- The nitrite concentration is equal to or greater than 500 mcg/ml (two different tests required);
- The chromium (VI) concentration is equal to or greater than 50 mcg/ml (two different tests required);
- The presence of halogen (e.g., bleach, iodine, fluoride) is detected and confirmed, with a specific halogen concentration equal to or greater than the limit of quantitation (LOQ) of the confirmatory test on the second aliquot (two tests required);
- The presence of glutaraldehyde is detected and confirmed, with the glutaraldehyde concentration equal to or greater than the LOQ of the confirmatory test on the second aliquot (two tests required);
- The presence of pyridine (pyridinium chlorochromate) is detected and confirmed, with a concentration equal to or greater than the limit of detection (LOD) of the confirmatory test of the second aliquot (two tests required);
- The presence of a surfactant is detected and confirmed, with a concentration equal to or greater than 100 mcg/ml dodecylbenzene sulfonate-equivalent cutoff concentration on the second aliquot (two tests required); or
- The presence of any other nonspecified adulterant is verified using an initial test on the first aliquot and a different confirmatory test on the second aliquot.

A specimen is invalid when

- Creatinine concentration and specific gravity are inconsistent with normal human urine;
- pH is equal to or greater than 3 and less than 4.5;
- pH is equal to or greater than 9 and less than 11;
- The nitrite concentration is equal to or greater than 200 mcg/ml but less than 500 mcg/dl;
- There is general oxidant activity that cannot be accounted for by identifying a specific agent; or
- A urine specimen does not meet the criteria for dilute, substitute, or adulterated but clearly is not normal.

Detection of Tampering

An important distinction must be made at this point between detection of tampering and prevalence of tampering. Detection of tampering is obtained through SVT. If SVT were

100% effective in detecting tampering, then the prevalence of tampering would equal the rate of detection. In reality, of course, SVT is not 100% effective in detecting tampering, and the true measure of prevalence of tampering is unknown. It can be noted that as part of a report on motor carrier safety by the U.S. Government Accountability Office (GAO 2008), eight undercover investigators provided specimens that were adulterated or substituted, and none was detected with SVT.

The relationship between the detection of tampered specimens and the prevalence of tampered specimens can be viewed in two competing ways. The first is that drug test takers are becoming more sophisticated and more successful in their methods of beating the test. The second view is that SVT has become increasingly effective in detecting tampered specimens. In this report, this view of the relationship was adopted. Thus, when a reduction in *detection* is referred to, it also implies a reduction in *prevalence*.

Table 1 reports the annual nonnegative rates by validity testing category for the federally mandated, safety-sensitive workforce from one large-scale laboratory (Quest Diagnostics, September 2010). Table 2 reports the annual tampered or rejected specimens for the DOT safety-sensitive workforce (Swart, personal communication, Nov. 22, 2010).

Figure 1 shows the adulterated, substituted, and invalid specimens as a percentage of tampered specimens (Swart, personal communication, Nov. 22, 2010). Note that the percentage of invalid specimens has declined over the past 3 years, whereas the percentage of substituted and adulterated specimens has increased.

TABLE 1
ANNUAL NONNEGATIVE RATES (%) BY VALIDITY TESTING CATEGORY

Specimen Validity Test Category	2005	2006	2007	2008	2009
Acid-Base	0.01	0.00	0.01	0.020	0.03
Invalid	0.12	0.12	0.11	0.11	0.09
Oxidizing Adulterants	0.00	0.00	0.00	0.00	0.00
Substitution	0.05	0.05	0.05	0.05	0.06

TABLE 2
SPECIMENS BY TAMPERED OR REJECTED STATUS FOR U.S.DOT SAFETY-SENSITIVE WORKFORCE

Test Category	2008 (July–December)	2009 (Full Year)	2010 (January–June)
Total Results	2,850,106	5,163,165	2,662,335
Tampered	5,106	8,421	3,948
Percentage Tampered	0.18	0.16	0.15
Rejected	4,636	7,106	3,484
Percentage Rejected	0.16	0.13	0.13

Vulnerabilities of DOT Drug Testing

A 2007 GAO report described an undercover operation that revealed significant vulnerabilities in the DOT's drug-testing program. GAO investigators created two fictitious trucking companies and produced bogus commercial drivers' licenses using software and hardware available on the market to the general public. The undercover investigators reported to urine collection sites pretending to have been selected by their

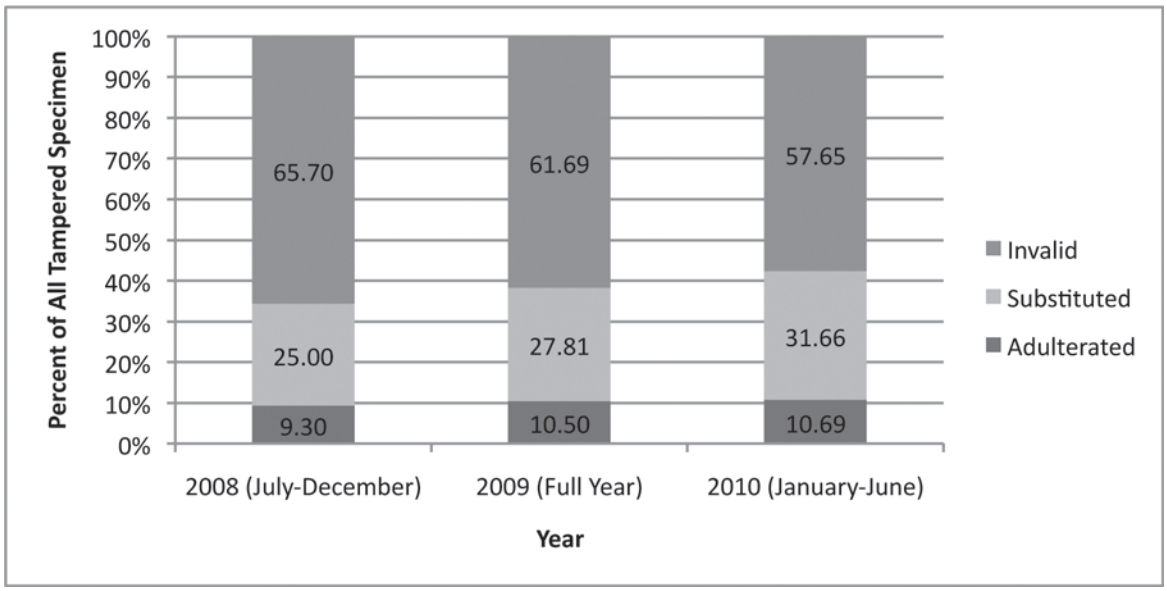

FIGURE 1 Substituted, adulterated, and invalid specimens as a percentage of all tampered specimens for the U.S.DOT safety-sensitive workforce.

companies for drug testing. Twenty-four sites were selected throughout the United States. At each collection site the investigators tested 16 specific DOT protocols. Eight of the 24 urine specimens were either adulterated or substituted.

The results indicated that 22 of the 24 sites showed varying degrees of failure to comply with DOT protocols. In addition, none of the eight adulterated or substituted specimens were detected. Interestingly, the GAO did not count these instances as violations of protocol because the collectors were not required to validate the identity of the employees, but only to ensure that employees presented identification (GAO 2007).

TABLE 3
FAILURE RATES FOR SELECTED DOT PROTOCOLS TESTED BY GAO

Selected DOT Urine Specimen Collection Protocol	Percentage of the 24 Collection Sites That Failed
Secure the facility from all substances that could be used to adulterate or dilute the specimen	75
Secure all sources of water in the restroom	67
Ask the employee to empty his/her pockets and display items to ensure that no items are present that could be used to adulterate the specimen	42
Check the temperature of the specimen	19
Place a bluing agent in the toilet or secure it with tape	17

Although the GAO investigation is now 3 years old, and new procedures have been implemented since then to combat adulteration and substitution, it would be useful to conduct similar undercover investigations on a regular basis to determine whether failure rates are decreasing over time. Table 3 reports the failure rates for the DOT protocols included in the investigation.

Classes of Drugs

Laboratories must test for the following five drugs or classes of drugs in a DOT drug test. DOT specimens cannot be tested for any other drugs.

- Marijuana metabolites,
- Cocaine metabolites,
- Amphetamines,
- Opiate metabolites, and
- Phencyclidine (PCP).

Cutoff Concentrations

In 2010, to harmonize DOT drug-testing requirements with those of DHHS, DOT amended certain provisions of its drug-testing procedures. In general, among other changes, DOT procedures now require initial testing for methylenedioxymethamphetamine (MDMA); confirmatory testing for MDMA, methylenedioxyamphetamine (MDA), and methylenedioxyethylamphetamine (MDEA); initial testing for 6-acetylmorphine; lower initial test and confirmatory test cutoff concentrations for amphetamines; and lower initial test and confirmatory test cutoff concentrations for cocaine. Table 4 reports the current cutoff concentrations for initial and confirmation tests.

TABLE 4
CURRENT CUTOFF CONCENTRATIONS FOR INITIAL AND CONFIRMATION TESTS

Initial Test Analyte	Initial Test Cutoff Concentration (ng/ml)	Confirmatory Test Analyte	Confirmatory Test Cutoff Concentration (ng/ml)
Marijuana Metabolites	50	THCA[a]	15
Cocaine	150	Benzoylecgonine	100
Opiate Metabolites			
Codeine/Morphine[b]	2,000	Codeine	2,000
		Morphine	2,000
6-Acetylmorphine	10	6-Acethylmorphine	10
Phencyclidine	25	Phencyclidine	25
Amphetamines[c]			
Amphetamine/Methamphetamine[d]	500	Amphetamine	250
		Methamphetamine[e]	250
MDMA[f]	500	MDMA	250
		MDA[g]	250
		MDEA[h]	250

[a] Delta-9-tetrahydrocannabinol-9-carboxylic acid.
[b] Morphine is the target metabolite for codeine/morphine testing.
[c] Either a single initial test kit or multiple initial test kits may be used, provided the single test kit detects each target analyte independently at the specified cutoff.
[d] Methamphetamine is the target analyte for amphetamine/methamphetamine testing.
[e] To be reported positive for methamphetamine, a specimen must also contain amphetamine at a concentration equal to or greater than 100 ng/ml.
[f] Methylenedioxymethamphetamine.
[g] Methylenedioxyamphetamine.
[h] Methylenedioxyethylamphetamine.

Reporting of Results

All drug test results fall into one of three categories:

1. Negative results

a. Negative
b. Negative-dilute, with numerical values for creatinine and specific gravity
2. Nonnegative results
a. Positive, with drug metabolites noted
b. Positive-dilute, with drug metabolites noted, with numerical values for creatinine and specific gravity
c. Adulterated, with adulterants noted
d. Substituted, with confirmatory values for creatinine and specific gravity
e. Invalid
3. Rejected for testing

Medical Review Officer

Laboratories send the drug test results to the medical review officer (MRO), a licensed physician. The MRO is the gatekeeper of the drug-testing program, responsible for verifying the laboratory test results and determining whether there may be a legitimate medical reason for a positive drug test or whether the employee has committed a rule violation. The MRO can evaluate explanations for certain drug results and, under certain circumstances, has the authority to downgrade a result from positive to negative. MROs must meet stringent qualifications and must submit to requalification examinations every 5 years. MROs must keep negative and cancelled results for 1 year and nonnegative results for 5 years.

ALCOHOL TESTING

Although alcohol is a legal drug, there is no legitimate medical explanation for alcohol in one's system. Thus, MROs have no role in alcohol testing.

Alcohol tests can be administered for the same reasons as drug tests: pre-employment, random, reasonable suspicion, postaccident, return-to-duty, and follow-up. Random alcohol testing is not required under some DOT administrations.

As for the drug tests, a dual-test procedure is used to determine whether an employee has prohibited alcohol concentrations in the system. The initial test can use either saliva or breath. If the initial test is positive, only breath can be used in the confirmation test to assess the level of alcohol in the system. An alcohol concentration of 0.040 and above is a positive test, and a violation of DOT regulations. An alcohol concentration between 0.020 and 0.039 is prohibited conduct, and the employee is removed from safety-sensitive work while in that alcohol concentration range.

CONSEQUENCES OF A DRUG OR ALCOHOL VIOLATION

An employee must be immediately removed from performing safety-sensitive functions if any of the following conditions occur:

- A verified positive drug test result.
- An alcohol test result of 0.040 or higher. (An employee must also be immediately removed from safety-sensitive duties with a blood alcohol content (BAC) of 0.020 or higher, although a regulatory violation occurs only at the 0.040 level.)
- Refusal to take the test, including verified adulterated or substituted drug test results.
- Violation of DOT agency drug and alcohol regulation.
- Employees with a drug or alcohol violation are not eligible to return to safety-sensitive work unless they successfully complete the return-to-duty requirements.

SUBSTANCE ABUSE PROFESSIONAL

The substance abuse professional (SAP) evaluates employees who have violated DOT drug and alcohol regulations and makes recommendations concerning education, treatment, follow-up testing, and aftercare. The SAP must have one of the following credentials: licensed physician, licensed or certified social worker, licensed or certified psychologist, licensed or certified employee assistance professional, state licensed or certified marriage and family therapist, or certified drug and alcohol counselor. The SAP must be knowledgeable about and have clinical experience in the diagnosis and treatment of alcohol- and controlled substances-related disorders, must be knowledgeable about the SAP function as it relates to employer interests in safety-sensitive duties, and must be knowledgeable and keep current on 49 CFR Part 40 and the various agency regulations.

RECORDS

The testing laboratory is required to maintain all records pertaining to each employee urine specimen for a minimum of 2 years. The MRO must keep negative and cancelled results for 1 year and positive results and refusals for 5 years. The SAP is required to maintain copies of the reports to employers for 5 years. The look-back period that an employer must check on the drug- and alcohol-testing record of employees it is intending to use to perform safety-sensitive duties is 2 years (with exceptions for motor carriers and aviation).

CHAPTER FOUR

SPECIFIC REGULATIONS BY MODE

To comply with DOT requirements, each DOT agency must specify aspects of its drug- and alcohol-testing program not directly covered in 49 CFR Part 40. At a minimum, each agency is required to specify the employees in safety-sensitive positions that must be drug and alcohol tested, the types of tests that must be conducted, the minimum annual percentage rate for random drug testing, and record retention periods. The following sections report the specific regulations by mode (see Table 5), as described in the DOT guidelines for the SAP (2009).

TABLE 5
REGULATIONS BY MODE

Mode	Agency	Regulation
Aviation	Federal Aviation Administration (FAA)	14 CFR Part 120
Maritime	United States Coast Guard (USCG)	46 CFR Parts 4, 5, and 16
Motor Carrier	Federal Motor Carrier Safety Administration (FMCSA)	49 CFR Part 382
Pipelines	Pipeline and Hazardous Materials Safety Administration (PHMSA)	49 CFR Part 199
Public Transit	Federal Transit Administration (FTA)	49 CFR Part 655
Rail	Federal Railroad Administration (FRA)	49 CFR Part 219

AVIATION

The aviation industry, regulated by the FAA, has approximately 397,960 employees subject to testing (Swart, personal communication, Nov. 15, 2010).

Employees who must be tested: Flight crew members, flight attendants, flight instructors, aircraft dispatchers, maintenance personnel, ground security coordinators, aviation screeners, and air traffic controllers.

Types of tests for drugs: Pre-employment, random, postaccident, reasonable cause, return-to-duty, and follow-up. The minimum annual percentage rate for random drug testing is based on the positive rate for the 2 prior consecutive years for the entire industry. For the year 2011, the minimum random drug-testing rate was set at 25%.

Types of tests for alcohol: Pre-employment (authorized, not mandated), random, postaccident, reasonable cause, return-to-duty, and follow-up. The minimum annual percentage rate for random alcohol testing is based on the positive rate for the 2 prior consecutive years for the entire industry. For the year 2011, the minimum random alcohol testing rate was set at 10%.

Definition of accident requiring testing: Accident means an occurrence associated with the operation of an aircraft that takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage.

Reasonable cause determination (drugs): Two of the employee's supervisors, one of whom is trained, shall substantiate and concur in the decision to test the employee. If the employer is not an air carrier operating under 14 CFR Part 121 and has 50 or fewer employees, a single trained supervisor can make the determination. A trained supervisor makes the determination based on specific contemporaneous physical, behavioral, or performance indicators of probable drug use.

Reasonable suspicion determination (alcohol): One trained supervisor makes the determination based on specific, contemporaneous, articulable observations concerning the employee's appearance, behavior, speech, or body odors.

Preduty alcohol prohibition: Eight hours prior to performance of flight crewmember duties, flight attendant duties, and air traffic controller duties. Four hours prior to performance of other duties.

Actions for BACs 0.020–0.039: If the employer chooses to return the employee to covered services within 8 h, the BAC retest must be below 0.020.

Employee training (drugs): An employer must train all employees who perform safety-sensitive duties on the effects and consequences of prohibited drug use on personal health, safety, and work environment, and on the manifestations

and behavioral cues that may indicate drug use and abuse. Employers must also implement an education program for safety-sensitive employees by displaying and distributing informational materials, a community service hotline telephone number for employee assistance, and the employer's policy regarding drug use in the workplace. The policy must include information regarding the consequences under the rule of using drugs while performing safety-sensitive functions, receiving a verified positive drug test result, or refusing to submit to a drug test required under the rule.

Employee training (alcohol): Employers must provide covered employees with educational materials that explain the alcohol misuse requirements and the employer's policies and procedures with respect to meeting those requirements. The information must be distributed to each covered employee and must include information such as the effects of alcohol misuse on an individual's health, work, and personal life; signs and symptoms of an alcohol problem; and the consequences for covered employees found to have violated the regulatory prohibitions.

Supervisor training (drugs): One hour of training is required on the specific, contemporaneous physical, behavioral, and performance indicators of probable drug use. In addition, supervisors must receive employee training as defined earlier. Reasonable recurrent training is also required.

Supervisor training (alcohol): One hour of training is required on the physical, behavioral, speech, and performance indicators of probable alcohol misuse.

Reportable employee drug and alcohol violation: Each employer must notify the FAA about any covered employee who holds a certificate issued under 14 CFR Parts 61 (pilots and flight and ground instructors), 63 (flight engineers and navigators), or 65 (air traffic control tower operators, aircraft dispatchers, airframe or power plant mechanics, and repairmen) who has refused to take a drug or alcohol test. The MRO may report a positive or refusal (i.e., adulterated results, substituted results, or no medical explanation for providing an insufficient specimen) on behalf of the employer.

Each employer must notify the FAA about any safety-sensitive employee who is required to hold an airman medical certificate issued under 14 CFR Part 67 who has a positive drug test result, an alcohol test result of 0.040 or greater, or who has refused to submit to testing. The MRO may report a positive or refusal (i.e., adulterated results, substituted results, or no medical explanation for providing an insufficient specimen) on behalf of the employer.

Each employer must not permit an employee who is required to hold a medical certificate under Part 67 to perform a safety-sensitive function to resume that duty until the employee has received a new medical certificate issued by the FAA Federal Air Surgeon and the employer has ensured that the employee meets the return-to-duty requirements of Part 40. (Medical certificates are not operating certificates, but employees cannot continue to perform airman duties without a medical certificate.)

According to FAA regulation 14 CFR Part 120, Subpart E, Section 120.113(d), when a MRO verifies a drug test result or a SAP performs the initial evaluation, he or she must ask the employee whether he or she holds or would be required to hold an airman medical certificate issued under 14 CFR Part 67 of this chapter to perform a safety-sensitive function for the employer. (This requirement applies only to MROs and SAPs who provide services for FAA-regulated employers.) If the employee answers in the affirmative, the employee must obtain an airman medical certificate issued by the Federal Air Surgeon dated after the drug and/or alcohol violation date.

The SAP must wait until the employee obtains the airman medical certificate before reporting to an employer that the employee demonstrated successful compliance with the SAP's treatment and/or education recommendations.

MARITIME

The maritime industry, regulated by the USCG, has approximately 100,955 employees subject to testing (Swart, personal communication, Nov. 15, 2010). Note that the USCG transferred to the Department of Homeland Security in 2003, but still conducts drugs testing under the DOT rules.

Employees who must be tested: A person who is on board a vessel acting under the authority of a license, certificate of registry, or merchant mariner's document. Also, a person engaged or employed on board a U.S.-owned vessel and such vessel is required to engage, employ, or be operated by a person holding a license, certificate of registry, or merchant mariner's document.

Types of tests for drugs: Pre-employment, periodic, random, reasonable cause, post-serious marine incident (SMI), return-to-duty, and follow-up. For the year 2011, the minimum random drug-testing rate was set at 50%.

Types of tests for alcohol: 49 CFR Part 40 alcohol-testing requirements do not apply to the maritime industry. 46 CFR Part 4.06 requires post-SMI chemical testing for alcohol use. 33 CFR Part 95.035 allows for a marine employer or a law enforcement officer to direct an individual to undergo a chemical test for intoxicants when reasonable cause exists or a marine casualty has occurred.

Definition of accident requiring testing: In general, an SMI is a discharge of 10,000 gal or more of oil into the navigable waters of the United States, whether or not

resulting from a marine casualty; a discharge of a reportable quantity of a hazardous substance into the navigable waters or into the environment of the United States, whether or not resulting from a marine casualty; or a marine casualty or accident required to be reported to the Coast Guard, involving a vessel in commercial service, and resulting in any of the following: one or more deaths, an injury to any person (including passengers) that requires professional medical treatment beyond first aid, and, in the case of a person employed on board a commercial vessel, that renders the person unable to perform routine vessel duties; damage to property in excess of $100,000; actual or constructive total loss of any inspected vessel; or actual or constructive total loss of any uninspected, self-propelled vessel of 100 gross tons or more.

Reasonable suspicion determination (drugs): The marine employer must have a reasonable and articulable belief that the individual has used a dangerous drug. This belief can be based on the direct observation of specific, contemporaneous physical, behavioral, or performance indicators of probable use and, where practicable, based on the observation of two persons in supervisory positions.

Reasonable cause determination (alcohol): The employee was directly involved in the occurrence of a marine casualty, or the individual operated a vessel and the effect of the intoxicant(s) consumed by the individual on the person's manner, disposition, speech, muscular movement, general appearance, or behavior is apparent by observation.

Preduty alcohol use prohibition: Four hours before performance of scheduled duty.

Actions for BACs 0.020–0.039: Not applicable.

Employee training: Employers must provide education with display and distribution of informational materials and a community service hotline telephone number. Distribution to each employee of the employer's policy regarding the use of drugs and alcohol is mandatory. Training must include the effects of drugs and alcohol on personal health, safety, and work environment, and the manifestations and behavioral cues that may indicate drug and alcohol use and abuse.

Supervisor training: One hour of training is required on the effects of drugs and alcohol on personal health, safety, and work environment, and the manifestations and behavioral cues that may indicate drug and alcohol use and abuse.

Reportable employee drug and alcohol violations: Results of all post-SMI tests and positive drug test results for all mariners who hold a license, certificate of registry, or merchant mariner's document must be reported to the nearest Coast Guard Officer in Charge, Marine Inspection.

MOTOR CARRIERS

The trucking industry, regulated by the FMCSA, has approximately 802,740 employees subject to testing (Swart, personal communication, Nov. 15, 2010).

Employees who must be tested: Drivers requiring a commercial driver's license (CDL) to drive commercial motor vehicles (CMV). A CMV is a vehicle with a gross weight rating of 26,001 or more pounds, is designed to transport 16 or more occupants (including the driver), or is of any size and is used in the transport of hazardous materials and is required to be placarded.

Types of tests for drugs: Pre-employment, random, postaccident, reasonable cause, return-to-duty, and follow-up. The minimum annual percentage rate for random drug testing is based on the positive rate for the two prior consecutive years for the entire industry. For the year 2011, the minimum random drug-testing rate was set at 50%.

Types of tests for alcohol: Pre-employment (authorized, not mandated), random, postaccident, reasonable cause, return-to-duty, and follow-up. The minimum annual percentage rate for random alcohol testing is based on the positive rate for the two prior consecutive years for the entire industry. For the year 2011, the minimum random alcohol testing rate was set at 10%.

Definition of accident requiring testing: Any accident involving a fatality, any accident with bodily injury with immediate medical treatment away from the scene and a citation given to the CMV driver, and any instance of disabling damage to any motor vehicle requiring tow away and a citation given to the CMV driver.

Reasonable suspicion determination: One trained supervisor or company official can make the decision based on specific, contemporaneous, articulable observations concerning the appearance, behavior, speech, or body odors of the employee.

Preduty alcohol use prohibition: Drivers cannot perform safety-sensitive functions within 4 h after using alcohol. No employer having actual knowledge that a driver has used alcohol within 4 h can permit a driver to perform or continue to perform safety-sensitive functions.

Actions for BACs 0.020–0.039: The employee cannot be returned to duty until the next day or the start of the employee's next regularly scheduled duty period, but not less than 24 h following the test.

Employee training: Employer must provide educational materials explaining drug and alcohol regulatory requirements and employer's policies and procedures for meeting

regulation requirements. Distribution to each employee of these educational materials and the employer's policy regarding the use of drugs and alcohol is mandatory.

Supervisor training: One hour of training is required on the specific, contemporaneous physical, behavioral, and performance indicators of probable drug use. One hour of training is also required on the specific, contemporaneous physical, behavioral, and performance indicators of probable alcohol use.

Reportable employee drug and alcohol violations: No requirements to report violations to FMCSA.

Penalties and consequences: Any employer or driver who violates the requirements of 49 CFR Part 382 or 49 CFR Part 40 is subject to the civil and/or criminal penalty.

Other: The background check period for a job candidate's previous drug- and alcohol-testing records for FMCSA is 3 years. Drivers are prohibited from using alcohol for 8 h following an accident or until they have undergone a postaccident alcohol test, whichever occurs first.

PIPELINE AND HAZARDOUS MATERIALS

The pipeline industry, regulated by the PHMSA, has approximately 122,962 employees subject to testing (Swart, personal communication, Nov. 15, 2010).

Employees who must be tested: A person who performs on a pipeline or liquefied natural gas (LNG) facility in operation, maintenance, or emergency-response function.

Types of tests for drugs: Pre-employment, random, reasonable cause, postaccident, return-to-duty, and follow-up. For the year 2011, the minimum random drug-testing rate was set at 25%.

Types of tests for alcohol: Postaccident, reasonable suspicion, return-to-duty, and follow-up.

Definition of accident requiring testing: An accident is one involving gas pipeline facilities or LNG facilities or involving hazardous liquid or carbon dioxide pipeline facilities.

Reasonable suspicion determination: One trained supervisor can make the decision based on signs and symptoms.

Reasonable cause determination: One trained supervisor can make the decision based on reasonable and articulable belief that the employee is using prohibited drugs on the basis of specific, contemporaneous physical, behavioral, or performance indicators of probable drug use.

Preduty alcohol use prohibition: Four hours before performance of duty.

Actions for BACs 0.020–0.039: If the employer chooses to return the employee to covered service within 8 h, the BAC retest must be below 0.020.

Employee training (drugs): Employer must provide EAP education with display and distribution of informational materials, display and distribution of a community service hotline telephone number, and display and distribution of the employer's policy regarding the use of prohibited drugs.

Employee training (alcohol): Employer must develop materials that explain policies and procedures (as well as names of those who can answer questions about the program) and distribute them to each covered employee.

Supervisor training: One hour of training is required on the specific, contemporaneous physical, behavioral, and performance indicators of probable drug use. One hour of training is also required on the specific, contemporaneous physical, behavioral, and performance indicators of probable alcohol use.

Reportable employee drug and alcohol violations: No requirements to report violations to PHMSA.

PUBLIC TRANSIT

The public transit industry, regulated by the FTA, has approximately 277,793 employees subject to testing (Swart, personal communication, Nov. 15, 2010).

Employees who must be tested: Employees performing safety-sensitive functions, including persons who perform a revenue vehicle operation, revenue vehicle and equipment maintenance, revenue vehicle control or dispatch (optional), CDL nonrevenue vehicle operation, or armed security duties.

Types of tests for drugs: Pre-employment, random, reasonable suspicion, postaccident, return-to-duty, and follow-up. For the year 2011, the minimum random drug-testing rate was set at 25%.

Types of tests for alcohol: Pre-employment (optional), random, reasonable suspicion, postaccident, return-to-duty, and follow-up. For the year 2011, the minimum random alcohol testing rate was set at 10%.

Definition of accident requiring testing: Any accident involving a fatality requires testing. Testing following a nonfatal accident is discretionary: If the employer can show that the employee's performance could not have contributed to the accident, no test is needed. Nonfatal accidents that may

require testing must have disabling damage to any vehicle or immediate medical attention away from the scene to meet the testing threshold.

Reasonable suspicion determination: One trained supervisor or company official can make the decision based on specific, contemporaneous, articulable observations concerning the appearance, behavior, speech, or body odors of the employee.

Preduty alcohol use prohibition: Four hours before performance of duty.

Actions for BACs 0.020–0.039: If the employer chooses to return the employee to covered service within 8 h, the BAC retest must be below 0.020.

Employee training: Employer must provide education with display and distribution of informational materials and a community service hotline telephone number, if available.

One hour of training on the effects and consequence of prohibited drug use on personal health, safety, and the work environment, and on the signs and symptoms that may indicate prohibited drug use. Distribution to each employee of the employer's policy regarding the use of drugs and alcohol with signed receipt is mandatory.

Supervisor training: One hour of training is required on the specific, contemporaneous physical, behavioral, and performance indicators of probable drug use. One hour of training is also required on the specific, contemporaneous physical, behavioral, and performance indicators of probable alcohol use.

Reportable employee drug and alcohol violations: No requirements to report violations to FTA.

Other: Anyone with direct or immediate supervisory authority over an employee may not collect that person's urine, saliva, or breath.

RAIL

The railroad industry, regulated by the FRA, has approximately 105,564 employees subject to testing (Swart, personal communication, Nov. 15, 2010).

Employees who must be tested: A person who performs hours of service functions at a rate sufficient to be placed into the railroad's random testing program. Categories of personnel who normally perform these functions are locomotive engineers, trainmen, conductors, switchmen, locomotive hostlers/helpers, utility employees, signalmen, operators, and train dispatchers.

Types of tests for drugs: Pre-employment, random, reasonable suspicion, reasonable cause, postaccident, return-to-duty, and follow-up. For the year 2011, the minimum random drug-testing rate was set at 25%.

Types of tests for alcohol: Pre-employment (optional), random, reasonable suspicion, reasonable cause, postaccident, return-to-duty, and follow-up. For the year 2011, the minimum random alcohol testing rate was set at 10%.

Definition of accident requiring testing: Any major train accident (one that results in a fatality or a release of hazardous material accompanied by an evacuation or a reportable injury resulting from the hazardous material release or damage to railroad property of $1,000,000 or more), an impact accident (one that results in a reportable injury or damage to railroad property of $150,000 or more), fatal train incident (one that involves a fatality to an on-duty railroad employee), and passenger train accident (one that involves a reportable injury to any person in a passenger train accident).

The postaccident testing rule requires urine and blood specimen collection from surviving employees and also tissue from deceased employees (these collection procedures go well beyond the normal Part 40 procedures). For surviving employees, these specimens are collected at an independent medical facility. FRA regulation, 49 CFR Part 219 Subpart C, stipulates the level of events requiring testing and who will be tested. The collected specimens are analyzed only at FRA's contract laboratory. Postaccident testing provides FRA with accident investigation and usage data.

Reasonable suspicion determination: One trained supervisor can make the decision for alcohol testing based on specific, contemporaneous, articulable observations concerning the appearance, behavior, speech, or body odors of the employee. A decision to conduct a drug test requires two supervisors (only the on-site supervisor must be trained).

Preduty alcohol use prohibition: Four hours before performance of duty or after receiving notice to report for covered service, whichever is the shorter period.

Actions for BACs 0.020–0.039: The employee cannot be returned to duty until the start of the employee's next regularly scheduled duty period, but not less than 8 h following the test.

Employee training: Employer must provide education materials that explain the requirements of the FRA rules as well as railroad policies and procedures with respect to meeting those requirements.

Supervisor training: A total of 3 h of training is required: 1 h on the specific, contemporaneous physical, behavioral, and performance indicators of probable drug use; 1 h of sim-

ilar training on probable indicators of alcohol use; and 1 h of training on how to determine whether an accident qualifies for postaccident testing.

Reportable employee drug and alcohol violations: No requirements to report violations to FRA. Engineers, who are the only certificate holders in the rail industry, will have their certificates reviewed for suspension or revocation by the employer when an FRA violation occurs. Note that an FRA alcohol violation occurs at 0.04% or greater. When a locomotive engineer is in a voluntary referral program, the counseling professional must report an engineer's refusal to cooperate in the recommended course of counseling or treatment.

Penalties and consequences: A comprehensive penalty schedule lists the civil penalties associated by various violations. The fines range from $1,000 to $10,000.

Reporting: Each railroad that has a total of 400,000 or more employee hours (including hours worked by all employees of the railroad, regardless of occupation, not only while in the United States but also while outside the United States) must submit to FRA by March 15 of each year a report covering the previous calendar year (January 1–December 31), summarizing the results of its control of alcohol and drug use program.

Other: Anyone with direct or immediate supervisory authority over an employee may not collect that person's urine, saliva, or breath.

Refusal to provide a specimen results in a mandatory minimum 9-month removal from covered service. During this 9-month period, there is no prohibition against the employee working in a noncovered service position if agreeable to the employer.

Locomotive engineers (or other employees certified as locomotive engineers at the time of the alcohol or drug violation) require both alcohol and drug return-to-duty tests and both alcohol and drug follow-up tests.

Locomotive engineers who have a driving under the influence (DUI) violation are required by Part 240 to be evaluated to determine whether they have an active substance abuse disorder. A DUI is not considered to be a violation of FRA regulations if it occurred during the employee's off-duty time; therefore, any testing would be conducted under employer authority.

Employers must provide both a voluntary referral program that allows an employee to self-refer for treatment and a coworker report program that allows one employee to refer another for treatment before the employer identifies a problem. Both of these EAPs guarantee that employees will retain their jobs if they cooperate and complete the required rehabilitation program. For an engineer who is in a voluntary referral program, the counseling professional must report an engineer's refusal to cooperate in the recommended course of counseling or treatment to the employer.

CHAPTER FIVE

ALCOHOL- AND DRUG-TESTING STATISTICS

Comprehensive alcohol- and drug-testing statistics for the transportation workplace are not readily available to the public. To obtain the most recent set of complete alcohol- and drug-testing statistics, DF Consulting (DFC) made a request for the most recent set of data to the DOT Office of Drug and Alcohol Policy and Compliance (ODAPC), the FAA, the USCG, the FMCSA, the PHMSA, the FTA, and the FRA. ODAPC provided a coordinated response to DFC in the form of a spreadsheet containing data for all the modes (Swart, personal communication, Nov. 15, 2010). Unless otherwise noted, the following statistics reflect what was provided to DFC by ODAPC.

DFC calculated the positivity rates for the individual modes based on the data provided by ODAPC. The positivity rate for drugs was calculated by adding the verified positive tests for one or more drugs to the total number of refusals (adulterated, substituted, "shy bladder," and other refusals) and dividing the sum by the total number of test results. The positivity rate for alcohol was calculated by adding the confirmed alcohol violations (tests with BAC $\geq$ 0.040) to the total number of refusals ("shy lung" and other refusals) and dividing the sum by the total number of test results. Refusals were added to verified positive tests because, according to 49 CFR Part 40.261, a refusal has the same consequences as a violation, presumably because an employee who refuses does so as an attempt to hide a positive test.

The positivity rates are not weighted by the stratified samples that were often used to collect the data. Therefore, they may not represent the true values for the relevant populations.

AVIATION

The FAA collects data from all major airlines (with 14 CFT Part 121 certification, such as Delta, United, and American). There are about 100 of these companies. The FAA also requires employers with 50 or more safety-sensitive employees to report data. In addition, approximately 2,000 companies with fewer than 50 safety-sensitive employees are selected at random to provide data.

Tables 6 and 7 report the FAA 2008 drug and alcohol test results, respectively. Figure 2 shows the drug and alcohol positivity rates by test type.

For drugs, pre-employment tests had the highest number of positives, followed by random tests and follow-up. Reasonable cause was the type of test with the highest weighted positivity rate. Marijuana was the most commonly detected drug.

For alcohol, reasonable cause tests had the highest number of positives, followed by random and follow-up tests. Reasonable cause was the type of test with the highest unweighted positivity rate.

TABLE 6
FAA 2008 DRUG TEST RESULTS

Test Reason	Total Number of Test Results	Verified Negative Tests	Verified Positive Tests for One or More Drugs	Positive for Marijuana	Positive for Cocaine	Positive for Phencyclidine	Positive for Opiates	Positive for Amphetamines	Refusals				Cancelled Tests
									Adulterated	Substituted	"Shy Bladder"	Other Refusals	
Pre-employment	85,291	84,409	833	645	125	9	13	52	1	4	6	38	185
Random	110,207	109,559	575	362	150	1	14	62	3	6	12	52	246
Postaccident	693	688	5	4	1	0	0	1	0	0	0	0	3
Reasonable Cause	197	159	30	15	11	0	1	7	0	2	1	5	1
Return-to-Duty	363	354	9	5	4	0	0	0	0	0	0	0	0
Follow-up	2,759	2,708	50	25	16	0	0	11	0	0	0	1	5
Total	199,510	197,877	1,502	1,056	307	10	28	133	4	12	19	96	440

TABLE 7
FAA 2008 ALCOHOL TEST RESULTS

Test Reason	Total Number of Screening Test Results	BAC < 0.020	BAC ≥ 0.020	Number of Confirmation Test Results	Confirmation Tests BAC 0.020–0.039	Confirmation Tests BAC ≥ 0.040	Refusals		Cancelled Tests
							"Shy Lung"	Other Refusals	
Pre-employment	2,022	2,021	1	5	0	0	0	0	10
Random	49,767	49,640	112	149	34	46	0	15	23
Postaccident	269	268	1	1	0	1	0	0	0
Reasonable Cause	223	89	124	117	19	96	0	10	1
Return-to-Duty	173	172	1	1	0	1	0	0	0
Follow-up	1,485	1,468	17	15	2	10	0	0	0
Total	53,939	53,658	256	288	55	154	0	25	34

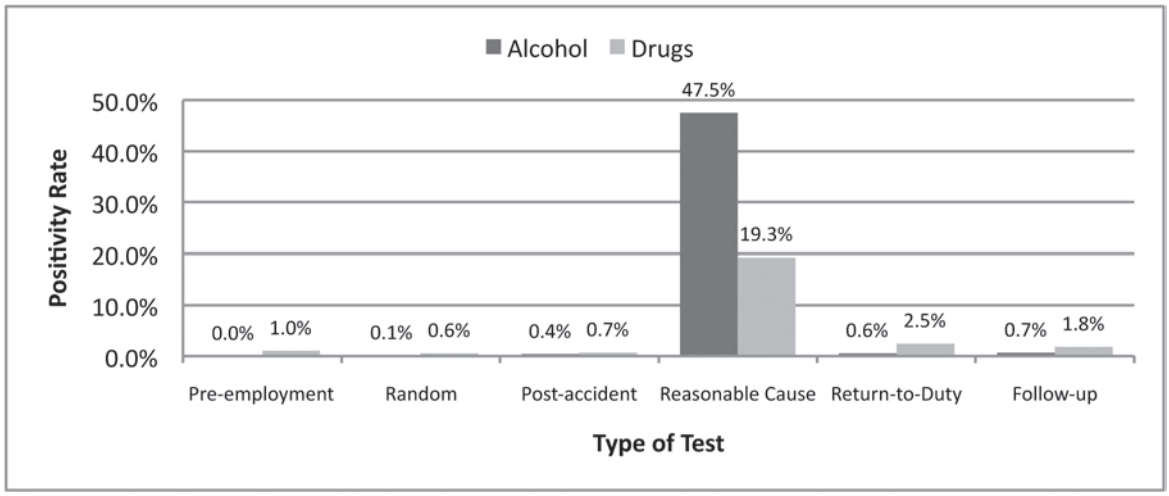

FIGURE 2 FAA 2008 drug and alcohol unweighted positivity rates by test type.

MARITIME

All marine employers are required to report testing data. However, 2008 data were received from approximately 50–55% of the marine employers—with consortia/third-party administrators (C/TPAs) doing the reporting for their individual companies. C/TPAs reported approximately 80–85% of the submitted data.

As mentioned earlier, 49 CFR Part 40 alcohol-testing requirements do not apply to the maritime industry. Thus, no alcohol data could be obtained.

Table 8 reports the USCG 2008 drug-testing results. Figure 3 shows the drug positivity rates by test type.

Pre-employment tests had the highest number of positives, followed by random and postaccident tests. Reasonable cause was the type of test with the highest unweighted positivity rate. Marijuana was the most commonly detected drug.

MOTOR CARRIERS

Because the size of motor carriers can range from one employee to several thousand employees, to obtain unbiased estimates of alcohol and drug usage, the FMCSA collects data from motor carriers on the basis of stratified samples, as follows:

- 1 CDL driver: select 600 carriers;
- 2 to 19 CDL drivers: select 900 carriers;
- 20 to 99 CDL drivers: select 450 carriers;
- 100 to 249 CDL drivers: select 400 carriers;
- 250 to 999 CDL drivers: select 400 carriers;
- 1,000 or more CDL drivers: select all carriers.

Tables 9 and 10 report the FMCSA 2008 drug and alcohol test results, respectively. Figure 4 shows the drug and alcohol unweighted positivity rates by test type.

For drugs, pre-employment tests had the highest number of positives, followed by random and postaccident tests.

TABLE 8
USCG 2008 DRUG TEST RESULTS

Test Reason	Total Number of Test Results	Verified Negative Tests	Verified Positive Tests for One or More Drugs	Positive for Marijuana	Positive for Cocaine	Positive for Phencyclidine	Positive for Opiates	Positive for Amphetamines	Refusals				Cancelled Tests
									Adulterated	Substituted	"Shy Bladder"	Other Refusals	
Pre-employment	36,677	35,669	937	726	167	1	17	56	19	3	4	45	239
Random	57,526	56,860	587	361	164	6	17	58	10	5	1	63	319
Postaccident	7,290	7,181	95	63	26	1	2	3	2	2	0	10	102
Reasonable Cause	709	641	54	39	10	0	1	12	1	0	0	13	1
Return-to-Duty	443	437	5	5	1	0	0	0	0	0	0	1	2
Follow-up	583	569	12	9	0	0	0	3	0	0	0	2	1
Total	103,228	101,357	1,690	1,203	368	8	37	132	32	10	5	134	664

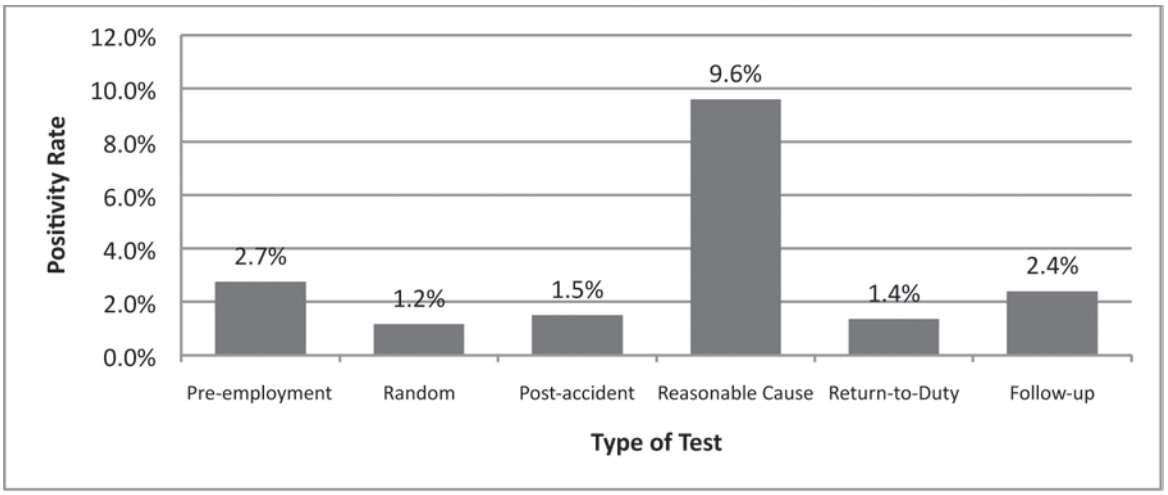

FIGURE 3 USCG 2008 unweighted drug positivity rates by test type.

TABLE 9
FMCSA 2008 DRUG TEST RESULTS

Test Reason	Total Number of Test Results	Verified Negative Tests	Verified Positive Tests for One or More Drugs	Positive for Marijuana	Positive for Cocaine	Positive for Phencyclidine	Positive for Opiates	Positive for Amphetamines	Refusals				Cancelled Tests
									Adulterated	Substituted	"Shy Bladder"	Other Refusals	
Pre-employment	457,511	451,008	6,077	4,161	1,514	51	154	354	36	38	75	277	1,121
Random	448,881	445,329	3,043	1,777	990	8	71	272	19	18	49	423	1,165
Postaccident	20,449	20,181	236	141	70	0	8	25	1	1	1	29	155
Reasonable Suspicion	728	605	97	43	40	1	10	11	2	0	1	23	7
Return-to-Duty	2,433	2,392	41	29	8	0	1	4	0	0	0	0	6
Follow-up	7,512	7,377	123	60	41	0	4	18	2	2	1	7	29
Total	937,514	926,892	9,617	6,211	2,663	60	248	684	60	59	127	759	2,483

TABLE 10
FMCSA 2008 ALCOHOL TEST RESULTS

Test Reason	Total Number of Screening Test Results	BAC < 0.020	BAC ≥ 0.020	Number of Confirmation Test Results	Confirmation Tests BAC 0.020–0.039	Confirmation Tests BAC ≥ 0.040	Refusals		Cancelled Tests
							"Shy Lung"	Other Refusals	
Pre-employment	5,235	5,218	17	125	3	3	0	0	2
Random	118,511	117,876	585	960	61	88	4	46	71
Postaccident	10,524	10,431	69	143	7	11	0	24	6
Reasonable Suspicion	498	339	139	126	30	87	0	20	0
Return-to-Duty	489	485	4	11	0	0	0	0	1
Follow-up	3,254	3,225	28	18	10	8	0	1	1
Total	138,511	137,574	842	1,383	111	197	4	91	81

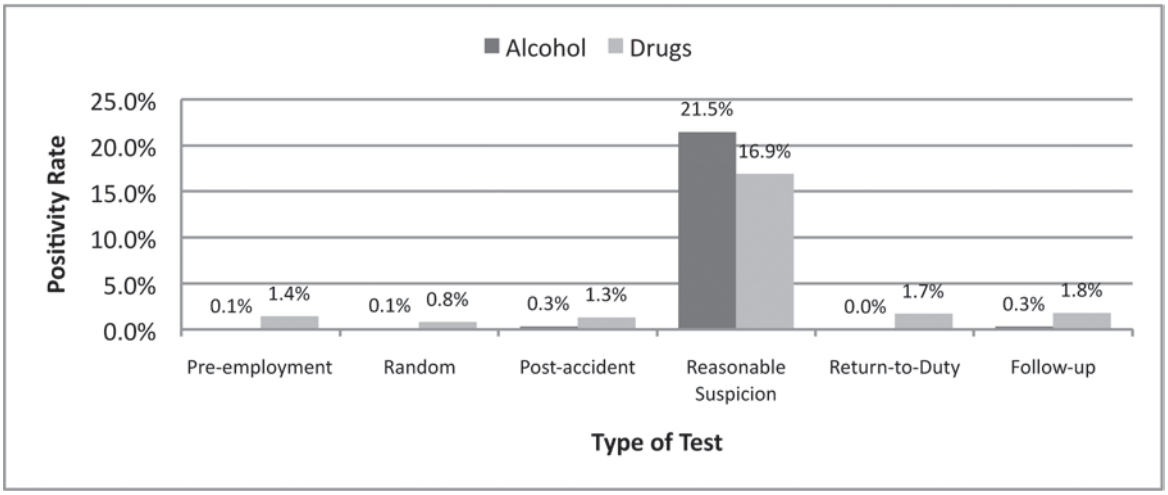

FIGURE 4 FMCSA 2008 drug and alcohol unweighted positivity rates by test type.

Reasonable suspicion was the type of test with the highest unweighted positivity rate. Marijuana was the most commonly detected drug.

For alcohol, random tests had the highest number of positives, followed by reasonable cause and follow-up tests. Reasonable suspicion was the type of test with the highest unweighted positivity rate.

Every few years, the FMCSA also publishes the results of its drug- and alcohol-testing survey (Gruberg 1997, 2007; Khan 2010). Those reports provide positivity rates that are weighted by stratified samples and therefore are a better estimation of the positivity rates in the national population of commercial drivers. Tables 11 to 13 report the adjusted positivity rates from 2003 to 2008.

Reasonable suspicion was the type of drug test with the highest weighted positivity rate. Marijuana was the most commonly detected drug. Reasonable suspicion was the type of alcohol test with the highest weighted positivity rate. Thus, no major discrepancies were observed between the unweighted and weighted rates.

TABLE 11
WEIGHTED YEARLY POSITIVITY RATES (%) FOR RANDOM DRUG TESTS BY DRUG TYPE

Drug Category	2003	2004	2005	2006	2007	2008
Any Drug	2.00	1.60	1.70	1.30	1.30	1.04
Amphetamines	0.10*	0.10*	0.40*	0.30*	0.20*	0.07
Cocaine	0.30	0.50	0.50	0.40	0.40	0.20
Marijuana	0.60	0.80	0.60	1.00	0.60	0.65
Opiates	0.01	0.10*	0.040*	0.03*	0.00	0.040*
Phencyclidine	0.00*	0.10*	0.00*	–	–	0.00

Note: Estimates marked with an asterisk (*) must be interpreted with caution because of extremely low precision. A dash (–) indicates no usage found in sample cases.

TABLE 12
WEIGHTED YEARLY DRUG POSITIVITY RATES (%) BY NONRANDOM TEST TYPE

Test Reason	2003	2004	2005	2006	2007	2008
Pre-employment	3.10	2.20	2.10	1.90	1.60	1.28
Postcrash	1.90	2.50	2.40	1.90	2.70	2.04
Reasonable Suspicion	19.40*	40.30	16.70	30.00	48.00	39.37
Return-to-Duty	3.60	9.30*	2.60	5.40*	6.50*	1.03
Follow-up	3.10	3.80	2.40	1.90	1.60	3.70
Phencyclidine	0.00*	0.10*	0.00*	–	–	0.00

Note: Estimates marked with an asterisk (*) must be interpreted with caution because of extremely low precision.

TABLE 13
WEIGHTED YEARLY ALCOHOL POSITIVITY RATES (%) BY TEST REASON

Test Reason	2003	2004	2005	2006	2007	2008
Pre-employment	0.01*	0.01*	0.03*	1.20*	0.20*	0.01*
Random	0.20	0.10	0.20*	0.30	0.25	0.19*
Postcrash	0.10*	0.10*	0.10*	0.30	0.10	0.13
Reasonable Suspicion	24.20	11.00	6.40	32.20*	29.40*	11.30
Return-to-Duty	0.00*	0.40*	0.05*	0.10*	0.60*	0.00*
Follow-up	4.70*	0.20*	0.20	0.10*	0.20	2.45*

Note: Estimates marked with an asterisk (*) must be interpreted with caution because of extremely low precision.

Based on the 2008 survey results (Khan 2010), 48% of all motor carriers have alcohol- and drug-testing programs in place, covering 89% of all commercial drivers. The two percentages are explained by the fact that small carriers, which tend to be less compliant with DOT regulations, constitute the majority of companies in the national fleet but include relatively few drivers.

One minor note of caution about the relatively low response rates in the surveys is warranted. For the 2008 survey, for example, drug survey forms were sent to 2,973 randomly selected motor carriers, covering 443,340 commercial drivers. The survey was completed and returned to FMCSA by 2,266 (76%) of the carriers. Of those, 1,678 provided usable data on random drug tests. Thus, usable data on random drug tests were obtained from 56% of the total company sample. Concerns about the relatively low response rate are mitigated by the sound sampling methodology, and there are no reasons to infer systematic differences between the carriers that provided usable data and carriers that did not. Nonetheless, a higher response rate would have been preferable.

PIPELINES

PHMSA defines a small employer as having 50 or fewer employees and a large employer as having 51 or more employees. For 2008, the compliance rate in submitting data to PHMSA was nearly 100% for large employers and 55% for small employers. Because small employers represent a relatively small percentage of the total workforce, however, it is estimated that the available data represent 96% of the total safety-sensitive workforce.

Tables 14 and 15 report the PHMSA 2008 drug and alcohol test results, respectively. Figure 5 shows the drug and alcohol positivity rates by test type.

For drugs, random tests had the highest number of positives, followed by pre-employment and follow-up tests. Reasonable cause was the type of test with the highest

TABLE 14
PHMSA 2008 DRUG TEST RESULTS

Test Reason	Total Number of Test Results	Verified Negative Tests	Verified Positive Tests for One or More Drugs	Positive for Marijuana	Positive for Cocaine	Positive for Phencyclidine	Positive for Opiates	Positive for Amphetamines	Refusals				Cancelled Tests
									Adulterated	Substituted	"Shy Bladder"	Other Refusals	
Pre-employment	18,174	17,949	210	168	24	1	2	18	3	2	0	10	50
Random	38,229	37,985	225	139	61	4	13	10	5	2	4	8	116
Postaccident	637	627	10	7	1	0	2	0	0	0	0	0	0
Reasonable Cause	70	58	12	5	7	0	0	1	0	0	0	0	1
Return-to-Duty	208	203	5	4	1	0	0	0	0	0	0	0	0
Follow-up	2,371	2,349	19	11	6	0	1	1	0	0	0	3	1
Total	59,689	59,171	481	334	100	5	18	30	8	4	4	21	168

TABLE 15
PHMSA 2008 ALCOHOL TEST RESULTS

Test Reason	Total Number of Screening Test Results	BAC < 0.020	BAC ≥ 0.020	Number of Confirmation Test Results	Confirmation Tests BAC 0.020–0.039	Confirmation Tests BAC ≥ 0.040	Refusals		Cancelled Tests
							"Shy Lung"	Other Refusals	
Postaccident	385	385	0	2	0	0	0	0	0
Reasonable Cause	85	70	15	13	0	13	0	0	0
Return-to-Duty	73	73	0	1	0	0	0	0	0
Follow-up	1,265	1,250	14	12	2	8	0	1	0
Total	1,808	1,778	29	28	2	21	0	1	0

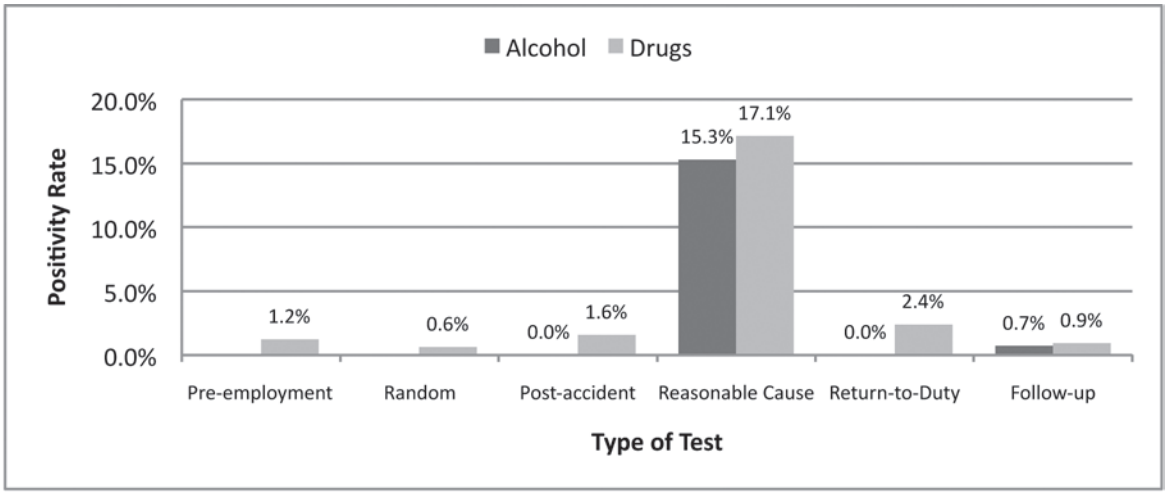

FIGURE 5 PHMSA 2008 drug and alcohol unweighted positivity rates by test type.

TABLE 16
FTA 2008 DRUG TEST RESULTS

Test Reason	Total Number of Test Results	Verified Negative Tests	Verified Positive Tests for One or More Drugs	Positive for Marijuana	Positive for Cocaine	Positive for Phencyclidine	Positive for Opiates	Positive for Amphetamines	Refusals				Cancelled Tests
									Adulterated	Substituted	"Shy Bladder"	Other Refusals	
Pre-employment	89,406	87,482	1,792	1,351	344	49	25	64	9	6	9	108	180
Random	97,546	96,742	715	448	234	4	16	31	5	4	20	60	207
Postaccident	14,630	14,450	168	87	64	1	10	12	0	0	1	11	41
Reasonable Suspicion	561	500	45	19	20	1	4	4	1	0	2	13	6
Return-to-Duty	761	747	12	10	1	0	0	1	0	0	0	2	3
Follow-up	6,154	6,071	75	29	40	0	2	5	0	0	4	4	6
Total	209,058	205,992	2,807	1,944	703	55	57	117	15	10	36	198	443

unweighted positivity rate. Marijuana was the most commonly detected drug.

For alcohol, reasonable cause tests had the highest number of positives, with follow-up tests second. Reasonable cause was the type of test with the highest unweighted positivity rate.

PUBLIC TRANSIT

The FTA collects and receives data from all regulated grantees and all subrecipients from the grantees and any safety-sensitive contractors who are considered to be covered employers by FTA.

TABLE 17
FTA 2008 ALCOHOL TEST RESULTS

Test Reason	Total Number of Screening Test Results	BAC < 0.020	BAC ≥ 0.020	Number of Confirmation Test Results	Confirmation Tests BAC 0.020–0.039	Confirmation Tests BAC ≥ 0.040	Refusals		Cancelled Tests
							"Shy Lung"	Other Refusals	
Pre-employment	15,102	15,081	19	22	8	6	1	1	4
Random	40,237	40,132	86	75	24	41	6	13	26
Postaccident	13,300	13,273	20	18	2	13	1	6	18
Reasonable Suspicion	538	388	138	129	26	94	1	11	5
Return-to-Duty	425	420	4	3	2	1	0	1	0
Follow-up	5,026	5,004	19	18	7	10	1	2	1
Total	74,628	74,298	286	265	69	165	10	34	54

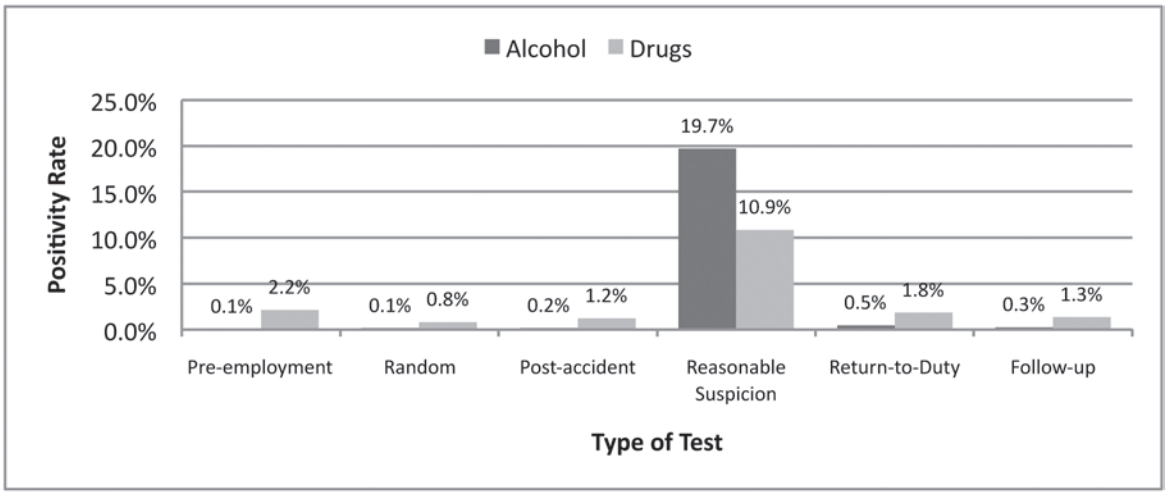

FIGURE 6 FTA 2008 drug and alcohol unweighted positivity rates by test type.

Tables 16 and 17 report the FTA 2008 drug and alcohol test results, respectively. Figure 6 shows the drug and alcohol positivity rates by test type.

For drugs, pre-employment tests had the highest number of positives, followed by random and postaccident tests. Reasonable cause was the type of test with the highest unweighted positivity rate. Marijuana was the most commonly detected drug.

For alcohol, reasonable suspicion tests had the highest number of positives, followed by random and postaccident tests. Reasonable cause was the type of test with the highest unweighted positivity rate.

The FTA regularly produces comprehensive reports on the results of its drug- and alcohol-testing program. The most recent (Redington et al. 2009) reports the drug and alcohol positivity rates from 1995 to 2007. As can be seen in Figure 7, the positivity rates for random drug tests and random alcohol tests both declined considerably over time.

RAIL

For 2008, the FRA collected data from all employers with 400,000 man-hours per year or more. These 40 railroads employ 105,564 of the estimated 130,000 industry safety-sensitive workforce.

Tables 18 and 19 report the FRA 2008 drug and alcohol test results, respectively. Figure 8 shows the drug and alcohol positivity rates by test type. Note that ODAPC provided no data for postaccident tests.

For drugs, random tests had the highest number of positives, followed by pre-employment and follow-up tests. Follow-up was the type of test with the highest unweighted positivity rate. Marijuana was the most commonly detected drug.

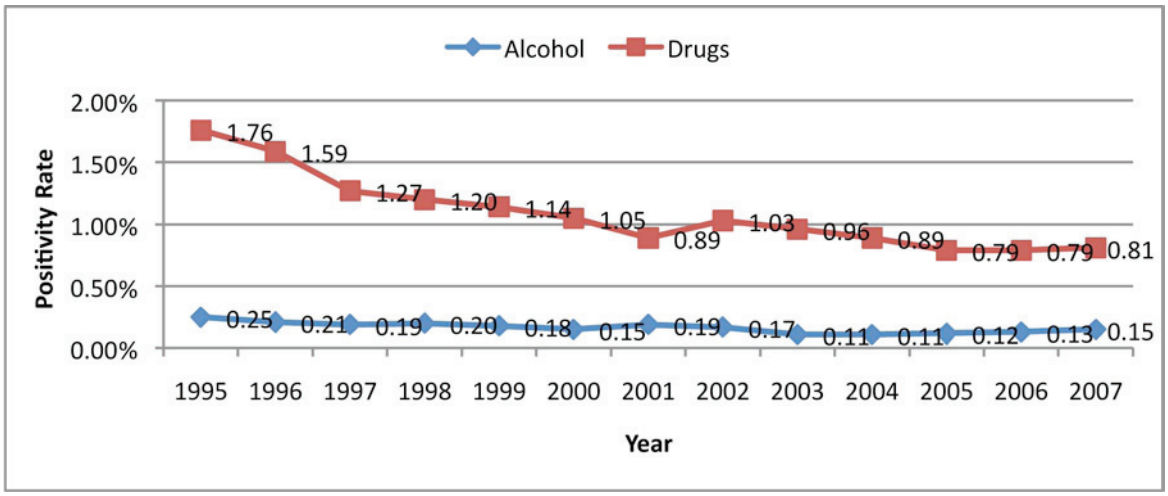

FIGURE 7 FTA annual drug and alcohol positivity rates for random tests.

TABLE 18
FRA 2008 DRUG TEST RESULTS

Test Reason	Total Number of Test Results	Verified Negative Tests	Verified Positive Tests for One or More Drugs	Positive for Marijuana	Positive for Cocaine	Positive for Phencyclidine	Positive for Opiates	Positive for Amphetamines	Refusals				Cancelled Tests
									Adulterated	Substituted	"Shy Bladder"	Other Refusals	
Pre-employment	9,093	9,034	56	47	6	1	1	1	0	0	0	3	14
Random	37,585	37,412	163	97	49	0	2	19	2	2	3	3	41
Reasonable Suspicion/Cause	298	296	1	0	1	0	0	0	0	0	0	1	1
Return-to-Duty	3,816	3,789	26	15	8	0	0	3	0	0	0	1	4
Follow-up	2,893	2,868	21	9	11	0	0	2	0	0	1	3	15
Total	53,685	53,399	267	168	75	1	3	25	2	2	4	11	75

TABLE 19
FRA 2008 ALCOHOL TEST RESULTS

Test Reason	Total Number of Screening Test Results	BAC < 0.020	BAC ≥ 0.020	Number of Confirmation Test Results	Confirmation Tests BAC 0.020–0.039	Confirmation Tests BAC ≥ 0.040	Refusals		Cancelled Tests
							"Shy Lung"	Other Refusals	
Pre-employment	960	959	1	1	1	0	0	0	0
Random	41,782	41,648	129	128	70	58	2	3	0
Reasonable Suspicion/Cause	253	251	1	1	0	1	0	1	0
Return-to-Duty	3,751	3,736	15	15	4	11	0	0	0
Follow-up	2,514	2,476	38	37	9	28	0	0	0
Total	49,260	49,070	184	182	84	98	2	4	0

For alcohol, random tests had the highest number of positives, followed by reasonable suspicion/cause and follow-up tests. Follow-up was the type of test with the highest unweighted positivity rate.

Figure 9 shows the combined drug and alcohol positivity rates for postaccident tests from 1987 to 2007 (United Transportation Union 2008). The data were obtained from 39 railroads with 400,000 man-hours per year or more.

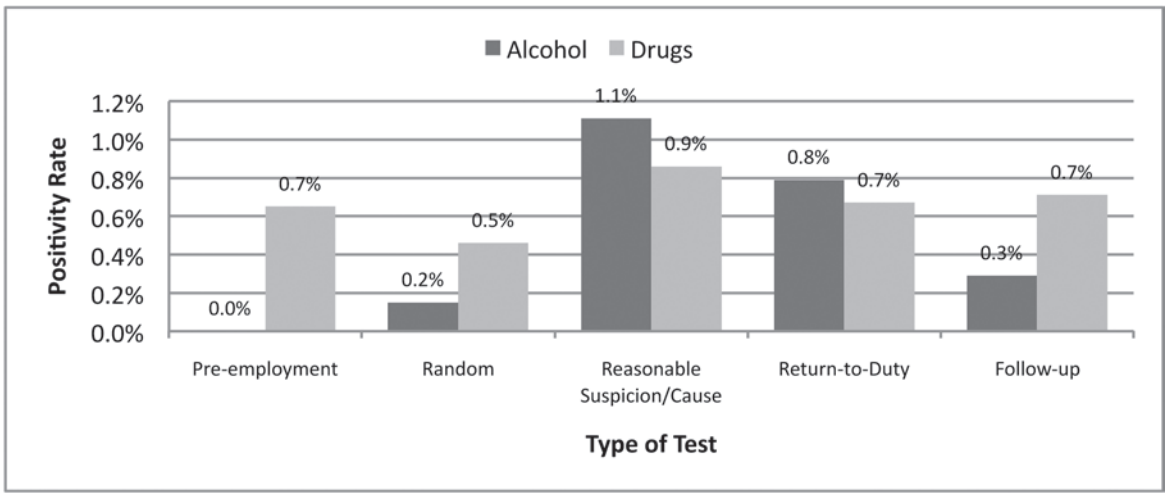

FIGURE 8 FRA 2008 drug and alcohol unweighted positivity rates by test type.

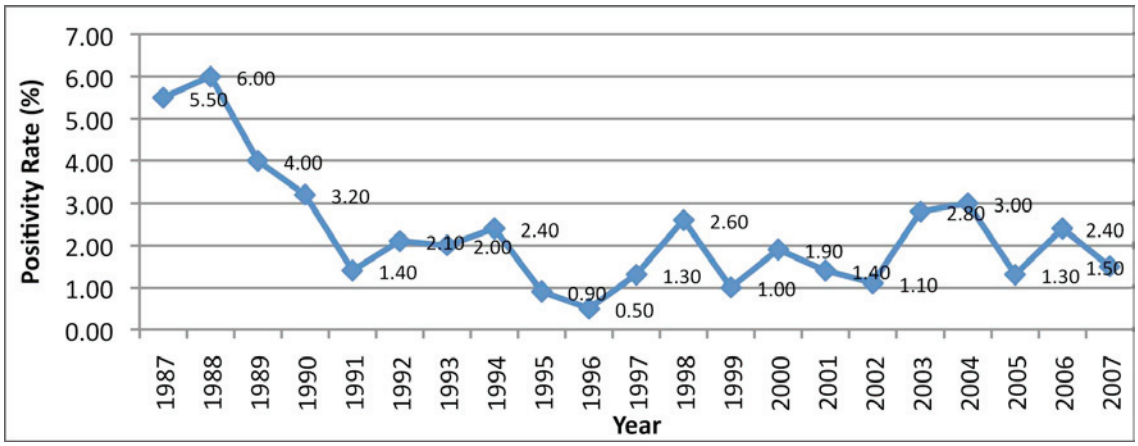

FIGURE 9 FRA combined drug and alcohol positivity rates for postaccident tests, 1987–2007, as reported by the United Transportation Union (2008).

DRUG POSITIVITY RATES IN DIFFERENT WORKFORCES

Figure 10 shows the overall positivity rates for four types of workforce: the combined U.S. workforce; the federally mandated, safety-sensitive workforce; the general U.S. workforce (Quest Diagnostics September 2010); and the DOT-only workforce (Swart, personal communication, Nov. 22, 2010). Note that the federally mandated, safety-sensitive workforce includes primarily the DOT-regulated workforce, with some non-DOT employees from the nuclear energy industry. Transportation Security Agency screeners are not included in the DOT-only workforce.

The positivity rate for the combined U.S. workforce dropped from 13.6% in 1988 to 3.6% in 2009. From 2005 to 2009, the positivity rate for the federally mandated, safety-sensitive workforce dropped from 2.3% to 1.5%. From 2008 to 2010, the positivity rate for the DOT-only workforce dropped from 1.64% to 1.49%. Thus, positivity rates have been declining over time, with the DOT-only workforce having the lowest positivity rates.

Consistent with ODAPC data for the individual modes, the test with the highest positivity rate was reasonable cause, for both the federally mandated, safety-sensitive workforce and the general U.S. workforce (see Table 20). Also consistent with ODAPC data, the most commonly detected drug was marijuana (see Table 21). Note, however, that the general U.S. workforce is also tested for some medicinal drugs.

In general, supervisors currently receive 1 h of training on the specific, contemporaneous physical, behavioral, and performance indicators of probable drug use and 1 h on the specific, contemporaneous physical, behavioral, and performance indicators of alcohol use. This training has proven to be effective. In all modes, reasonable cause tests have the highest alcohol and drug positivity rates, as shown in Table 22.

Although the results vary by mode, it appears that supervisors are better able to detect alcohol than drugs. This is not surprising, as people tend to have more familiarity with the visible effects of alcohol than the visible

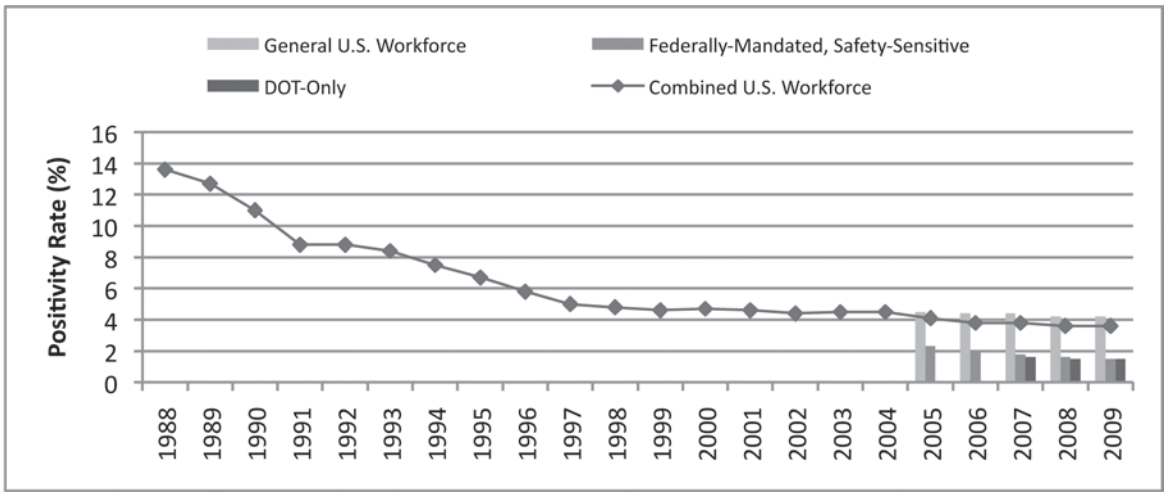

FIGURE 10 Urine drug test annual positivity rates.

TABLE 20

ANNUAL POSITIVITY RATES (%) FOR FEDERALLY MANDATED, SAFETY-SENSITIVE WORKFORCE AND GENERAL U.S. WORKFORCE, BY TESTING REASON

	Federally Mandated, Safety-Sensitive Workforce					General U.S. Workforce				
Test Reason	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009
Pre-employment	2.6	2.3	2.0	1.7	1.5	3.9	3.9	3.9	3.6	3.4
Postaccident	3.0	2.7	2.6	2.3	2.2	5.8	5.7	5.8	5.6	5.3
Random	1.8	1.5	1.5	1.4	1.4	6.6	5.5	5.7	5.3	5.4
Reasonable Cause	13.4	12.4	11.1	9.9	11.1	28.3	18.1	19.2	22.0	26.8
Return-to-Duty	3.0	3.2	3.3	3.1	3.0	6.0	5.8	5.6	5.3	4.6
Follow-up	3.1	3.0	2.8	2.2	2.5	9.6	7.4	7.7	7.6	7.5
Periodic	0.8	0.6	0.8	0.7	0.8	2.4	1.9	1.4	1.4	1.5

Note. Periodic testing is not part of DOT testing.

TABLE 21

ANNUAL POSITIVITY RATES (%) FOR FEDERALLY MANDATED, SAFETY-SENSITIVE WORKFORCE AND GENERAL U.S. WORKFORCE, BY DRUG TYPE

	Federally Mandated, Safety-Sensitive Workforce					General U.S. Workforce				
Drug Category	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009
Overall	2.30	2.00	1.80	1.60	1.50	4.50	4.40	4.40	4.20	4.20
Amphetamines	0.35	0.28	0.25	0.26	0.29	0.48	0.42	0.44	0.48	0.57
Barbiturates						0.25	0.23	0.24	0.25	0.26
Benzodiazepines						0.58	0.62	0.67	0.70	0.74
Cocaine	0.60	0.58	0.44	0.32	0.24	0.69	0.69	0.55	0.39	0.28
Marijuana	1.10	0.94	0.88	0.77	0.69	2.30	2.00	2.00	1.80	1.70
Methadone						0.23	0.22	0.23	0.22	0.23
Opiates	0.18	0.17	0.18	0.20	0.21	0.29	0.28	0.32	0.34	0.39
Oxycodone						0.56	0.64	0.88	0.83	1.00
Phencyclidine	0.04	0.03	0.04	0.04	0.04	0.02	0.02	0.02	0.02	0.02
Propoxyphene						0.57	0.55	0.58	0.56	0.48

effects of drugs. In either case, what is remarkable is that with a minimum of 2 h of training, 1 for alcohol and 1 for drugs, supervisors can correctly identify so many signs of illegal alcohol and drug use.

TABLE 22
PROBABLE CAUSE ALCOHOL AND DRUG POSITIVITY RATES (%) BY MODE

Mode	Positive Alcohol Rate	Positive Drug Rate
Aviation	47.5	19.3
Maritime		17.1
Motor Carrier	21.5	16.9
Pipelines	15.3	17.1
Public Transit	19.7	10.9
Rail	1.1	0.9

CHAPTER SIX

ALTERNATIVE STRATEGIES

Efforts were made to reach out to the regulated community to identify current practices used to deter drug and alcohol use among operators. Forty-six companies were contacted for the purpose of the synthesis. Although the original work plan specified that small, medium, and large companies should be sampled for each mode, it became clear early on in the data-collection phase that only large and medium companies would have the resources and personnel to comply with requests for information. Regardless of size, few companies responded to the initial contact, and fewer than 10 agreed to provide information. The low level of participation may have resulted from the absence of a clear incentive, a reluctance to share alcohol- and drug-testing policies, a reluctance to participate in telephone surveys, or a combination of these factors. In any case, it is important to note that the responses only reflect the companies that agreed to respond. Whether these responses are representative of the entire industry is unknown. Table 23 shows the companies that responded to our initial contact and those that provided information.

TABLE 23
COMPANIES SAMPLED FOR THE STUDY

Mode	Companies That Responded to Initial Contact	Companies That Provided Information
Aviation	US Airways, Inc.; Southwest Airlines Co.; Continental Airlines	Continental Airlines
Maritime	None	None
Motor Carrier	IWX Motor Freight; McLane Company, Inc.; Swift Transportation, Inc.; J.B. Hunt Transport Services, Inc.	J.B. Hunt Transport Services, Inc.
Pipelines	Sunoco, Inc.; U.S. Steel Corp.; Koch Pipeline Co. LP; U.S. Pipeline, Inc.; Halliburton	Halliburton
Public Transit	First Transit; Trailways Transportation System, Inc.; Greyhound Lines, Inc.	Greyhound Lines, Inc.; Trailways Transportation System, Inc.
Rail	Amtrak, BNSF Rail Co., CSX Corp., Norfolk Southern Corp., Union Pacific RR, Watco Companies, Inc.	BNSF Rail Co.

Data were obtained through unstructured phone and e-mail interviews with assigned company representatives. No efforts were made to independently verify the representatives' claims. After the interviews, the relevant sections of this report were provided to the respective companies to confirm that the report accurately portrayed what they communicated.

The following sections outline some of the procedures aimed at deterring employees' drug and alcohol abuse that exceed the minimum regulatory requirements. Some procedures are applicable to all modes, whereas others are most likely limited to a single mode. Also, some procedures are already in place, whereas others are in the planning stage.

ZERO-TOLERANCE POLICIES

With zero-tolerance policies, if an employee has a positive drug or alcohol test, or the employee refuses to take the test, the employee is immediately removed from the safety-sensitive position and not given a second chance to return to that position. Of the companies responding to the request for information, Continental Airlines and BNSF have some variant of a zero-tolerance policy.

Continental Airlines, operating a fleet of more than 300 aircrafts, implements a variation of a zero-tolerance policy. In general, no employee is guaranteed a second chance. After a confirmed positive test, an employee may be permanently removed from his or her position or offered a last-chance agreement. The last-chance agreement requires the employee to enroll in an EAP and pass a return-to-duty test and a series of follow-up tests. The last-chance agreement may be offered on the basis of the employee's history with the company, routine evaluation results, work ethic, potential drug or alcohol problem, and the professional opinion of the MRO.

BNSF Rail Company links 28 states and two Canadian provinces with a network of railways, covering two-thirds of the United States. BNSF does not guarantee second chances following the first confirmed positive drug and/or alcohol violation. If any employee tests positive, then the violation can lead to dismissal. Refusals to test are also not tolerated, and the employee can be disqualified for 9 months and may also be subject to termination. Likewise, extended shy-lung and shy-bladder incidents, where the subsequent medical evaluation does not confirm an underlying medical cause, will be considered refusals to test and the employee can be disqualified for 9 months and may also be subject to termi-

nation. Zero-tolerance policies may increase compliance with drug and alcohol regulations by establishing stricter and immediate consequences after a single violation. They also limit the need for return-to-duty and follow-up testing, providing more time, effort, and funding for random testing. These policies, however, appear to violate the spirit of the original intent of the policy, which is to provide a "helping hand" to violators.

PRE-EMPLOYMENT ALCOHOL SCREENING

As previously discussed, pre-employment alcohol screening is optional, rather than mandated by DOT, because alcohol is not an illegal substance and no illegal act is performed if the applicant has not yet been involved in safety-sensitive duties. One of the seven surveyed companies uses pre-employment alcohol testing. Trailways, an independent group of more than 80 privately owned motor coach companies, implements alcohol tests as part of its pre-employment screening. Pre-employment alcohol tests are an inexpensive way to identify applicants who most likely have alcohol addiction and cannot abstain from drinking.

PRE-EMPLOYMENT BACKGROUND CHECK

Companies may choose to investigate an applicant's drug- and alcohol-testing history for more than the required minimum of 2 to 3 years. Trailways, for example, checks past test records for up to 5 prior years for potential employees in safety-sensitive functions.

ALTERNATIVE SPECIMENS

Although the FRA requires both urine and blood tests following an accident, urinalysis is the basis of the DOT drug-testing program. Use of alternative specimens, however, has been gaining momentum, with several companies using hair, oral fluids, and sweat testing in addition to testing urine and blood. Among the companies sampled for this project, J.B. Hunt, Continental Airlines, Trailways, and BNSF reported making use of alternative specimens. Note that alternative specimens are collected based on company-only policies, not DOT-regulated testing.

As one of the largest transportation logistics companies in North America, J.B. Hunt oversees thousands of employees, many with safety-sensitive functions. J.B. Hunt has been using hair testing since May 2006, and it is now used for all pre-employment tests for all employees, not just the safety-sensitive population. Approximately over 80% of J.B. Hunt's drivers had a hair test by September 2010 for that year, and the company had observed a decrease in the rate of positive urine tests by about 75%. They attribute this to the deterrent effect of hair testing, which can detect prior drug use for up to 90 days. J.B. Hunt also tests oral fluids following some accidents. Continental Airlines may use blood for follow-up tests. Trailways may use blood for postaccident tests and for some confirmation tests.

BNSF uses hair testing for pre-employment drug screening for job applicants. Hair testing occurs in addition to the FRA- and FMCSA-mandated pre-employment urine drug test at the job candidate's medical examination. BNSF company requirements may also vary by state. In Minnesota, BNSF requires a blood specimen when an employee has a BAC of 0.020 and higher on a company-mandated (non-DOT) breath alcohol test. Nebraska law requires that the railway company obtain a blood sample from the employee on a positive company authority test 0.020 and above if requested by the employee at the time of the test.

BNSF may also use DOT-approved saliva tests for initial alcohol screening. If positive, then the employee must be screened and confirmed using an Evidential Breath Testing (EBT) device. Oral fluid tests were noted to be beneficial for screening employees with complex pulmonary medical histories contributing to inadequate breath supply.

The use of alternative specimens has elicited considerable controversy because of many unresolved scientific, logistical, and legal issues. A summary of some of the main scientific and technical issues is presented in the following sections, which are based in large part on the following publications: Baselt and Cravey (1995), Verstraete (2004), Cone et al. (2007), Kintz et al. (2007), Bush (2008), Gallardo and Queiroz (2008), and Drummer (2010). The reader is encouraged to refer to them for additional material.

Since DHHS proposed in 2004 to establish scientific and technical guidelines for the testing of hair, sweat, and oral fluid in addition to urine, considerable efforts have been made in this area of research. Table 24 shows the DHHS proposed initial screening and confirmatory cutoffs for alternative specimens, as reported by Bush (2008). It can be noted that decisions about what testing methods to authorize are the province of DHHS, not DOT, and that DOT has no legal authority under the Omnibus Act to permit or require types of testing that DHHS has not incorporated into its mandatory guidelines.

Blood

Blood drawing is an intrusive procedure and is not often performed for the purposes of workplace drug testing. Blood, however, is the primary mode of entry of drugs and metabolites into hair, sweat, and oral fluid. It provides the most direct evidence of the presence of a drug in the system and allows estimation of its likely behavioral effects.

TABLE 24
DHHS PROPOSED INITIAL SCREENING AND CONFIRMATORY CUTOFFS FOR ALTERNATIVE SPECIMENS

Drug/Analyte	Hair (pg/mg)		Oral Fluid (ng/ml)		Sweat Patch (ng/patch)		Urine (ng/ml)	
	Screen	Confirm	Screen	Confirm	Screen	Confirm	Screen	Confirm
Marijuana metabolites	1						50	
Marijuana (parent)			4		4			
THC (parent drug)				2		1		
THCA (metabolite)		.05						15
Cocaine								
Cocaine metabolites	500		20		25		150	
Cocaine		500[a]		8[b]		25[b]		
Benzoylecgonine		50		8		25		100
Cocaethylene		50						
Norcocaine		50						
Opiate Metabolites[c]	200		40		25		2,000	
Morphine		200		40		25		2,000
Codeine		200		40		25		2,000
6-Acetylmorphine		200[d]		4		25		10
Phencyclidine	300		10		20		25	
Phencyclidine		300		10		20		25
Amphetamines[e]	500		50		25		500	
MDMA	500		50		25		500	
Amphetamine		300		50		25		250
Methamphetamine		300[f]		50[g]		25[g]		250[h]
MDMA		300		50		25		250
MDA		300		50		25		250
MDEA		300		50		25		250

[a] Laboratories are permitted to initially test all specimens for 6-acetylmorphine (6-AM) using the appropriate cutoff for each matrix.
[b] Methamphetamine is the target analyte.
[c] BZE/cocaine ratio ≥ 0.005 or cocaethylene ≥ 50 pg/ml or norcocaine ≥ 50 pg/ml.
[d] Specimen must also contain morphine at concentration ≥ 200 pg/mg.
[e] Must contain amphetamine ≥ 50 pg/mg.
[f] A confirmatory test must be performed for either cocaine or BZE.
[g] Must contain amphetamine ≥ LOD.
[h] Must contain amphetamine ≥ 100 ng/ml.

Each drug has specific absorption, distribution, metabolism, and excretion characteristics. Absorption refers to the rate at which a drug enters the bloodstream, which can be affected by the route of administration (i.e., oral ingestion, inhalation, insufflations, and injection). After a drug is absorbed into the bloodstream, it circulates through the body and is distributed in various body tissues. Equilibrium is reached when the drug concentration in plasma is equal to the drug concentration in tissues. After equilibrium is reached, the blood drug concentration diminishes because of metabolism and elimination. The liver is the major site of drug metabolism. In the body, drugs are metabolized into other compounds—some psychoactive, some not—that can have different properties than the parent drug. Drugs and their metabolites can be excreted through urine, feces, bile, saliva, sweat, hair, and other pathways.

Blood is composed of plasma and several kinds of cells (red blood cells, white blood cells, and platelets). The serum half-life is the amount of time required for a drug concentration to decrease by one-half. Table 25 reports the half-lives of various illegal drugs.

In this document, detection time is defined as the time a product can be detected after it was taken. The detection time for a specific drug depends on several factors: the route of administration, the pharmacokinetic properties of the drug, the metabolism of the individual, the drug dose, and the drug test cutoff selection. Table 26 reports typical detection times of selected drugs in blood, serum, or plasma.

Urine

As the blood is pumped by the heart through the system, it goes through the kidneys at a rate of 1,200 ml per minute. As blood goes through the kidneys, electrolytes, nutrients, and water are returned to the bloodstream, whereas excess water, waste products, and drugs and their metabolites continue to the tubes that propel urine from the kidneys to the urinary bladder. Because some of the water in the

blood is reabsorbed by the kidneys, the concentration of drugs and their metabolites is higher in urine than in the kidneys. A healthy adult produces from 1 to 2 L of urine per day.

TABLE 25
HALF-LIVES OF SELECTED DRUGS AND THEIR METABOLITES

Drug	Analyte	Half-Life
Marijuana	Tetrahydrocannabinol	30 min
	Delta-9-tetrahydrocannabinol-9-carboxylic acid	Infrequent users: 20–57 h Frequent users: 3–13 days
Cocaine	Cocaine	Intravenous: 37–41 min Smoked: 58–89 min Intranasal: 73–207 min
	Benzoylecgonine	6 h
Opiates	Morphine	2–3 h
	6-Acetylmorphine	6–25 min
Phencyclidine	Phencyclidine	7–46 h
Amphetamines	Amphetamine	7–34 h
	Methamphetamine	Oral: 10.1 h
		Intravenous: 12.2 h
MDMA	Methylenedioxymethamphetamine (MDMA)	7.6 h
	Methylenedioxyamphetamine (MDA)	16–18 h
	Methylenedioxyethylamphetamine (MDEA)	N/A

Note. Half-life rates obtained from Baselt and Cravey (1995), Burns et al. (1998), Mas et al. (1999), Couper and Logan (2004), and Verstraete (2004). N/A = not available.

Urine drug levels vary as a function of the pharmacokinetic properties of the drug, the metabolism of the individual, the drug dose, the drug test cutoff selection, and the quantity and frequency of the voids before collecting the specimen. Detection times in the scientific literature, therefore, can vary from study to study, depending on the experimental protocol. Table 27 shows urine drug detection times as reported by Verstraete (2004). Note the distinction between detection time and maximal detection time. Table 28 shows urine drug detection times as reported by Moeller et al. (2008). In general, the window of detection for most drugs is 2 to 3 days.

A positive urine drug test indicates only that the person has used the drug and cannot be used to determine whether the person is under the influence of the drug.

One of the advantages of urine drug testing is that it has been examined extensively, is scientifically proven, and is forensically defensible. Entering the keywords "urine drug testing" in PubMed and limiting the search to humans yielded 3,575 results. It is a mature technology that is toxicologically accurate and reliable.

Oral Fluid

Oral fluid consists of saliva, gingival fluid, and cellular debris. Saliva is produced by the salivary glands, which are highly vascularized. Therefore, drugs in plasma are rapidly distributed to the salivary glands. Relative to plasma concentrations, drug concentrations in oral fluids depend on the water and lipid solubility of the drugs and their metabolites. Table 29 shows drug detection times in oral fluids as reported by Verstraete (2004). Note that the drug detection window in oral fluid is similar to that of blood.

Entering the keywords "saliva drug testing" and "oral fluid drug testing" in PubMed yielded 558 and 396 results, respectively. One of the advantages of oral fluid drug testing is that drug concentrations can be related to plasma-free drug concentrations and to the pharmacological effects of the drugs (Gallardo and Queiroz 2008). Also, oral fluid can be easily collected in a fairly noninvasive fashion, under direct observation, which reduces the probability of adulteration and substitution.

TABLE 26
DETECTION TIMES FOR SELECTED DRUGS IN BLOOD, SERUM, OR PLASMA

Drug	Dose (mg)	Route of Administration	Analyte	Cutoff (ng/ml)	Detection Time (h)
Marijuana	34	Smoked	Tetrahydrocannabinol (THC)	10	5
			Delta-9-tetrahydrocannabinol-9-carboxylic acid (THCA)	10	36
Cocaine	100	Intranasal	Cocaine	10	12
			Benzoylecgonine	10	48
Heroin	12–20	Smoked	Morphine	1	20
Amphetamine	6	Oral	Amphetamine	4	46
Methamphetamine	22	Smoked	Methamphetamine	3	48
MDMA	100	Oral	MDMA	20	24

Note. Adapted from Verstraete (2004).

TABLE 27
DETECTION TIMES FOR SELECTED DRUGS IN URINE

Drug	Dose (mg or THC)	Route of Administration	Analyte	Cutoff (ng/ml)	Detection Time (h)	Maximal Detection Time (days)
Marijuana	1.75	Smoked	Delta-9-tetrahydrocannabinol-9-carboxylic acid (THCA)	15	34	95
	3.50	Smoked	Delta-9-tetrahydrocannabinol-9-carboxylic acid (THCA)	15	87	
Cocaine	100	Intranasal	Benzoylecgonine	1,000	48–72	22
Heroin	10–15	Intravenous, Smoked	Morphine		11–54	11.3
Amphetamine						9
Methamphetamine	10	Oral	Methamphetamine	2.5	87 ± 51	6
MDMA	100	Oral	MDMA	20	48	

Source: Verstraete (2004).

TABLE 28
DETECTION TIMES FOR SELECTED DRUGS IN URINE

Drug		Time
Marijuana	Single use	3 days
Marijuana	Moderate use, 4 times per week	5–7 days
Marijuana	Daily use	10–15 days
Marijuana	Long-term heavy smoker	More than 30 days
Cocaine Metabolites		2–4 days
Opioids	Codeine	48 h
	Heroin (morphine)	48 h
	Hydromorphone	2–4 days
	Methadone	3 days
	Morphine	48–72 h
	Oxycodone	2–4 days
	Propoxyphene	6–48 h
Amphetamines	Amphetamine/ Methamphetamine	48 h
Phencyclidine		8 days

Source: Moeller et al. (2008).

One disadvantage of oral fluid drug testing is that recently consumed drugs can leave residual amounts in the mouth. The effect and duration of oral contamination have not been established, and it is unknown whether this can be overcome by a realistic observed wait period. Furthermore, possibly a second disadvantage is that people are sometimes unable to produce enough oral fluid for analysis (Gallardo and Queiroz 2008).

Oral fluid, however, has been gaining prominence as an alternative matrix for monitoring drugs of abuse in law enforcement and criminal justice purposes, driving under the influence of drugs programs, and treatment settings (Schwope et al. 2010; Vindenes et al. 2011). Its role in traffic safety is likely to increase in the coming years.

Hair

Hair follicles are highly vascularized, and as the blood circulates, drugs are absorbed into the growing hair. The growing phase, the antegen phase, lasts 2 to 6 years. Blood supply to the hair shaft stops during the catagen phase, which lasts 1 to 2 weeks. The final stage when the separation from the blood supply is complete is known as the telogen stage or the resting phase. Approximately 2% to 3% of head hair is

TABLE 29
DETECTION TIMES FOR SELECTED DRUGS IN ORAL FLUID

Drug	Dose (mg)	Route of Administration	Analyte	Cutoff (ng/ml)	Detection Time (h)
Marijuana	20–25	Smoked	Tetrahydrocannabinol	0.5	34
Cocaine	25–42	Intravenous, intranasal, smoked	Cocaine	1	5–12
			Benzoylecgonine	1	12–24
Heroin	20	Intravenous	6-Acetylmorphine	1	0.5–8
Amphetamine		Oral	Amphetamine	10	20–50
Methamphetamine	10	Sustained release, oral	Methamphetamine	2.5	24
MDMA	100	Oral	MDMA	126	24

Source: Verstraete (2004).

in the catagen stage and 10% to 15% in the telogen stage at any point in time. Therefore, drug concentrations will differ between hairs within one location and between locations such as scalp hair, pubic hair, and arm or leg hair (Cone et al. 2007: Gallardo and Queiroz 2008). For hair drug testing, however, specimens are typically collected from the back of the head.

Hair testing has received considerable attention in recent years. Entering the keywords "hair drug testing" in PubMed and limiting the search to humans yielded 834 results. Because of the nature of hair growth, and the fact that hair is typically exposed to the environment, hair drug testing has unique sets of advantages and disadvantages.

The main advantage of hair drug testing is the long window of detection of drugs, which can extend from weeks to months, depending on the rate of hair growth and the length of hair available for sampling. Another advantage is that hair collection is relatively easy and noninvasive, with the opportunity to obtain additional specimens.

One disadvantage is contamination from the environment. There are three known mechanisms for incorporating drugs into the hair shaft. The first is from blood. The second is from sweat in the tissues surrounding the follicle, usually after the hair emerges from the skin. The third is from environmental exposure to the drug.

Detection of a drug is not sufficient to identify drug use because hair may be contaminated by exposure to the smoked drug and by powder residue from surfaces where use occurred (Ropero-Miller and Stout 2008). Contamination is an issue for drugs that may be smoked, such as marijuana, cocaine, amphetamine, methamphetamine, and heroin (Stout 2007).

Several studies have shown that being in contact with a drug can result in the accumulation of the drug in the hair and result in a false positive. Mieczkowski (1995) found that undercover narcotics officers who had chronic environmental exposure to cocaine had detectable amounts of the drug in the hair; Koren et al. (1992) found concentrations of both cocaine and benzoylecgonine in hair exposed to varying quantities of crack smoke in a small, unventilated room; and Thorspecken et al. (2004) found that in vitro hair exposed to marijuana smoke tested positive for the drug, depending on concentrations in the air, hair care habits, and cosmetic treatment.

Thus, the issue is not whether contamination can occur, for which there is broad consensus, but whether there are ways of discriminating between active use and passive contamination. Currently, laboratories use two complementary procedures to minimize the possibility of passive contamination. The first is decontamination of hair samples by washing the hair before analysis. Several decontamination—or washing—procedures are described in the literature, but there is no agreement on which procedure must be used (Pragst and Balikova 2006), whether washing the hair is able to remove all potential risks from external contamination (Romano et al. 2001; Stout 2007; Ropero-Miller and Stout 2008), and whether variations in washing techniques produce analytical variability (Stout 2007). Washing procedures include organic solvents, aqueous buffers, water, and a combination of these (Gallardo and Queiroz 2008).

Some laboratories have included analysis of the wash solution as a crucial step in the decontamination procedure. After several washes, measurement of a drug in the solution is compared with the measurement of the drug in the hair. In general, if the drug is detected in the hair and not in the solution, it is an indication of active drug use, whereas if the drug levels in the solution vis-à-vis the hair exceed a given criterion, it is an indication of passive contamination. A summary of those procedures is beyond the scope of this project, but the reader is encouraged to read the following articles for details: DuPont and Baumgartner (1995), Romano et al. (2001), Schaffer et al. (2002), Cairns et al. (2004a,b), Schaffer et al. (2005); Kintz et al. (2007), Stout (2007), Hill et al. (2008), Ropero-Miller and Stout (2008), and Tsanaclis and Wicks (2008).

The second step is detection of drug metabolites, specifically those that are unambiguously related to endogenous processing of the drugs. In some cases, ratios of the metabolite to the parent drug must be interpreted to report results (DHHS Proposed Revisions to Mandatory Guidelines for Federal Workplace Drug Testing, 69 *Fed. Reg.* 19,644). The metabolites may be present in much lower concentrations than the parent drug (Pragst and Balikova 2006), and their detection requires highly sensitive and specific analytical techniques (Gallardo and Queiroz 2008). Recent developments in immunochemical, GC/MS, and especially LC/MS, which have allowed lower LODs and LOQs, have made this possible (Barroso et al. 2011; Wada et al. 2010).

Note, however, that some metabolites are not unambiguously related to endogenous processing of the drugs. Some metabolites (e.g., MDA) are used as a drug themselves (Pragst and Balikova 2006), some may appear as congeners in the parent drug, and some may be formed by degradation during processing (Hoelzle et al. 2008). The latter is especially true for some extraction methods (Barroso et al. 2011). Thus, criteria for interpretation need to be adjusted for the specific analytical conditions (Hoelzle et al. 2008).

Because of the issue of contamination, the Federal Bureau of Investigation laboratory no longer conducts cocaine analyses in hair for most cases involving subjects who have a legitimate reason to be in contact with cocaine, such as attorneys involved in drug cases, law enforcement officers handling drug evidence, and crime laboratory employees (LeBeau

and Montgomery 2009). As Pragst et al. (2010) point out, however, it is unlikely that innocent citizens in their daily environment might contaminate their hair to such an extent that it could lead to cocaine-positive results with the current criteria. When contamination is suspected, they suggest that additional investigation be conducted of nonhead hair, which is much less prone to external contamination, and that hair analysis continues to be a suitable tool in the majority of application fields, including testing for cocaine exposure. The Federal Bureau of Investigation laboratory is actively researching this issue of contamination, and it has expressed the belief that it can be resolved by identifying a truly unique metabolite that does not exist in street cocaine and/or through additional wash kinetic studies (LeBeau and Montgomery 2010).

A second disadvantage is that hair drug testing cannot detect recent drug use. Three to 5 days of hair growth are typically required for the hair to emerge from the skin surface. During that time, the drug may be detected in the sweat bathing the hair, but washing procedures can make detection unlikely.

A third disadvantage is that incorporation of the drugs into the hair is affected by melanin. Studies have shown that melanin content increases with hair "darkness" (Baumgartner and Hill 2001) and that the drug concentration in pigmented hair can be significantly higher than in nonpigmented hair (Kidwell and Smith 2007). Some researchers have further suggested that because minority groups tend to have dark hair, the melanin bias is in effect a race bias. Others have suggested that differences in hair structures, permeability of the hair, use of cosmetic hair treatment, personal hygiene, and artificial hair color may also affect the drug analyses (Kidwell et al. 2000; Wennig 2000).

Entering in PubMed the keywords "melanin bias in hair drug testing," "race bias in hair drug testing," and various combinations of these yielded 32 articles. Of those, seven could not be retrieved and 10 were outside the narrow focus of interest. Of the 15 articles that were reviewed, some found that drug levels were higher in darker color hair (Kelly et al. 2000; Mieczkowski and Newel 2000; Mieczkowski et al. 2002; Hill et al. 2005; and Mieczkowski and Kruger 2007), but none of the reviewed articles found direct support for the race bias hypothesis (Mieczkowski and Newel 1993; DuPont and Baumgartner 1995; Hoffman 1999; Kelly et al. 2000; Mieczkowski et al. 2002; Tassiopoulos et al. 2004; Bernstein et al. 2005; Hill et al. 2005; Mieczkowski and Kruger 2007; Mieczkowski et al. 2007). The apparent inconsistency may be explained by the fact that different ethnic groups have different patterns of drug use (Kelly et al. 2000) and that some analytical procedures remove the melanin by centrifugation prior to the analysis of keratin, another component of human hair (Baumgartner and Hill 2001).

It can be noted, however, that because of the logistical and ethical difficulties in studying the pharmacokinetics and pharmacodynamics of illicit drugs under controlled conditions, most of the studies cited previously compared the results of hair drug tests of subjects of varying hair color without an accurate and dependable reference standard against which the sensitivity and specificity of the hair drug tests could be calculated. Because of this difficulty, researchers have resorted to less direct analytical strategies, comparing hair drug test results with urine drug test results and/or self-report measures.

Mieczkowski and Newel (1993), for example, compared the outcome of hair and urine drug tests for cocaine in White and Black arrestees. Urine tests indicated that 35.9% of Blacks and 16.5% of Whites were positive for cocaine, for a ratio of 2.18 (35.9/16.5 = 2.18, Blacks were 2.18 times more likely to test positive than Whites). Hair tests indicated that 62.5% of Black and 36.1% of Whites were positive for cocaine, for a ratio of 1.73 (62.5/36.1 = 1.73, Blacks were 1.73 times more likely to test positives than Whites). Relative to Whites, therefore, positive cocaine tests for Blacks were more likely with urine tests than with hair tests. Thus, no evidence of a race bias in hair testing was found. Similar results were obtained by Hoffman (1999) with Black and White applicants for employment with a large metropolitan police department. A recent report by Ropero-Miller and Stout (2011) further suggests that whereas cocaine analyte concentrations may be significantly higher in dark hair types, including African American individuals, use of benzoylecogonine/cocaine ratios and extensive decontamination wash criteria greatly reduce positive hair in vitro testing results in contaminated hair.

A fourth disadvantage is the interference of cosmetic treatment on the analysis of hair. Because of cultural differences in ethnic grooming, some groups tend to wash their hair less often than others. Some researchers have suggested that the lower frequency of hair washing causes less leaching of the drug out the hair as a result of washing, which results in a potential increase of positive tests. Conversely, because most cosmetic treatment involves oxidation of the hair, it may reduce the availability of drugs for detection in hair testing, which results in a potential increase of negative tests.

In summary, although some researchers assert that the inherent drawbacks of hair testing preclude it for use in the workplace, where accuracy and fairness in employment decisions are paramount (Romano et al. 2001; Stout 2007; Ropero-Miller and Stout 2008), others assert that the main analytical problems have been adequately dealt with (Barroso et al. 2011), and it is important that hair preferentially be chosen for pre-employment and random tests (Pragst and Balikova 2006).

Sweat

Sweat is produced by eccrine and apocrine glands in the skin for the purpose of thermal regulation of the body. Drugs are

incorporated into sweat by passive diffusion from blood and by transdermal passage across the skin. Entering the keywords "sweat drug testing" in PubMed and limiting the search to humans yielded 147 results. Sweat is typically collected with a patch made of transparent film that is attached to skin. While wearing the patch, sweat saturates the pad and the drugs present in sweat are retained.

The main advantage of sweat testing is a relatively longer window of detection, which spans the duration the patch is applied to the skin, usually 1 week, plus 24–48 h before the application of the patch. Other advantages are that the patch is noninvasive, relatively tamper-proof, and provides a cumulative measure of drug exposure.

Because it is difficult to estimate sweat volume and to evaluate drug concentrations, sweat testing is primarily a qualitative rather than quantitative method of measuring drug use. Disadvantages include low acceptability of patch wearing, the possibility of accidental removal or purposeful removal, and the potential for contamination at the time of removal.

Relative Utility of Different Specimen by Type of Drug Test

Does the larger detection window of hair analysis—relative to urine analysis—result in higher positivity rates? There is evidence that this may be the case.

Sample (2010) examined 193,000 same-donor paired specimens of hair and urine, collected over a 5.5-year period from 2004 to 2009. As shown in Table 30, overall positivity rates for hair were considerably higher than the positivity rates for urine. Hair analyses detected use of amphetamines (particularly methamphetamine) and cocaine to a greater extent than urine analyses.

Studies from different donors (independent specimens of urine and hair) also show differences in positivity rates between urine and hair, but only for certain type of drugs (Quest Diagnostics November 2009). Table 31 reports the positivity rates by drug category for urine and hair drug tests for the general U.S. population (Quest Diagnostics November 2009). According to these data, hair positivity rates tend to higher than urine for amphetamine/methamphetamine, cocaine, and marijuana, whereas urine positivity rates tend to be higher for opiates and phencyclidine.

TABLE 30
SAME-DONOR HAIR AND URINE POSITIVITY RATES (%)

Drug	Hair	Urine
Overall	12.6	7.6
Amphetamines	5.9	2.1
Methamphetamine Only	5.9	1.8
Cocaine/Metabolites	4.8	0.65
Opiates	0.23	0.52
Phencyclidine	0.05	0.05
Marijuana Metabolites	3.4	3.4

Source: Sample (2010).

Overall, the pattern of higher positivity rates for hair testing is robust. Table 32 reports the positivity rates by type of test for urine and hair drug tests for the general U.S. workforce (Quest Diagnostics November 2009).

Mieczkowski (2010) examined 11,242 same-donor paired urine and hair specimens for pre-employment tests and 1,458 urine and hair specimen for random tests. Of the pre-employment tests, approximately 2% of the urine specimens and 9% of the hair specimens were positive. Of the random tests, 0.6% of the urine specimens and 3% of the hair specimens were positive.

An important distinction must be made at this point between drug use and impairment. Drug use can be detected with a drug test by the presence of active or inactive analytes, whereas impairment can only be inferred by the presence of active analytes and/or behavioral signs and symptoms. As shown in the previous sections, active analytes tend to have shorter half-lives than inactive analytes and can, therefore, be detected for shorter periods of time.

The suitability of different specimens varies as a function of the type of test that is being performed. Pre-employment tests, for example, are administered to determine whether

TABLE 31
POSITIVITY RATES (%) BY DRUG CATEGORY FOR URINE DRUG TESTS AND HAIR DRUG TESTS FOR THE GENERAL U.S. WORKFORCE

Year	Amphetamines		Cocaine		Marijuana		Opiates		Phencyclidine	
	Urine	Hair	Urine	Hair	Urine	Hair	Urine	Hair	Urine	Hair
2005	0.48	2.1	0.70	5.0	2.5	3.0	0.32	0.14	0.020	0.01
2006	0.42	1.1	0.72	4.5	2.4	3.5	0.32	0.14	0.020	0.01
2007	0.44	1.2	0.58	5.3	2.3	3.9	0.35	0.17	0.020	0.01
2008	0.48	0.86	0.41	4.2	2.1	3.4	0.38	0.14	0.020	0.00
2009 (Jan.–June)	0.55	1.1	0.30	3.2	2.0	3.2	0.44	0.15	0.01	0.01

an individual is an illegal drug user. These tests benefit from a relatively large detection window, hence the usefulness of hair testing. Postaccident tests, in contrast, may be administered not only to determine whether an individual is an illegal drug user, but also to determine, for forensic and legal purposes, whether the individual was impaired at the time of the accident. These tests require the detection of the active analytes and benefit from a relatively short detection window, which frames the co-occurrence of the accident and of the drug use within a relatively brief period of time. Blood and oral fluids tests are best suited for these needs.

TABLE 32
POSITIVITY RATES (%) BY TYPE OF TEST FOR URINE DRUG TESTS AND HAIR DRUG TESTS FOR THE GENERAL U.S. WORKFORCE

Year	Pre-employment		Random	
	Urine	Hair	Urine	Hair
2005	3.9	7.0	6.6	12.7
2006	3.9	7.2	5.5	11.0
2007	3.9	7.4	5.7	15.8
2008	3.6	6.3	5.3	9.6
2009 (Jan.–June)	3.4	4.7	5.4	10.4

The usefulness of additional specimens to the DOT protocol must be weighed against the practical complexity of managing a drug-testing program with different specimens. For each type of specimen, collection methods, analyte cutoffs, and laboratory standards and procedures must be implemented. Given the size of the DOT drug-testing program, careful consideration must be given to the logistical and financial burden associated with the use of additional specimens.

Although specific types of specimens are best suited for specific types of tests, urine is the only specimen that is adequately suited for all types of tests. Table 33 rates the usefulness of the window of detection of different specimens as a function of type of drug test. If only one type of specimen is to be used for practical and economic reasons, urine is currently the best option.

TABLE 33
UTILITY (LOW, MEDIUM, HIGH) OF DIFFERENT SPECIMENS AS A FUNCTION OF TYPE OF DRUG TEST

Test	Blood	Oral Fluids	Urine	Sweat	Hair
Random	Low	Low	Medium	Low	High
Pre-employment	Low	Low	Medium	Low	High
Postaccident	High	High	Medium	Low	Low
Reasonable Suspicion	High	High	Medium	Low	Low
Return-to-Duty	Low	Low	Medium	Medium	Low
Follow-up	Low	Low	Medium	Medium	Low

HIGHER RANDOM TESTING RATES

Some companies set target rates for the random alcohol and drug tests that exceed the minimum rates established by their regulatory agencies. Of the companies sampled for this project, Greyhound Lines, J.B. Hunt Transport, and BNSF conduct random alcohol and drug tests above the minimum requirements.

Greyhound Lines, Inc., is the largest provider of intercity bus transportation, with 8,500 employees nationwide. Greyhound's third-party administrator is HireRight, a global provider of employment drug and background screening. According to HireRight, Greyhound Lines maintains annual random testing rates at 55% for drugs and 15% for alcohol.

J.B. Hunt Transport testing rates are 55% for drugs and more than 10% for alcohol. Unannounced, random drug and alcohol tests are spread periodically throughout the year, aiming for completion on a quarterly basis. This method attempts to eliminate the possibility of falling short of the random rates at the end of the year owing to unpredictable circumstances, such as employees leaving the company before being tested.

BNSF conducts random testing at a higher frequency than the minimum for both drug and alcohol tests. As of November 1, 2010, all FRA and company random testing is administered at 37.5% for both alcohol and drug tests. Exceptions include all FRA random road tests are alcohol tests only for all outbound trains, and FMCSA random tests continue at 50% for alcohol and 50% for drugs.

Higher random testing rates are a fair and effective strategy for increasing compliance with alcohol and drug policies. With the exception of costs to the company, this strategy has no adverse effects.

LONGER PREDUTY ALCOHOL ABSTINENCE PERIODS

Companies can require longer preduty alcohol abstinence periods than the required 4 to 8 h. J.B. Hunt, for example, requires 12 h of alcohol abstinence before initiating safety-sensitive work.

CONSEQUENCES FOR BACS 0.020–0.039

There is considerable empirical evidence that alcohol negatively affects human performance with any deviation from BAC 0.000 (Moskowitz and Fiorentino 2000). Consistent with this view, DOT rules require that an employee with BACs 0.020–0.039 be immediately removed from all safety-sensitive duties. The employee cannot return to safety-sensitive duty until the BAC has dropped below 0.020, and a minimum period of time has elapsed, usually between 8 and 24 h.

To deter employees from having BACs in the 0.020–0.039 range, some employers have imposed stricter consequences for those lower BACs. Of the companies sampled for this project, three impose these stricter consequences: Halliburton, Continental Airlines, and BNSF.

Halliburton is an energy company with employees and locations worldwide. Its policy allows immediate removal of employees with BACs of 0.020–0.039 from all safety-sensitive work. The employees are sent home with safe travel arrangements. The employees are also suspended from all duties and functions and cannot return to work for 2 weeks.

Continental Airlines immediately removes employees with BACs in the 0.020–0.039 range from safety-sensitive work. The employees are taken off the future work schedule. Employees are reported to the SAP and enrolled in an EAP. The SAP and EAP, together, decide when the employee is fit to return to work. If the employee is already participating in a last-chance agreement, then this BAC range of 0.020–0.039 counts as a positive, which would violate the terms of the agreement. The employee is then terminated from the company.

BNSF considers any alcohol test with BAC of 0.020 or above as a positive test and a violation of the company's drug and alcohol policy. Employees are immediately removed from performing services and referred to the EAP. The company may extend a waiver of charges agreement on a first-time positive and require that the employee enter an EAP. When released back to work by the SAP and EAP, the employee is subject to a return-to-duty test and follow-up testing as directed by the SAP. Alternatively, if a waiver is not offered, the employee would be subject to a formal investigation and face termination.

STRICTER POSTACCIDENT TESTING

Postaccident drug and alcohol tests must be conducted within a particular timeframe, typically 8 h for alcohol and 32 h for drugs. Of the companies sampled for this project, four have policies that shorten the postaccident test timeframe: Halliburton, Continental Airlines, Greyhound Lines, and BNSF.

Following an accident, Halliburton's testing staff and company officials are dispatched to the scene. The objective is to test all employees, for both alcohol and drugs, within 2 h of the accident. If for some reason an unforeseen delay occurs, a 4-h window is accepted. With strict postaccident testing windows, Halliburton has experienced its lowest rates for injury and vehicle incidents in the past 2 years at under 0.75 and 0.50 per 200,000 work-hours, respectively (Halliburton 2010).

Continental Airlines aims to test its personnel within 5 h of an accident. Employees are tested for both alcohol and drugs.

Greyhound Lines set its postaccident testing window to 2 h, with drug and alcohol tests conducted at the same time. There can be exceptions, however, as if a citation is not issued within 30 min of the accident or if location and/or weather prevent the employee from reaching the testing facility within the 2-h window.

BNSF makes every effort to complete FRA postaccident testing within 4 h following the incident at a medical facility where employees are required to provide urine and blood samples. However, reasonable delays can occur because of railroads in remote locations with limited access points, rugged terrain, and, at times, severe weather conditions.

STRICTER FOLLOW-UP TESTING

Currently, no fewer than six tests in 12 months are allowed for follow-up testing. Companies that elect to exceed those requirements may increase the number of tests, extend the duration of the testing period, or both. Of the companies sampled for this project, two exceed the minimum requirements: Halliburton and Greyhound.

Halliburton employees are given a chance to sign a last-chance agreement and enroll in an EAP after the first confirmed positive result. If the employee signs the last-chance agreement and passes the return-to-duty tests, the EAP or SAP determines when the employee can return to safety-sensitive duties. In the EAP, the employee is followed over a 2-year period, with no fewer than 12 unannounced follow-up tests per 12-month period (for a total of 24 tests). The tests are conducted at random each month of the program. If at any time the employees test positive, they are expelled from the EAP and removed from the company entirely. Likewise, after the EAP is complete, if the employees ever test positive again, they are terminated with no chance of rehire.

Greyhound follows a similar pattern. Following a confirmed positive result, the employee is referred to a SAP in the area and must sign a last-chance agreement to continue with the company. If the agreement is made, the employee is subject to between 6 and 12 unannounced follow-up tests per year for up to 5 years. Currently, Greyhound has fewer than 20 employees participating in follow-up testing programs—0.02% of its total workforce. If any of these employees test positive again on any other drug or alcohol test, they will not be given another chance and will be permanently removed from the company.

NATIONAL DATABASE

As mentioned earlier, only 48% of all motor carriers have alcohol- and drug-testing programs in place, covering 89% of all commercial drivers (Khan 2010). A 2008 GAO report

estimated that fewer than half of commercial drivers who test positive or refuse to take a test complete the return-to-duty process.

According to J.B. Hunt Transport, the primary problem of verification of previous drug and alcohol test results is with drivers failing to disclose their own refusals to take the test and with employers that have gone out of business. Those drivers who do not complete the return-to-duty process continue to drive, primarily by "job hopping." Job hoppers test positive with one carrier, stop working for that carrier, do not go through the return-to-duty process, stop using drugs for the necessary period of time to test negative on pre-employment tests, and begin working for another carrier, where they may resume using drugs, and the cycle begins anew.

Another category of drivers who are not likely to remove themselves from service after testing positive are owner-operators. Note that DOT regulations require owner-operators to participate in a random testing program, which includes other owner-operators. The random testing pool is typically managed by a C/TPA. The exact number of owner-operators is unknown, making measurement of compliance difficult.

The 2008 GAO report makes a strong case for the usefulness of a national database in reducing the number of drivers who test positive and continue to drive. Such a national database would maintain drug and alcohol test positives and refusals information. Carriers would be required to search applicants in the database before hiring them. Such an approach depends on the level of compliance of carriers in reporting employees' testing data, with some owner-operators unlikely to voluntarily provide such data.

The FMCSA is in the process of developing rules that would mandate reporting requirements for C/TPAs, MROs, and additional parties who participate in the DOT testing program. These rules would require that carriers access and review the relevant information contained in a database to ensure that only drivers in compliance with the DOT alcohol- and drug-testing requirements be allowed to perform safety-sensitive functions. The FMCSA plans to implement the national database by the end of 2012.

The proposed system will allow authorized FMCSA staff and state law enforcement personnel to access the data and create reports. For purposes of enforcement, the system will likely require the expansion of civil penalty enforcement authority to cover all DOT service agents. Note that some states (Arkansas, New Mexico, Oregon, Texas, California, North Carolina, and Washington) have already enacted regulations mandating the reporting of positive tests and refusals (GAO 2008).

DRIVING RECORD NOTATIONS

Some states have enacted regulations that place a notation on the driving record of commercial drivers who have tested positive in a drug or alcohol test. DOT took regulatory action to remove legal barriers allowing states to implement such regulations. We have obtained information from North Carolina, Washington, and Oregon.

In general, those statutes work as follows. The department responsible for the licensing of commercial drivers must place a notation on the driving record of the driver on receipt of notice of a positive result in an alcohol or drug test. The notation of disqualification is retained on the record of the person for a predetermined period, usually 2 or 3 years.

After a positive alcohol or drug test, the driver is notified by the department of the pending disqualification. The driver has a predetermined period of time (usually 20 days) from the day of the notice to request an appeal. If no request is received within the time period, the disqualification becomes effective. If the driver requests a hearing, the disqualification is stayed pending the outcome of the hearing. The hearing is typically limited to issues of testing procedure and protocol.

CHAPTER SEVEN

SUMMARY AND RESEARCH RECOMMENDATIONS

Currently, the U.S.DOT regulates the largest drug- and alcohol-testing program in the world. In general, the drug-testing program is aimed at deterring use of illegal drugs, and the alcohol-testing program is aimed at preventing prohibited use of a legal substance while the employee is at work or within a short period of time before reporting for work. Drug and alcohol testing may be conducted under six conditions: pre-employment, postaccident, at random, under reasonable suspicion (and, for railroads, for cause), on return-to duty after a positive test, and follow-up.

Since the inception of the program, a game of cat and mouse has unfolded, with a cottage industry selling products aimed at defeating the drug tests. The three most common methods of defeating the drug test are dilution, adulteration, and substitution. Many new products work when first introduced, but as they are identified and detected their use wanes, and they are replaced with newer formulations, repeating the cycle.

Specimen validity testing (SVT) is a set of laboratory analyses and procedures aimed at detecting whether a specimen is diluted, adulterated, or substituted. The usefulness of SVT depends on the ability to identify and detect the tampering. SVT appears to be effective in reducing tampering, with the overall percentage of specimens identified as tampered being relatively low and declining over time. Some vulnerabilities, however, especially the adherence to specimen collection procedures at the collection sites, may continue to weaken the program.

The DOT drug-testing program requires laboratories to test for five types of drugs: marijuana, cocaine, amphetamines, opiates, and phencyclidine. The cutoff concentrations of the different analytes for the initial test and the confirmatory test have been updated recently to harmonize the DOT requirement with those of the U.S. DHHS.

To comply with DOT requirements, each DOT agency must specify aspects of its drug- and alcohol-testing program not directly covered in the Code of Federal Regulations (49 CFR Part 40). We summarized how each agency defines the employees in safety-sensitive work who need to be tested, the minimum annual percentage rates for random drug testing, and record retention periods.

In general, drug positivity rates for the general U.S. workforce, the federally mandated, safety-sensitive workforce, and the DOT-only workforce have been declining over time. From 2008 to 2010, the drug positivity rate for the DOT-only workforce declined from 1.64% to 1.49%. In 2008, the alcohol positivity rate for the DOT-only workforce was 0.002%.

Across modes, pre-employment, random, and reasonable cause tests resulted in the highest number of positive tests. In all modes, the type of tests with the highest positivity rate was reasonable cause/suspicion. Marijuana was the most commonly detected drug.

An attempt was made to contact companies in the DOT-regulated community to identify the current best practices used to deter illegal drug and alcohol use among employees. Only a few of the companies contacted agreed to provide information. These tended to be medium- and large-sized companies, and it is unlikely that their responses are representative of the entire industry, because small companies tend to not have as extensive alcohol and drug testing procedures. Nonetheless, the information they provided was useful for the purposes of this project. They identified the following strategies as being currently in use or in the process of being deployed.

- **Zero-tolerance policies** require that employees with positive alcohol or drug tests are immediately removed from the safety-sensitive position and are not immediately given a second chance to return to that position.
- **Pre-employment alcohol screening,** which is not mandated by DOT, can be an effective and inexpensive way to identify applicants who most likely have alcohol addiction and cannot abstain from alcohol.
- **Pre-employment background check periods** range up to 5 years instead of the mandated 2 or 3 years.
- **Analysis of alternative specimens, especially hair, for pre-employment tests.** Because hair analysis has a larger detection window than urine analysis, it results in higher positivity rates for amphetamine/methamphetamine, cocaine, and marijuana, the most commonly detected drugs in both types of analyses.
- **Higher company-set random testing rates** increase the deterrent value of the drug and alcohol program and make it unlikely that the company will not comply with the DOT-mandated random test rates.

- Longer preduty alcohol abstinence periods are meant to decrease the likelihood of the employee being under the influence of alcohol prior to the beginning the work shift.
- Stricter consequences for blood alcohol contents (BACs) between 0.020 and 0.039 are consistent with what is currently known about the effects of alcohol on human performance, even at low BACs, and are meant to signal a company's low tolerance for violations of preduty abstinence periods.
- Stricter postaccident testing reduces the time elapsed between an accident and the subsequent required alcohol and drug testing. If the employee involved in the accident was under the illegal influence of alcohol or drugs, this increases the probability of a positive test.
- Stricter follow-up testing procedures increase the frequency of tests following a positive test, the duration of the testing period, or both.
- Access to a national database would ensure that drivers who test positive and/or refuse a DOT test are in compliance with the substance abuse professional requirements before returning to a safety-sensitive function by making their results available to prospective motor carriers when performing background checks. Such a database is expected to be implemented by FMCSA the end of 2012.
- Driving record notations are retained for drivers who test positive in a drug or alcohol test for a pre-determined period, usually 2 to 3 years.

Based on the results of the synthesis, the following research recommendations were made:

- Given the high positivity rate for reasonable-cause tests with relatively limited supervisor training, it may be useful to investigate whether additional supervisor training would result in higher detection rates for reasonable-cause tests. To that end, it may be possible to develop a training program that would allow a deeper and wider understanding of the observable signs and symptoms of illegal alcohol (BAC > 0.040) and drug use. Such training could be based on the Advanced Roadside Impaired Driving Performance (ARIDE) program developed by the National Highway Traffic Safety Administration with input from the International Association of Chiefs of Police Technical Advisory Panel (TAP) and the Virginia Association of Chiefs of Police.

ARIDE was created to address the gap in training between the Standardized Field Sobriety Testing (SFST) and the Drug Evaluation and Classification (DEC) program. The SFST program trains officers to identify and assess drivers suspected of being under the influence of alcohol, and the DEC program provides more advanced training to evaluate suspected drug impairment. ARIDE is intended to bridge the gap between these two programs by providing officers with general knowledge related to drug impairment. It is a 16-h training course. The development of such training would require time and effort and would have to be tailored to the specific needs of the regulated community, with input likely required from DOT, TAP, industry representatives, and labor unions.

- In this synthesis, the distinction was made between detection of drug use and detection of impairment. The current DOT drug-testing program is aimed at detection of illegal drug use. However, it may be beneficial to expand the purpose of testing to include detection of impairment by all drugs that are known to negatively affect human performance and that are empirically linked to reductions in transportation safety.

The shift in emphasis is fraught with difficulties. First, drugs that are current and emerging threats to transportation safety have to be identified. Studies must be conducted in the laboratory and in the field to identify drugs that clearly reduce transportation safety. Those studies, especially field studies, such as case–control studies, require large sampling populations, are methodologically complex, and are expensive. However, the identification of such drugs hinges on integration of knowledge from previous research and investment in future projects.

Second, the analytical cutoffs of testing must be established. Impairment-based regulations for drugs that have legal use require criteria above which the levels of risks outweigh the benefits. For any medicinal drug, the criterion must separate normal use of the drug (i.e., within the prescribed dose) and the illegal or improper use of that same drug. Establishment of that criterion must be based on the empirical evidence of the dose–effect relationships in a majority of the user population.

Third, the approach requires the integrated dissemination of information in different groups outside of DOT. Physicians and pharmacists must make informed decisions on prescribing and dispensing medications that are impairing to patients in safety-sensitive positions; medications must be properly labeled as impairing, using an easy-to-understand, graded-level warning system; and employees must learn to identify their own signs and symptoms of impairing drugs. These difficulties notwithstanding, the shift in emphasis from detection of illegal drug use to detection of drug impairment is likely to have beneficial effects on transportation safety.

- As previously discussed, some researchers assert that the inherent drawbacks of hair testing preclude it for use in the workplace, where accuracy and fairness in employment decisions are paramount, whereas other researchers assert that the main analytical problems have been adequately resolved and it is important that

hair be preferentially chosen for pre-employment and random tests. Some companies in the regulated community, however, have been routinely using hair for the purpose of pre-employment tests. Thus, a situation has arisen in which market forces within a portion of the regulated community have selected hair as the matrix of choice for pre-employment tests but DOT regulations allow urine only for purposes of workplace drug testing.

The controversy on hair testing may be resolved on the basis of empirical data. To that end, an appropriate number of studies would need to be conducted to examine the unresolved issues. It would be particularly important that the issue of external contamination be examined using state-of-the-art analytical procedures, including wash criteria.

Because retrospective data are potentially unsuitable for drug studies, the issue of race bias may be examined with prospective data. One potentially useful set of studies would compare drug positivity rates for different matrices between groups of men and women with different shades of hair pigmentation and racial background. For each drug of interest, the participants would be casual drug users who would agree to abstain for a period of time of sufficient duration for them to be verifiably clear of drugs prior to participation in the study and who would agree to abstain for a minimum of 90 days following participation in the study. During the study, participants would be administered different doses of a single drug under controlled conditions. The doses would vary from zero (placebo) to the average street dose for that drug. Blood, urine, hair, sweat, and saliva analyses would then be conducted at regular intervals for a minimum of 90 days from the administration of the drug. Such studies would have to be carefully designed and executed, paying particular attention to the welfare of the participants, the quality of collection procedures and analyses, and the overarching ethical and legal issues involved in such research.

REFERENCES

Barroso, M., E. Gallardo, D.N. Vieira, J.A. Queiroz, and M. Lopez-Rivadulla, "Bioanalytical Procedures and Recent Developments in the Determination of Opiates/Opioids in Human Biological Samples," *Analytical and Bioanalytical Chemistry*, Vol. 400, 2011, pp. 1665–1690.

Baselt, R.C. and R.H. Cravey, *Disposition of Toxic Drugs and Chemicals in Man*, Chemical Toxicology Institute, Foster City, Calif., 1995.

Baumgartner, W.A. and V.A. Hill, "Hair Analysis for Drugs of Abuse: An Investigation of the Melanin Bias Hypothesis," *International Journal of Drug Testing*, Vol. 2, 2001, pp. 1–19.

Bernstein, E., J. Bernstein, K. Tassiopoulos, A. Valentine, T. Heeren, S. Levenson, and R. Hingson, "Racial and Ethnic Diversity Among a Heroin and Cocaine Using Population: Treatment System Utilization," *Journal of Addictive Diseases*, Vol. 24, 2005, pp. 43–63.

Burns, M., T.E. Page, and J.B. Leikin, *Drug Information Handbook*, Lexi-Comp., Hudson, Ohio, 1998.

Burris, A., "HB Man Sentenced for Making Fake Pee Products," *The Orange County Register* [Online]. Available: http://www.ocregister.com/articles/drug-243187-press-release.html [accessed Apr. 8, 2010].

Bush, D.M., "Federal Regulation of Workplace Drug and Alcohol Testing," in *Drug Abuse Handbook*, S.B. Karch, Ed., CRC Press, Boca Raton, Fla., 2007, pp. 736–747.

Bush, D.M., "The U.S. Mandatory Guidelines for Federal Workplace Drug-Testing Programs: Current Status and Future Considerations," *Forensic Science International*, Vol. 174, 2008, pp. 111–119.

Cairns, T., V. Hill, M. Schaffer, and W. Thistle, "Levels of Cocaine and Its Metabolites in Washed Hair of Demonstrated Cocaine Users and Workplace Subjects," *Forensic Science International*, Vol. 145, 2004a, pp. 175–181.

Cairns, T., V. Hill, M. Schaffer, and W. Thistle, "Removing and Identifying Drug Contamination in the Analysis of Human Hair," *Forensic Science International*, Vol. 145, 2004b, pp. 97–108.

Caplan, Y., "Specimen Validity Testing," In *Drug Abuse Handbook*, S.B. Karch, Ed., CRC Press, Boca Raton, Fla., 2007, pp. 842–856.

Cody, J.T. and S. Valtier, "Effects of Stealth Adulterant on Immunoassay Testing for Drug of Abuse," *Journal of Analytical Toxicology*, Vol. 25, 2001, pp. 466–470.

Cone, E.J., R. Lange, and W.D. Darwin, "In Vivo Adulteration: Excess Fluid Ingestion Causes False-Negative Marijuana and Cocaine in Urine Test Results," *Journal of Analytical Toxicology*, Vol. 22, 1998, pp. 460–473.

Cone, E.J., A. Sampson-Cone, and M.A. Huestis, "Interpreting Alternative Matrix Test Results," In *Drug Abuse Handbook*, S.B. Karch, Ed., CRC Press, Boca Raton, Fla., 2007, pp. 814–842.

Couper, F.J. and B.K. Logan, *Drug and Human Performance Drug Sheets*, Report No. DOT HS 809-725, 2004, National Highway Traffic Safety Administration website [Online]. Available: http://www.nhtsa.gov/people/injury/research/job185drugs/drugs_web.pdf.

Dasgupta, A., "The Effects of Adulterants and Selected Ingested Compounds on Drug-of-Abuse Testing in Urine," *American Journal of Clinical Pathology*, Vol. 128, 2007, pp. 491–503.

Drummer, O.H., "Forensic Toxicology," *Experientia*, Vol. 100, 2010, pp. 579–603.

DuPont, R.L. and W.A. Baumgartner, "Drug Testing by Urine and Hair Analysis: Complementary Features and Scientific Issues," *Forensic Science International*, Vol. 70, 1995, pp. 63–76.

Gallardo, E. and J.A. Queiroz, "The Role of Alternative Specimens in Toxicological Analysis," *Biomedical Chromatography*, Vol. 22, 2008, pp. 795–821.

GAO, *Undercover Tests Reveal Significant Vulnerabilities in DOT's Drug Testing Program*, GAO Publication No. 08-225T, Washington, D.C., 2007 [Online]. Available: http://www.gao.gov/new.items/d08225t.pdf.

GAO, *Motor Carrier Safety: Improvements to Drug Testing Programs Could Better Identify Illegal Drug Users and Keep Them Off the Road*, GAO Publication No. 08-600, Washington, D.C., 2008 [Online]. Available: http://www.gao.gov/new.items/d08600.pdf.

Goldberger, B.A. and Y.H. Caplan, "Effect of Glutaraldehyde (UrinAid) on Detection of Abused Drugs in Urine by Immunoassay," *Clinical Chemistry*, Vol. 40, 1994, pp. 1605–1606.

Gruberg, R., Memorandum to Terry Sheldon, Federal Motor Carrier Safety Administration, Washington, D.C., 1997.

Gruberg, R., *Drug and Alcohol Testing Survey: 2004 and 2005 Results*, Report No. FMCSA-RRA-07-013, 2007 [Online]. Available: http://www.fmcsa.dot.gov/facts-research/research-technology/analysis/FMCSA-RRA-07-014.htm.

Halliburton, *Halliburton Safety Statistics: 1 Jan 2000 through 30 Jun 2010*, 2010 [Online]. Available: http://

www.halliburton.com/public/about_us/pubsdata/hse/pdf/Glbl_Mon_Rpt_YTD_Public.pdf.

Hill, V., T. Cairns, and M. Schaffer, "Hair Analysis for Cocaine: Factors in Laboratory Contamination Studies and Their Relevance to Proficiency Sample Preparation and Hair Testing Practices," *Forensic Science International*, Vol. 176, 2008, pp. 23–33.

Hill, V., M. Schaffer, and T. Cairns, "Absence of Hair Color Effects in Hair Analysis Results for Cocaine, Benzoylecgonine, Morphine, 6-Monoacetylmorphine, Codeine, and 11-nor-9-carboxy-Δ9-THC in Large Workplace Populations," *Annales de Toxicologie Analytique*, Vol. 17, 2005, pp. 285–297.

Hoelzle, C., F. Scheufler, M. Uhl, H. Sachs, and D. Thieme, "Application of Discriminant Analysis to Differentiate Between Incorporation of Cocaine and Its Congeners into Hair and Contamination," *Forensic Science International*, Vol. 176, 2008, pp. 13–18.

Hoffman, B.H., "Analysis of Race Effects on Drug Test Results," *Journal of Occupational and Environmental Medicine*, Vol. 41, 1999, pp. 612–614.

Jaffee, W.B., E. Trucco, C. Teter, S. Levy, and R.D. Weiss, "Ensuring Validity in Urine Drug Testing," *Psychiatric Services*, Vol. 59, 2008, pp. 140–142.

Jambor, L., "Adulterants Continue to Challenge Laboratories," *Clinical & Forensic Toxicology News*, Dec. 2008, pp. 1, 8–10.

Kelly, R.C., T. Meiczkowski, S.A. Sweeney, and J.A. Bourland, "Hair Analysis for Drug of Abuse. Hair Color and Race Differentials or Systematic Differences in Drug Preferences?" *Forensic Science International*, Vol. 107, 2000, pp. 63–86.

Khan, M.A., *Results from the 2008 Drug and Alcohol Testing Survey*, Federal Motor Carrier Safety Administration, Washington, D.C., 2010.

Kidwell, D.A., and F.P. Smith, "Passive Exposure, Decontamination Procedures, Cutoffs, and Bias: Pitfalls in the Interpretation of Hair Analysis Results for Cocaine Use," In *Analytical and Practical Aspects of Drug Testing in Hair*, P. Kintz, Ed., Taylor and Francis, Boca Raton, Fla., 2007, pp. 25–72.

Kidwell, D.A., E.H. Lee, and S.F. DeLauder, "Evidence for Bias in Hair Testing and Procedures to Correct Bias," *Forensic Science International*, Vol. 107, 2000, pp. 39–61.

Kintz, P., M. Villain, and V. Cirimele, "Analytical Approaches for Drugs in Biological Matrices Other Than Urine," In *Drug Abuse Handbook*, S.B. Karch, Ed., CRC Press, Boca Raton, Fla., 2007, pp. 800–813.

Koren, G., J. Klein, R. Forman, and K. Graham, "Hair Analysis of Cocaine: Differentiation Between Systemic Exposure and External Contamination," *Journal of Clinical Pharmacology*, Vol. 32, 1992, pp. 671–675.

LeBeau, M.A. and M.A. Montgomery, "Considerations on the Utility of Hair Analysis for Cocaine," *Journal of Analytical Toxicology*, Vol. 33, 2009, pp. 343–344.

LeBeau, M.A. and M.A. Montgomery, "Hair Analysis for Cocaine Continues to Be a Valuable Tool in Forensic and Clinical Toxicology: The Authors' Reply," *Journal of Analytical Toxicology*, Vol. 34, 2010, pp. 355–356.

Mas, M., M. Farre, R. De La Torre, P.R. Roset, J. Ortuño, J. Segura, and J. Cami, "Cardiovascular and Neuroendocrine Effects and Pharmacokinetics of 3,4-Methylenedioxymethamphetamine in Humans," *The Journal of Pharmacology and Experimental Therapeutics*, Vol. 290, 1999, pp. 136–145.

Mieczkowski, T., "Passive Contamination of Undercover Narcotics Officers by Cocaine: An Assessment of Their Exposure Using Hair Analysis," *Microgram*, Vol. 27, 1995, pp. 193–198.

Mieczkowski, T., "Urinalysis and Hair Analysis for Illicit Drugs of Driver Applicants and Drivers in the Trucking Industry," *Journal of Forensic and Legal Medicine*, Vol. 17, 2010, pp. 254–260.

Mieczkowski, T. and M. Kruger, "Interpreting the Color Effect of Melanin on Cocaine and Benzoylecgonine Assays for Hair Analysis: Brown and Black Samples Compared," *Journal of Forensic and Legal Medicine*, Vol. 14, 2007, pp. 7–15.

Mieczkowski, T. and R. Newel, "An Evaluation of Patterns of Racial Bias in Hair Assays for Cocaine: Black and White Arrestees Compared," *Forensic Science International*, Vol. 63, 1993, pp. 85–98.

Mieczkowski, T. and R. Newel, "Statistical Examination of Hair Color as a Potential Biasing Factor in Hair Analysis," *Forensic Science International*, Vol. 107, 2000, pp. 13–38.

Mieczkowski, T., K.M. Lersch, and M. Kruger, "Police Drug Testing, Hair Analysis, and the Issue of Race Bias," *Criminal Justice Review*, Vol. 27, 2002, pp. 124–139.

Mieczkowski. T., C. Sullivan, and M. Kruger, "The Use of Bayes Coefficients to Assess the Racial Bias–Hair Analysis Conjecture for Detection of Cocaine in Hair Samples," *Forensic Science Communications*, Vol. 9, 2007, pp. 1–12.

Mikkelsen, S.L. and K.O. Ash, "Adulterants Causing False Negatives in Illicit Drug Testing," *Clinical Chemistry*, Vol. 34, 1988, pp. 2333–2336.

Moeller, K.E., K.C. Lee, and J.C. Kissack, "Urine Drug Screening: Practical Guide for Clinicians," *Mayo Clinic Proceedings*, Vol. 83, 2008, pp. 66–76.

Moskowitz, H. and D. Fiorentino, *A Review of the Literature on the Effects of Low Doses of Alcohol on Driving-Related Skills*, Report No. DOT HS 809 028, National Highway Traffic Safety Administration, Washington, D.C., 2000.

Paul, B.D. and A. Jacobs, "Effects of Oxidizing Adulterants on Detection of 11-nor-delta9-thc-9-Carboxylic Acid in Urine," *Journal of Analytical Toxicology*, Vol. 26, 2002, pp. 460–463.

Paul, B.D. and A. Jacobs, "Spectrophotometric Detection of Iodide and Chromic (III) in Urine After Oxidation to Iodine and Chromate (VI)," *Journal of Analytical Toxicology*, Vol. 29, 2005, pp. 658–663.

Pearson, S.D., K.O. Ash, and F.M. Urry, "Mechanism of False-Negative Urine Cannabinoid Immunoassay Screens by Visine Eyedrops," *Clinical Chemistry*, Vol. 35, 1989, pp. 636–638.

Pragst, F. and M.A. Balikova, "State of the Art in Hair Analysis for Detection of Drug and Alcohol Abuse," *Clinica Chimica Acta*, Vol. 370, 2006, pp. 17–49.

Pragst, F., H. Sachs, and P. Kintz, "Hair Analysis for Cocaine Continues to Be a Valuable Tool in Forensic and Clinical Toxicology," *Journal of Analytical Toxicology*, Vol. 34, 2010, 354–355.

Quest Diagnostics, *New Hair Data Validate Sharp Downward Trend in Cocaine and Methamphetamine Positivity in General U.S. Workforce, According to Quest Diagnostics Drug Testing Index*, Nov. 2009 [Online]. Available: http://www.questdiagnostics.com/employersolutions/dti/2009_11/dti_index.html.

Quest Diagnostics, *U.S. Worker Use of Prescription Opiates Climbing, Shows Quest Diagnostics Drug Testing Index*, Sep. 2010 [Online]. Available: http://www.questdiagnostics.com/employersolutions/dti/2010_09/dti_index.html.

Redington, M., E. Rutyna, N. Grace, and F. Shanahan, *Drug and Alcohol Testing Results: 2007 Annual Report*, Report No. DOT-VNTSC-FTA-09-01, 2009 [Online]. Available: http://transit-safety.fta.dot.gov/publications/substance/damis07/pdf/damis07.pdf.

Romano, G., N. Barbera, and I. Lombardo, "Hair Testing for Drugs of Abuse: Evaluation of External Cocaine Contamination and Risk of False Positives," *Forensic Science International*, Vol. 123, 2001, pp. 119–129.

Ropero-Miller, J.D. and P.R. Stout, *Analysis of Cocaine Analytes in Human Hair: Evaluation of Concentration Ratios in Different Hair Types, Cocaine Sources, Drug-User Populations, and Surface-Contaminated Specimens*, 2008 [Online]. Available: http://www.ncjrs.gov/pdffiles1/nij/grants/225531.pdf.

Ropero-Miller, J.D. and P.R. Stout, *Analysis of Cocaine Analytes in Human Hair II: Evaluation of Different Hair Color and Ethnicity Types*, 2011 [Online]. Available: https://www.ncjrs.gov/app/publications/Abstract.aspx?id=256586.

Sample, B., "Recent Trends in Workplace Testing of Illicit Drugs in Hair and Urine," Jan. 28, 2010 [Online]. Available: http://employersolutions.zynite.com/seminars.cfm [accessed June 24, 2010].

Schaffer, M.I., W.L. Wang, and J. Irving, "An Evaluation of Two Wash Procedures for the Differentiation of External Contamination Versus Ingestion in the Analysis of Human Hair Samples for Cocaine," *Journal of Analytical Toxicology*, Vol. 26, 2002, pp. 485–488.

Schaffer, M., V. Hill, and T. Cairns, "Hair Analysis for Cocaine: The Requirement for Effective Wash Procedures and Effects of Drug Concentration and Hair Porosity in Contamination and Decontamination," *Journal of Analytical Toxicology*, Vol. 29, 2005, pp. 1–8.

Schwope, D.M., G. Milman, and M.A. Huestis, "Validation of an Enzyme Immunoassay for Detection and Semiquantification of Cannabinoids in Oral Fluid," *Clinical Chemistry*, Vol. 56, 2010, pp. 1007–1014.

Stout, P.R., "Hair Testing for Drugs—Challenges for Interpretation," *Forensic Science Review*, Vol. 19, 2007, pp. 69–84.

Tassiopoulos, K., J. Bernstein, T. Heeren, S. Levenson, R. Hignson, and E. Bernstein, "Hair Testing and Self-Report Cocaine Use by Heroin Users," *Addiction*, Vol. 99, 2004, pp. 590–597.

Thorspecken, J., G. Skopp, and L. Potsch, "In Vitro Contamination of Hair by Marijuana Smoke," *Clinical Chemistry*, Vol. 50, 2004, pp. 596–602.

Tsai, S.C., M.A. ElSohly, T. Dubrovsky, B. Twarowska, J. Towt, and S.J. Salamone, "Determination of Five Abused Drugs in Nitrite-Adulterated Urine by Immunoassay and Gas Chromatography–Mass Spectrometry," *Journal of Analytical Toxicology*, Vol. 22, 1998, pp. 474–480.

Tsanaclis, L. and J.F.C. Wicks, "Differentiation Between Drug Use and Environmental Contamination When Testing for Drugs in Hair," *Forensic Science International*, Vol. 176, 2008, pp. 19–22.

United Transportation Union, *FRA Drug and Alcohol Presentation*, 2008 [Online]. Available: http://www.utu.org/worksite/safety.htm.

Urry, F.M., G. Komaromy-Hiller, B. Staley, D.K. Crockett, M. Kushnir, G. Nelson, and R.E. Struempler, "Nitrite Adulteration of Workplace Urine Drug-Testing Specimens. I. Sources and Associated Concentrations of Nitrite in Urine and Distinction Between Natural Causes and Adulteration," *Journal of Analytical Toxicology*, Vol. 22, 1998, pp. 89–95.

U.S. DOT, The Substance Abuse Professional Guidelines, 2009, U.S. Department of Transportation website: [Online]. Available: http://www.dot.gov/ost/dapc/sap.html.

Verstraete, A.G., "Detection Times of Drug of Abuse in Blood, Urine, and Oral Fluid," *Therapeutic Drug Monitoring*, Vol. 26, 2004, pp. 200–205.

Vindenes, V., B. Yttredal, E.L. Oiestad, H. Waal, J.P. Bernard, J.G. Morland, and A.S. Christophersen, "Oral Fluid Is a Viable Alternative for Monitoring Drug Abuse: Detection of Drugs in Oral Fluid by Liquid Chromatography–Tandem Mass Spectrometry and Comparison to the Results from Urine Samples from Patients Treated with Methadone or Buprenorphine," *Journal of Analytical Toxicology*, Vol. 35, 2011, pp. 32–39.

Wada, M., R. Ikeda, N. Kuroda, and K. Nakashima, "Analytical Methods for Abused Drugs in Hair and Their Applications," *Analytical and Bioanalytical Chemistry*, Vol. 397, 2010, pp. 1039–1067.

Wennig, R., "Potential Problems with the Interpretation of Hair Analysis Results," *Forensic Science International*, Vol. 107, 2000, pp. 5–12.

Wu, A.H.B., B. Bristol, K. Sexton, G. Cassella-McLane, V. Holtman, and D.W. Hill, "Adulteration of Urine by "Urine Luck," *Clinical Chemistry*, Vol. 45, 1999, pp. 1051–1057.

Wu, A., J. Schmaltz, and W. Bennett, "Identification of UrinAid-Adulterated Urine Specimens by Fluorometric Analysis," *Clinical Chemistry*, Vol. 40, 1994, pp. 845–846.

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

TRANSPORTATION RESEARCH BOARD
500 Fifth Street, N.W.
Washington, D.C. 20001

ADDRESS SERVICE REQUESTED

THE NATIONAL ACADEMIES™
Advisers to the Nation on Science, Engineering, and Medicine

The nation turns to the National Academies—National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and National Research Council—for independent, objective advice on issues that affect people's lives worldwide.
www.national-academies.org

ISBN: 978-0-309-22344-7