SmartNotes

Understanding the SAMHSA Guidelines for Drugs of Abuse Testing

The Substance Abuse and Mental Health Services Administration (SAMHSA) is an agency within the US Department of Health and Human Services (HHS). They are responsible for establishing the Mandatory Guidelines for Workplace Drug Testing Programs for federally regulated employees. These guidelines define which drugs are included in the program, what cutoffs are used to determine a positive versus negative test result, and other testing and collection criteria.[1]

Since the guidelines are based on scientific research conducted by leaders in the field of toxicology, many non-SAMHSA laboratories have chosen to follow the SAMHSA guidelines: this includes companies performing pre-employment screening or on-going employment screening, pain management clinicians monitoring for patient compliance, and treatment or criminal justice programs testing participants for drugs of abuse.

Background

In 1986, President Reagan signed an executive order that required federal agencies to achieve a drug-free federal workplace. Scientists from the National Institute on Drug Abuse (NIDA) and forensic toxicologists worked to define a practical laboratory program that would permit testing human urine for five commonly used illicit drugs and their metabolites. This resulted in the first publication of the "Mandatory Guidelines for Federal Workplace Drugs Testing Programs" in April 1988 (Federal Register, 1988).[2]

In 1992, the Substance Abuse and Mental Health Services Administration (SAMHSA) was established by Congress as part of a reorganization of the Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA). SAMHSA became the agency within the U.S. Department of Health and Human Services with a directive to "…reduce the impact of substance abuse and mental illness on America's communities."[1]

Since the 1988 Federal Registry was first released, SAMHSA has updated the Workplace Drug Testing Guidelines multiple times, most recently in October 2017. These changes are based on guidance from the Drug Testing Advisory Board (DTAB) and feedback from other laboratories and drugs of abuse testing manufacturers.

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The "SAMHSA Panel"

The 1988 Federal Register included testing for five commonly abused drugs referred to as the "SAMHSA 5": Amphetamines, Cocaine Metabolite, Marijuana, Opiates, and Phencyclidine (PCP). The Federal Register also established guidelines around specimen collection, drug cutoff levels, confirmation, laboratory certification and quality control procedures, reporting and review of results, to name just a few of these requirements.

Two additional drugs, Ecstasy and Heroin, were added to the testing panel in 2010, which came to be known informally as the "SAMHSA 7." More recently, effective October 1, 2017, SAMHSA added two pain management treatment drugs to the panel: Hydrocodone and Oxycodone. SAMHSA also established new testing criteria for the drug metabolites, adding hydromorphone, oxymorphone, and methylenedioxyamphetamine (MDA) (a metabolite of Ecstasy or MDMA). Those assays with a secondary analyte must have ≥ 80% cross reactivity.[3] Table 1 summarizes these testing criteria.

Table 1: The SAMHSA Panel[3]

Common Name / Street Name	Scientific Name	Initial Test
	Parent Drug / Metabolite	**Cutoff (ng/mL)**
Meth	d-Methamphetamine/ d-Amphetamine	500
Marijuana (Pot)	THCA (11-nor-Δ^9-THC-COOH)	50
Cocaine (Coke)	Cocaine metabolite (Benzoylecgonine)	150
Opiates	Codeine / Morphine	2000
PCP	Phencyclidine	25
Heroin	6-Acetylmorphine (6-AM)	10
Ecstasy	MDMA/MDA	500
Vicodin® / Dilaudid®	Hydrocodone / Hydromorphone	300
OxyContin®	Oxycodone / Oxymorphone	100

History - Federal Workplace Testing

September 15, 1986 — **Executive Order 12564 signed by President Ronald Reagan:**
Federal Agencies required to achieve a drug-free federal workplace.[1]

April 11, 1988 — **First publication of the Federal Register "Mandatory Guidelines for Federal Workplace Drugs Testing Programs."**
Required initial tests for five analytes:
Amphetamines, cutoff 1,000 ng/mL
Cocaine Metabolite, cutoff 300 ng/mL
Marijuana (THC), cutoff 100 ng/mL
Opiates, cutoff 300 ng/mL
Pencyclindine (PCP), cutoff 25 ng/mL[1]

1992 — **SAMHSA established**
Substance Abuse and Mental Health Services Administration was established by Congress as part of a reorganization of the Federal Administration of Mental Health Services (ADAMHA).[1,4]

Effective: September 1, 1994 — **THC cutoff reduced** from 100 ng/mL to 50 ng/mL[5]

Effective: December 1, 1998 — **Opiate (codeine and morphine) cutoff increased** from 300 ng/mL to 2,000 ng/mL (due to false positives from poppy seeds).[6]

Effective: November 1, 2004 — **Introduction of Specimen Validity Tests:**
Creatinine: < 5 mg/dL and Specific gravity: < 1.002 or ≥ 1.020
pH: < 3 .0 or > 11.0
Nitrites: ≥ 500 mcg/mL
Oxidizing Adulterants: pyridinium chlorochromate, chromates, bleach, iodine/iodide, halogens, peroxidase, hydrogen peroxide[7]

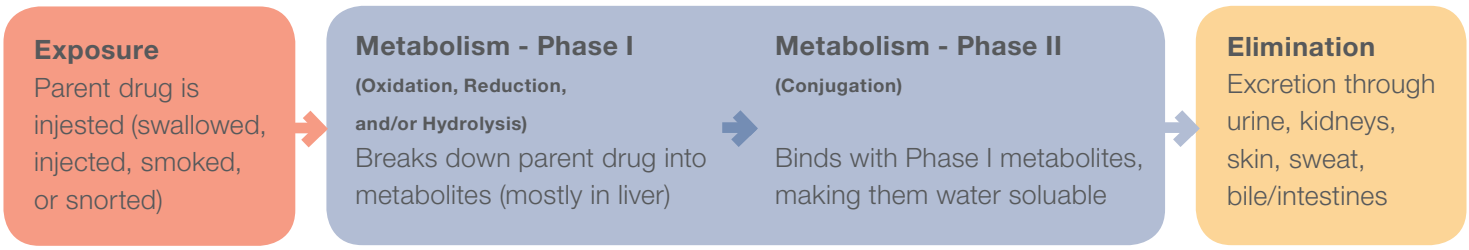
Effective: October 1, 2010 — **Addition of two new analytes:**
Heroin Metabolite (6-AM), cutoff of 10 ng/mL
Ecstasy (MDMA), cutoff of 500 ng/mL
Amphetamines cutoff reduced from 1,000 ng/mL to 500 ng/mL
Cocaine metabolite cutoff reduced from 300 ng/mL to 150 ng/mL[8]

Effective: October 1, 2017 — **Addition of two new analytes:**
Hydrocodone / Hydromorphone, cutoff 300 ng/mL
Oxycodone / Oxymorphone, cutoff 100 ng/mL
Requirement that those assays with a secondary analyte must have ≥ 80% cross-reactivity. [Hydromorphone, Oxymorhone, MDA (Ecstasy), Morphine (Opiates)]
pH: low end increased from pH 3.0 to pH 4.0[3]

Monitoring for Parent Drug and Metabolites

Many drugs are metabolized and excreted into the urine along with the parent drug. Both the parent drug and metabolites may be psychoactive/addictive and thus, are considered important to detect. In the SAMHSA Panel, five drugs (Amphetamines, Opiates, Ecstasy, Hydrocodone, and Oxycodone) require detection of both the parent and the metabolite due to their presence and concentration levels in the urine. On the other hand, some drugs metabolize quickly and are detectable only a few hours after they are taken. However, the metabolite remains in the urine at high enough concentrations for an extended period of time. From the SAMHSA panel, Marijuana, Cocaine, and Heroin are metabolized quickly, so only the metabolite is required for screening. Lastly, PCP is the only drug within the SAMHSA panel that is excreted unchanged in the urine, so only the parent drug is required for detection.

Diagram 1: Phases of Drug Metabolism



The Thermo Scientific™ Drugs of Abuse assays meet the SAMHSA requirement to detect the primary analyte and the secondary analyte at ≥ 80% cross reactivity. Table 2 below summarizes these drug attributes.

Table 2: SAMHSA Panel: Analyte Attributes

Common Name	Analytes (check table 6 for ordering)	Detection Window*	Screening for Abuse
Meth	Parent: d-Methamphetamine Metabolite: d-Amphetamine	up to 2 days[9]	d-Methamphetamine and its active metabolite, d-Amphetamine, remain in the urine for up to two days after consumption and thus, are both required to detect for abuse.[15]
Marijuana (Pot)	Metabolite: THCA (11-nor-Δ^9 -THC-COOH)	Single Use: 3 days 4 times/wk Use: 5-7 days Daily Use: 10-15 days Heavy User: 3+ weeks[9]	Marijuana is rapidly metabolized, with little to none found in the urine. However, its major metabolite, THCA, is detectable within hours after exposure and for up to 3+ weeks in heavy users. Therefore, only the metabolite is required for detection.[16]
Cocaine (Coke)	Metabolite: Cocaine metabolite (Benzoylecgonine)	2-4 days Heavy User: 3 weeks[9,10]	Cocaine is rapidly metabolized, with little to none found in the urine. However, one of its major metabolites, Benzoylecgonine, is found in the urine from up to a few days to 3 weeks for heavy users. As such, only the metabolite is required for detection.[17]
Opiates	Parent: Codeine Metabolite: Morphine	2-4 days[9] up to 2 days[9]	Opiates, like codeine and morphine, are naturally occuring chemicals found in opium, an extract from the opium poppy seeds. Codeine is metabolized to morphine and both are detectable in the urine for several days and thus, required testing to assess abuse.[18]
PCP (Angel Dust)	Parent: Phencyclidine (PCP)	up to 8 days[9]	PCP is excreted in the urine, mostly unchanged, and therefore, is the only analyte required for detection to assess abuse.[19]
Heroin	Metabolite: 6-Acetylmorphine (6-AM)	up to 2 days[9]	Heroin is rapidly metabolized in the body and is not detectable after about 30 minutes, once ingested or injected. It is metabolized to 6-AM. The presence and detection of 6-AM in the urine is considered a specific marker for the illicit use of heroin.[20,21]
Ecstasy	Parent: MDMA 3,4-Methylenedioxymethamphetamine Metabolite: MDA 3,4-Methylenedioxyamphetamine	up to 4 days[11] up to 2-4 days[11]	Ecstasy, also known as MDMA, and its metabolite, MDA, are both found in the urine for up to 4 days and thus, are both required to screen for abuse.[22]
Vicodin®	Parent: Hydrocodone	24 hours[12]	Hydrocodone is metabolized into its active metabolite, hydromorphone. Hydrocodone is detectable in the first 24 hours but hydromorphone can be detected for longer periods in urine. Both are considered important to screen for potential abuse.[23]
Dilaudid®	Metabolite: Hydromorphone	up to 3 days[12]	
OxyContin®	Parent: Oxycodone	up to 2 days[13,14]	Oxycodone and its metabolite, oxymorphone, are widely used as pain relievers. Either can be found in the urine for up to 2 days after consumption.[24]
Opana®	Metabolite: Oxymorphone		

*Approximation of detection time. Actual detection time is dependent on dose, frequence of use and inividual metabolism.

Specimen Validity Tests (SVT)

SAMHSA has established guidelines to assess whether a specimen has been compromised. These tests identify specimens that may be diluted, substituted or tampered with by the addition of various liquids or agents.

Substitution and Dilution

Substitution and dilution of the urine samples is done by using either water or other liquids which have a color similar to urine, such as tea and/or apple juice. SAMHSA recommends several ways to assess for this type of substitution/dilution by using Creatinine and Specific Gravity tests. Creatinine is a waste product produced by the body and excreted in the urine at a relatively constant rate. Fluctuations in creatinine concentration may be an indication of hydration, dilution or substitution.

Table 3: Monitoring for Substitution

Indicator	SAMHSA Guidelines	Thermo Scientific Test
Creatinine Specific Gravity	< 2 mg/dL and ≤ 1.0010 or ≥ 1.0200	DRI Creatinine-Detect DRI Gravity-Detect

Specific gravity reflects the density of the urine specimen when compared to water. The lower the specific gravity, the closer its consistency to water and therefore possible indication of dilution or substitution. Table 3 above and table 4 below summarize the SAMHSA criteria for assessing substitution or dilution.

Table 4: Monitoring for Dilution

Indicator	SAMHSA Guidelines*	SAMHSA Guidelines†	Thermo Scientific Test
Creatinine Specific Gravity	> 5 mg/dL but < 20 mg/dL and ≥ 1.002 but < 1.003	≥ 2 mg/mL but < 20 mg/dL and > 1.0010 but < 1.0030	DRI Creatinine-Detect DRI Gravity-Detect

*For an HHS-certified lab or HHS-certified IITF lab (detailed criteria found in Section 3.8, Federal Register: Jan 23, 2017)
†Additional requirement for HHS-certified lab (detailed criteria found in Section 3.8, Federal Register: Jan 23, 2017)

Adulterants

Oxidizing agents can be purchased commercially and used to adulterate urine samples. The most commonly used oxidizing agents are nitrite (Klear™), chromate (Urine Luck™), iodine, bleach, and horseradish peroxidase (Stealth). These oxidizing agents, when added to urine, do not show any significant change to the appearance of the urine and may not be detected by other methods such as pH, specific gravity or even creatinine concentration.

Testing the urine for pH gives an indication of whether the specimen is adulterated with bleach or ammonia (producing a basic pH >11.0) or adulterated with lemon juice or vinegar (producing an acidic pH < 4.0). Table 5 summarizes the testing criteria for assessing adulteration.

Table 5: Monitoring for Adulteration

Indicator	SAMHSA Guidelines	Thermo Scientific Test
pH	pH < 4.0 or > 11.0	DRI™ pH-Detect
Nitrite	≥ 500 µg/mL	DRI General Oxidant-Detect
Chromium	≥ 50 µg/mL	DRI General Oxidant-Detect
Halogens (bleach, iodine, fluoride)	Use either a general oxidant or halogen colorimetric test	DRI General Oxidant-Detect
Pyridine	Use either a general oxidant or chromium colorimetric test	DRI General Oxidant-Detect

The Thermo Scientific Solution for Meeting the SAMHSA Guidelines

Thermo Fisher Scientific offers a complete testing solution to address all nine analytes and the most commonly used specimen validity tests required by SAMHSA. These testing products meet the SAMHSA criteria for cutoffs, cross reactivity (parent and metabolite), and include quality control materials that are 25% above and below the cutoff. Tables 6 and 7 below summarize these testing criteria with the corresponding Thermo Scientific™ assays and their attributes.

Table 6

Therrmo Scientific Assay	Analytes	Cutoff ng/mL	Cross-reactivity	Part Numbers
DRI Amphetamine	Amphetamine	500	100%	10014585 (3x18 mL), 0017 (100 mL), 0018 (500 mL)
	Methamphetamine		100%	
DRI THC	THCA (11-nor-Δ^9 THC-COOH)	50	100%	10014665 (3x18 mL), 0185 (100 mL), 0186 (500 mL)
DRI Cocaine	Cocaine metabolite (Benzoylecgonine)	150	100%	10014593 (3x18 mL), 0055 (100 mL), 0056 (500 mL)
DRI Opiate	Morphine	2000	100%	10014601 (3x18 mL), 0135 (100 mL), 0136 (500 mL)
	Codeine		210%	
DRI Phencyclidine (PCP)	Phencyclidine (PCP)	25	100%	10014673 (3x18 mL), 0432 (100 mL), 0433 (500 mL)
CEDIA™ Heroin Metabolite (6-AM)	6-Acetylmorphine (6-AM)	10	100%	10015213 (3x17 mL, Indiko), 100107 (3x17 mL), 100108 (65 mL), 100186 (495 mL)
DRI Ecstasy Plus	MDMA	500	100%	10024631 (500 mL, MDMA), 10024435 (25 mL, MDA Control)
	MDA		80%	
DRI Hydrocodone	Hydrocodone	300	102%	10018054 (3x18 mL), 10018053 (500 mL) 10026302 (25 mL, Hydromorphone Control)
	Hydromorphone		97%	
DRI Oxycodone	Oxycodone	100	100%	10015632 (3x18 mL), 100248 (68 mL), 100249 (500 mL)
	Oxymorphone		103%	

Calibrators and controls are also available; contact your local sales representative for further information.
The National Laboratory Certification Program (NLCP) guidelines require SAMHSA Labs to run a control for the additional analytes with cross-reactivity ≥ 80% and < 100%. The controls are targeted at a concentration of 25% to 50% above the cutoff.

Table 7

Thermo Scientific Specimen Validity Tests	Detection Range	Part Numbers
DRI Creatinine-Detect	Creatinine-Detect Test: Linear range: 0.78 mg/dL to 420 mg/dL	1797 (500 mL)
		10015638 (3x18 mL)
	Calibrator Set, 2.0 and 20.0	100272 (2x25 mL)
	Creatinine 1.3 Control	100273 (25 mL)
	Creatinine 7.5 Control	100274 (25 mL)
	Creatinine 23.0 Control	100275 (25 mL)
DRI Gravity-Detect	Gravity-Detect Test: Reportable range: 1.000 g/mL to 1.040 g/mL	1194 (2x500 mL)
		19918532 (6x8 mL)
	Low Gravity Calibrator, 1.010	1754 (25 mL)
	High Gravity Calibrator, 1.025	1755 (25 mL)
	Level 1 Gravity Control, 1.015	1756 (25 mL)
	Level 2 Gravity Control, 1.030	1757 (25 mL)
DRI pH-Detect	pH-Detect Test	10015654 (6x18 mL)
		100054 (2 x 500 mL)
	pH 4.0 and pH 11.0 Calibrator Kit	10024403 (2x25 mL)
	pH-Detect 3.6 Control	10009549 (1x25 mL)
	pH-Detect 4.5 Control	100248083 (1x25 mL)
	pH-Detect 7.0 Control	100284 (1x25 mL)
	pH-Detect 10.0 Control	100285 (1x25 mL)
	pH-Detect 11.5 Control	100281 (1x25 mL)
DRI General Oxidant-Detect	General Oxidant-Detect test: Nitrite: ≥ 200 µg/mL *Chromium Specificity: 50 µg/mL *Bleach Specificity: 2% sensitivity *Iodine Specificity: 0.2% *Peroxidase Specificity: 50 U/mL *Produce a positive result when nitrite is ≥ 200 µg/mL	10009958 (2x500 mL)
		10018528 (6x18 mL)

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