The efficacy of oral fluid testing versus urine testing in the workplace
Professor MacDonald Christie and Dr John Lewis, December 2011

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Dear Ms Matthews

You have asked us to provide our opinion on the relative efficacies of on-site oral fluid under Australian Standard, AS4760-2006 and urine testing under AS/NZ 4308-2008 for enabling resource industry employers to manage the risks arising from drug and alcohol use at work in order to fulfill their duty of care to workers and others on-site. Following initial discussions you requested that we address the series of questions listed below. Our general views are summarized first. We have then provided our responses to the specific question in summary followed by detailed justification of these opinions.

On-site urine testing is much more likely than oral fluid testing to provide insight into risk of being adversely affected by drugs in the workplace because, in addition to having a higher likelihood of detecting use during intoxication, it has a much higher likelihood of detecting regular, chronic and dependent users of drugs who are at risk more frequently than casual users because of their frequent episodes of intoxication by, and withdrawal from drugs which produce impairment. Arguably, this is the highest risk group of drug users in the workplace, in part because of impairment by frequent cycles of intoxication and withdrawal but also a higher likelihood of attendance at work while intoxicated and impaired by drugs and attempts to evade detection.

Main questions in summary:

1. *What are the different types of drugs known to be used in the community which are capable of affecting a person's fitness for work (the relevant drugs)?*

   Many drugs that can cause impairment are available in the community, both legal (prescription and over the counter: OTC) and illicit. The most significant drugs are those that can produce substantial impairment and are widely available. These include the following classes: **cannabis, stimulants, opioids, benzodiazepines** and **antihistamines**.

2. *For each relevant drug, what effects can the drug have on a person that could affect the person's fitness for work, particularly for the type of tasks performed in the mining industry? (Include short and medium term effects and longer term effects from regular or chronic use).*

   These risks are summarized in the following table.

Impairment risk	Risk during intoxication with low to moderate dose	Risk during intoxication with high dose	Hangover risk	Ongoing risk in chronic/ dependent users
Cannabis	**Moderate**	**Moderate to high**	**Low**	**Moderate**
Psychostimulant (methamphetamine, ecstasy, cocaine)	**Low**	**Moderate to high**	**High to severe**	**High to severe**
Opioids	**Moderate to high**	**Severe**	**Low to moderate**	**High to severe**
Sedative benzodiazepines	**High to severe**	**Severe**	**Moderate to high**	**High to severe**

3. *For each relevant drug, what does the research to date indicate about the incidence of use of the drug in the Australian community and different sectors in it?*

   Prevalence in the general community: Cannabis is most prevalent followed by amphetamine-like stimulants, opioids (prescription and illicit), MDMA (ecstasy), benzodiazepines, cocaine and heroin.

   Prevalence in the workplace: Rates of use in the workplace indicate prevalence trends that reflect the patterns in the general population but with a somewhat reduced incidence.

4. *What methods of testing can be used to test for the presence of the drug in a person's blood?*

   Determination of the presence and actual concentration of a given drug in blood has a higher correlation (but never perfect) with severity of actual impairment than analysis of secondary body fluids such as urine oral fluid and sweat.

5. *For each relevant drug, compare the effectiveness of oral fluid and urine testing to detect recent use and regular, heavy or chronic use of the drug. It would be great to have a specific and very clear conclusion on this.*

   In the context of the workplace risks associated with drug use outlined above, the capacity of oral fluid testing under AS4760-2006 to detect individuals in different risk categories (and the severity of risk) is consistently inferior to urine testing under AS/NZ4308-2006.

6. *Are there means readily available to persons in the workplace who may be randomly tested for evading detection and, if so, which of the two methods under consideration (oral fluid testing or urine testing) is better suited to dealing with such means?*

Urine testing can conceivably be evaded by methods such as urine sample substitution or dilution with water during sample collection in private. Procedures have been developed over many years and are in place for testing under AS/NZ4308-2008 to eliminate or minimize these possibilities. Oral fluid testing appears to be evasion proof because samples are collected under direct observation but there are means to evade or minimize the risk of detection, particularly for regular or dependent cannabis users.

7. *What, if any laboratories have been accredited to perform oral fluid testing under AS4760-2006?*

There are a number of institutions accredited to AS 4760-2006, however most of these are accredited for collection and dispatch only. Two facilities are accredited for confirmation only, VIFM (Victorian Institute of Forensic Medicine) and QML (Queensland Medical Laboratories). There are three laboratories accredited for both screening (Section 4) and confirmation (Section 5) of AS 4760. These are Queensland Health, Racing Analytical Services and Australian Racing Forensic Laboratory.

8. *Please comment on the state of technology for oral fluid testing in relation to AS4760 and current developments in that technology. Does the AS4760 need to be revised and if so how?*

The technology for oral fluid screening is developing rapidly but evidence on the performance in the field and its confirmation in the laboratory necessarily lags behind this and generally indicates poor performance in the field. New sample collection and detection devices are beginning to overcome these difficulties. If appropriately revised as the technology matures, oral fluid testing could become a viable alternative to urine testing but will probably remain inferior for many risk categories in the foreseeable future.

9. *In comparing oral fluid testing in accordance with AS 4760-2006 (at each stage of the testing, i.e. screening and final confirmatory testing) with urine testing under AS 4308:2008, which test is more likely to produce false negatives and false positives at each stage of the testing?*

Oral fluid tests are considerably more likely to produce false negatives and false positives at each stage of the testing than urine tests. The risk of failure to detect individuals who are intoxicated at the time of testing is therefore higher for oral fluid than urine screening tests. Laboratory confirmation is adequate for both testing modalities.

10. *Does the efficacy or otherwise of different forms of testing undermine the ability for employers to perform accurate on-site screening? ie. does it mean employers should rely more on lab testing if they want accurate results? If so, does this undermine the ability of performing accurate on-site drug screening and remove flexibility for employers?*

On-site oral fluid tests remain unreliable for some drugs, particularly cannabis but some devices also show poor performance for other drugs. Many devices are insensitive and very unlikely to detect cannabis use during the period of impairment. Others are inaccurate for other drugs and no device achieves a reliable sensitivity for detection of sedative benzodiazepines during the period of impairment. AS4760-2006 does not mandate quality control of screening devices although NATA may do so when accrediting laboratories and collection agencies. Employers would therefore need to rely on laboratory testing for all random tests to have confidence in accuracy of results of oral fluid tests whether or not screening results were positive. This removes flexibility from employers in managing immediate risks of potentially impaired employees from safety sensitive worksites in the mining industry.

Accurate results can be produced by the analytical methods used for laboratory confirmation laboratory testing of both urine and oral fluid. However drug recovery from oral fluid collection devices is very variable and may not provide reliable confirmation for some devices. Urine testing is accurate with sensitivity and reliable both screening and sensitivity of testing devices is controlled under AS/NZ 4308-2008.

11. Do shortfalls in particular testing methods, such as increased false negatives arising from some testing methods, deny employees the ability to participate in employer-provided rehabilitation programs at an early stage?

Employees and member of the general community tend to engage with rehabilitation programs only after an adverse event such as a positive drug or alcohol test result. The low likelihood of detection of regular or dependent drug users by oral fluid testing excludes the highest risk group of employees in terms of safety and likelihood to benefit from assistance. Urine testing quite reliably detects regular/dependent drug users at an early stage.

12. Are there drugs in common use which cannot be tested in accordance with AS 4760-2006 which can be tested in accordance with AS/NZ 4308-2008?

Sedative benzodiazepines are widely used and are readily detected by urine screening tests but a very difficult to detect using oral fluid screening tests. AS4760-2006 does not specify any procedures for detection of benzodiazepines

13. Which of the methods of testing (namely, oral fluid testing or urine testing) is more likely to detect a "hang over effect" or the possibility of a "hang over effect"? Is one method of testing more or less likely to provide an indication of the 'depth' or 'severity' of a "hang over effect" and if so which one?

Hangover effects from use of some drugs produce moderate to severe impairment. Urine screening tests are vastly superior to oral fluid tests for detection of a hangover effect.

14. *Which of the options, namely oral fluid testing or urine testing:*

(a) *is more likely to identify a regular or chronic user of illicit drugs,*

Urine screening tests have a very high likelihood to identify regular or chronic users of illicit drugs but oral fluid tests have a lower likelihood of detecting regular and chronic users of all drugs unless they have used shortly before testing. This is particularly so for cannabis users who can only be detected for 1-2 hours after use using oral fluid screening procedures of AS4760-2006.

(b) *is more likely to identify impairment or potential impairment by reason of the use of such drugs by regular or chronic users,*

Regular and chronic use of many illicit drugs is associated with ongoing risk which can be severe in some cases. Urine screening tests are superior to oral fluid tests for detecting this risk category.

(c) *is, if assessment and management of risk of being at work adversely affected by drugs (rather than impairment per se) is important, more likely to provide a better insight into such risk.*

Urine testing has a much higher likelihood than oral fluid testing of detecting individuals with high safety risks associated with occasional, regular or chronic misuse of drugs.

In Detail

1. *What are the different types of drugs known to be used in the community which are capable of affecting a person's fitness for work (the relevant drugs)?*

Many drugs that can cause impairment are available in the community, both legal (prescription and over the counter: OTC) and illicit. The most significant drugs are those that can produce substantial impairment and are widely available. These include the following:

- **Cannabis** is illicit but very widely used.

- **Psychostimulants** are most commonly illicit (cocaine, methamphetamine, amphetamine and others). Ecstasy is illicit (methylenedioxymethamphetamine; an amphetamine-related drug with distinct actions).

- **Opioid** based pain relievers (also misused) and illicit opioids (including codeine, morphine, oxycodone, fentanyl, buprenorphine, methadone, heroin and others).

- Sedative and anti-anxiety **benzodiazepines** are usually prescribed but are widely misused (including Valium [diazepam], Normison [temazepam], Mogadon [nitrazepam] Xanax [alprazolam], Ativan [lorazepam] and others).

- Sedating **antihistamines** are commonly OTC medications contained in cough and cold remedies and sleeping aids (Phenergan [promethazine], Restavit [doxylamine] and many others).

The most commonly used (but not all) members of each of the above drug classes, except antihistamines, are detected by urine and/or oral fluid screening tests. Notable exceptions are that benzodiazepines are not mandated or detected (and very difficult to detect) by oral fluid tests and detection of cannabis by oral testing is still difficult. Detection of most illicit, synthetic cannabis substitutes is currently not possible using oral fluid or urine screening tests and remains difficult by laboratory testing.

2. *For each relevant drug, what effects can the drug have on a person that could affect the person's fitness for work, particularly for the type of tasks performed in the mining industry? (Include short and medium term effects and longer term effects from regular or chronic use).*

Determining which drugs are important to manage because they affect a person's fitness for work in safety sensitive industries such as mining depends on a number of factors as follows:

1. The severity and duration of impairment during acute intoxication with the drug with regard to dose.

2. The severity and duration of impairment during the post-intoxication period (hangover).

3. The severity of long-term impairment associated with chronic or dependent use of the drug.

4. The prevalence of misuse of the drug in the community and workplace, and prevalence of different patterns of use of the drug ranging from casual to dependent, chronic use.

Statistics for serious motor vehicle accident causation provide the most comprehensive and reliable means to assess risk for impairment and provides a large body of evidence of risks comparable to those likely in the mining industry. For some drugs, there is clear evidence from the published literature on accident causation. For others, it can only be inferred from the known impairing effects of the drugs in the laboratory which provides strong evidence for impairment and by inference accident risk. Levels of risk are summarized below for the most commonly abused drugs using a general framework of the levels of accident risk that are established and legally accepted for impairment by alcohol. In the general population, the risk of accident causation by alcohol is significantly elevated at a blood alcohol concentration (BAC) above 0.05 g%. Some groups (young, inexperienced drivers and the aged) have increased risk between 0.02 and 0.05 g% and most individuals show some impairment on very demanding laboratory performance tasks. This would be considered indicative of **low** (but not zero) impairment. For BACs between 0.05 and 0.08 g%, risk is **moderate** (up to 3-fold increase in accident causation). It is **high** between 0.08 and 0.15 g% (up to 20-fold) and **severe** above 0.15 g% (~50-fold at 0.18). These are summarized in the following table on the basis of both laboratory and field research, and discussed in detail below:

Summarised risks:

Impairment risk	Risk during intoxication with low to moderate doses	Risk during intoxication with high doses	Hangover risk	Ongoing risk in chronic/ dependent users
Cannabis	**Moderate**	**Moderate to high**	Low	**Moderate**
Psychostimulant (methamphet., ecstasy cocaine)	**Low**	**Moderate to high**	**High to severe**	**High to severe**
Opioids	**Moderate to high**	**Severe**	**Low to moderate**	**High to severe**
Sedative benzodiazepines	**High to severe**	**Severe**	**Moderate to high**	**High to severe**

__Impairments produced by each drug class:__
__Cannabis:__ Doses of cannabis usually preferred by users produce impairment in the moderate range (comparable BAC > 0.05 g%) for up to 6 hours after use. There is good evidence that higher doses produce more severe and prolonged impairment but there is only weak evidence for hangover effects up to 24 hours after use (Hall et al., 2002). A substantial proportion of cannabis users consume frequently, with up to 10% being daily users (Hall et al., 2002; Darke et al., 2000). Daily users often consume cannabis more than once per day and so are frequently intoxicated (Hall et al., 2002).

The duration of intoxication by cannabis and its relationship to concentrations of the drug in body fluids has been widely studied and forms the basis for examining the relationship between detection in various body fluids and impairment. The quantified presence of a substantial amount of THC in blood indicates that recent use and impairment is very likely. For cannabis, the general consensus is that impairment and increased accident risk persists for up to six hours after consumption of the usual doses preferred by users and the active drug, and THC can be detected in blood for a similar period (eg. Hall et al., 2002; Ramaekers et al., 2006a). Impairment by cannabis persists while blood THC concentrations are elevated in the vicinity of or above 5 ng/ml (see Ramaekers et al., 2006a for introduction). When testing a variety of tasks, the likelihood of impairment increases as blood THC concentration (it should be noted that these values must be divided by two to convert from the serum concentrations reported to blood concentrations) increases with a significant increase between 2 and 5 ng/ml, 75-90% of measures showing impairment between 5 and 10 ng/ml, and at blood THC concentrations above 30 ng/ml all tests show impairment (Ramaekers et al., 2006a). Increased accident risk has also been demonstrated in drivers with blood THC concentrations above 1 ng/ml and many fold-higher above 5 ng/ml (Drummer et al., 2004), and this is supported by other large studies (Mura et al., 2003). These studies suggest that blood THC concentrations near or above 5 ng/ml are associated with risk of causing motor vehicle accidents greater than a blood alcohol concentration of 0.05 g% suggesting that the severity of impairment by cannabis is usually in the moderate range. Heavy regular users also suffer an impairing withdrawal syndrome on cessation of use (ibid.), and heavy regular users exhibit mild impairments of cognitive functions whether or not they are using cannabis.

Synthetic cannabinoids: A large number of synthetic cannabinoids have been developed. They are chemically distinct but act in the body in a similar manner to cannabis and can therefore produce similar impairments. Most synthetic cannabinoids are experimental drugs that have not been tested in humans so there is little information available on potency duration of action and unexpected side-effects. There is also little or no information available on the relationship between blood concentrations of these substances and impairment and they are not readily detected by screening tests.

Amphetamines, cocaine and other psychostimulants: Any use of methamphetamine or cocaine should be considered to be a high to severe risk in the workplace unless proven otherwise. Low doses of stimulants appear to enhance performance and can overcome fatigue but they can produce impairment of judgment. High doses and chronic use of these drugs is associated with profound impairment both during the acute phase of intoxication and after the drug effects have worn off, producing profound fatigue and hypersomnolence (crash). Psychostimulants, particularly cocaine and methamphetmamine, are profoundly addictive although rates of dependent use in the Australian community are still uncertain. Serious psychological impairments that would be expected to adversely affect performance result from chronic use of these drugs.

Low doses of psychostimulants such as methamphetamine demonstrably enhance alertness and improve reaction time but may also increase risk-taking and impair judgment (Burrows et al., 1993; de la Torre et al., 2004). High doses of stimulants, particularly repeated use of the amphetamines and cocaine, produce severe adverse. Amphetamines including methamphetamine and amphetamine are powerful psychostimulants, producing increased alertness, wakefulness, insomnia, energy and self-confidence in association with decreased fatigue and appetite, as well as enhanced mood, well-being and euphoria. High doses can cause convulsions, stereotypic movements and psychosis. Fatigue, anxiety and tiredness can appear when the effects vanish. These negative symptoms ('crash') are more intense when high or repeated doses are administered, and depression and lethargy can appear. Long-term use of amphetamines may be associated with the so-called 'amphetamine psychosis' characterised by psychotic reactions, hallucinations and paranoia. Amphetamines show a high abuse potential and can induce dependence, tolerance and withdrawal symptoms. (ibid.). The latter effects would be expected severely impair performance of skilled tasks and judgment and are considered to be a cause of serious accidents (ibid.). Studies of accident victims and drivers apprehended for suspected impairment by drugs confirm that the blood levels of amphetamine and methamphetamine found in the defendant are associated with impairment. Griggs et al. (2007) reported that amphetamine and methamphetamine in blood was significantly over-represented in accident victims and severity of accidents. Gustavsen et al. (2006) found a strong relationship between blood methamphetamine concentrations and accident causation.

The duration of acute impairment by these drugs depends on the drug that is abused. Cocaine has a relatively short duration of action. Where the cognitive and psychomotor effects of low, intoxicating doses of cocaine have been studied in detail (ibid.), signs of impairment persist only for several (certainly less than 6 hours) hours after acute consumption of the drug Burrows et al., 1993; de la Torre et al., 2004). Methamphetamine has a much longer duration of action and produces acute effects for up to twelve hours. Only a mild hangover effect would be expected after use of a single, moderate dose. However, many cocaine and methamphetamine users consume the

drug compulsively in protracted binges that may last for many days without sleep, until physical exhaustion prevents further consumption. The latter pattern of use produces a severe hangover of depressed mood, somnolence, drug craving and a high risk of disorganized thinking and psychosis that persists for many days after cessation of use. Users experiencing severe amphetamine "hangovers" or withdrawal are not safe.

Opioids: Any misuse of opioids such as heroin, morphine, oxycodone or high dose codeine should be considered to be a high to severe risk in the workplace unless proven otherwise. Opioids such as codeine, morphine, oxycodone, heroin and methadone (much less common) are used both in therapeutic settings (not heroin) as well as illicitly. All produce sedative effects, which can adversely affect performance of many tasks. The doses of codeine recommended for use in OTC medications are not high enough to produce impairment. Single, prescribed therapeutic or non-medical doses of all opioids impair reaction time, motor coordination, attention and short-term memory sufficiently to adversely affect performance (Vainio et al., 1995). However, little or no impairment has been observed in patients maintained for long periods on moderate to high doses of morphine for pain relief (Vainio et al., 1995), or high doses of methadone for opioid dependency management (Chesher et al., 1989). Therefore, the therapeutic status of the individual is of critical importance in determination of the potential for impairment by these drugs. Users of illicit opioids commonly cycle through periods of intoxication and withdrawal, both of which produce severe impairment, but patients using stable doses of therapeutic opioids develop considerable tolerance and are usually not impaired by moderate to high doses of these drugs. A mild hangover effect would be expected after use of a single, moderate dose of an opiate. However, many opiate users consume the drug compulsively and repeatedly in an addictive pattern that produces impairment. Users experiencing severe opiate withdrawal are not safe.

Benzodiazepines: Sedative benzodiazepines produce severe impairment of performance. As with opioids, tolerance to the effects of these drugs develops, so that the therapeutic status of the individual is critical for determining whether or not an individual is a safety risk. There is no doubt that usual therapeutic doses of these drugs impair psychomotor performance during periods of use (Kunsman et al., 1992). Use of therapeutic doses of sedative benzodiazepines, such as temazepam (Normison), have also been reported to produce impairment on the morning after use for induction of sleep (ibid.). Patients administered benzodiazepines for management of waking anxiety often exhibit impaired performance for several days after initiation of therapy (ibid.). Misuse and illicit use of these drugs usually involves high, frequent doses, which is certainly associated with a high to severe risk of impairment. Benzodiazepine misuse or abuse is associated with periods of alternation between periods of severe acute intoxication with impairment, and periods of severe withdrawal.

Other drugs not tested in AS/NZ4308-2008 and AS4760-2006: A range of drugs that can cause impairment are not identified in AS4760-2006 or ASNZ4308. Some are prescription medications, others are available over the counter and some others are illicit. Notably, sedative antihistamines are widely available for as anti-allergy, cough and cold treatments and as sleeping medications. All can produce impairment, some more than others (eg. McDonald et al., 2008) and are labeled as such. Antihistamines are not included in drug screens, partly because they are primarily OTC medications but also because the large range of chemically distinct antihistamines on the market (ibid.) precludes development of selective screening tests. A range of illicit drugs other than those

tested can produce profound impairment. The prevalence of use of most is low but growing prevalence of illicit use of severely impairing "party" drugs such as ketamine and GHB will require ongoing monitoring.

3. *For each relevant drug, what does the research to date indicate about the incidence of use of the drug in the Australian community and different sectors in it?*

Prevalence in the general community: Drug and alcohol use is common in Australia, with 38% of the population over 14 years old reporting ever using an illicit drug and nearly one half of those having used in the past 12 months (the latter is defined as recent use by AIHW, 2008a).

Cannabis is the most widely used illicit drug in Australia. 34% of the Australian population has ever used cannabis (AIHW, 2008a), with 9% having used within the last twelve months. The latest published data, taken from the National Cannabis Prevention and Information Centre (NCPIC, 2011) shows that there was a significant increase in recent cannabis use from 9.1% in 2007 to 10.3%, with around 1.9 million Australians having used cannabis in the past year. This change was largely driven by increases in men aged 50-59 years (up from 5.4% in 2007 to 7.8% in 2010). Some groups within the general population have a higher prevalence of cannabis use than others and problematic use is common. The 20-29 year age group has the highest prevalence of cannabis use but declines with age (AIHW, 2008a). The prevalence of cannabis use is higher among males than females. About 10% of those who ever use cannabis become daily users, and another 20-30% use weekly (Darke et al., 2000). Many daily users could be considered as suffering from a cannabis dependency problem (Darke et al., 2000) and most dependent users use cannabis more than once daily (Hall et al., 2002). Higher prevalence of cannabis use is also associated with use of other illicit drugs.

The prevalence of illicit use of drugs other than cannabis is relatively low but use of amphetamine-like stimulants is escalating, eg. Nationally, recent ecstasy (MDMA) use increased from 0.9% of the population in 1995 to 3.5% in 2007. In 2007, the prevalence of recent use of amphetamines, MDMA (ecstasy), cocaine and heroin were reported to be 2.3%, 3.5%, 1.6% and 0.2%, respectively (AIHW, 2008a). Although rates of heroin use are relatively stable, misuse of prescription opioids has grown at an alarming rate in the past decade with 4.4% of Australians reporting abuse of these drugs.

There is no data on the extent of synthetic cannabis use. Major mining companies in WA and NSW have expressed concern over (admitted) use of these substances and have since commenced testing for them. A number of laboratories are conducting limited testing and are finding some positives. Testing for these substances is in its infancy and there are many issues to resolve before such testing becomes reliable and appropriate.

Medically prescribed drugs are also commonly misused in Australia. The major misused drugs of are pain killers (predominantly opiate drugs), and tranquilizers (predominantly benzodiazepines), with 4.4% and 3.3% of Australians reporting abuse at some time, respectively (AIHW, 2008a).

Prevalence in the workplace: Rates of use of illicit drugs, nonmedical use of medicinal drugs and alcohol use in the workplace indicate prevalence trends that reflect the patterns in the general

population but with a somewhat reduced incidence. In Australia, 4% of respondents reported attending work in the past 12 months while under the influence of alcohol (and 12% drove a motor vehicle; AIHW, 2008a). 1.6% of individuals (2.5% for males) reported attending work while under the influence of other drugs (and 2.9% drove a motor vehicle; AIHW, 2008b). Of individuals using drugs while driving (which presumably reflects similar trends in the workplace), cannabis is by far the most prevalent drug reported (Jones et al., 2006). More than 80% of drug users report cannabis as the most recent drug used while driving (see Jones et al., 2006). Episodes of cannabis use while driving are approximately nine times more frequent than the next most prevalent drug (methamphetamine; Davey et al., 2007). Regular, chronic users and dependent drug users display the highest frequencies of willingness to drive (and presumably engage in other activities such as work) while intoxicated by cannabis (Jones et al., 2006).

Reports of positive results from random workplace tests for alcohol also indicated a prevalence of approximately 1% positive results in more than 30,000 tests throughout New South Wales, Queensland and Western Australia. 2.9 % of more than 5,000 urine tests for other drugs were found to be positive of which 62% were positive for cannabis (ACARP 2001). I have examined test results from a number of large work sites for more than a decade and consistently observed similar trends of overall positive results in the 1-5% range, predominantly for cannabis.

4. *What methods of testing can be used to test for the presence of the drug in a person's blood?*

Determination of the presence and actual concentration of a given drug in blood has a higher correlation (but never perfect) with severity of actual impairment than analysis of secondary body fluids such as urine oral fluid and sweat. This forms the basis for per se legislation that specifies allowable blood concentrations of THC in some jurisdictions (the active drug in cannabis, set at 1 or 2 ng/ml in some countries). The same methods of testing used for other body fluids can (and are) screened and confirmed by blood tests. The range of drugs, performance and cut-off levels for blood tests are not subject to any standards mandated by Standards Australia. The list of possible drugs that can be screened and analyzed in blood samples is much larger than in the Australian Standards but most screens (mandated by law for drivers involved in serious motor vehicle accidents) cover the same general range of drugs as used in the standards and only diverge if there is suspicion of other drugs (eg. GHB).

5. *For each relevant drug, compare the effectiveness of oral fluid and urine testing to detect recent use and regular, heavy or chronic use of the drug.*

As shown in the tables below, oral fluid testing is inferior to urine testing for detection of risks associated with recent use and regular or heavy use of most drugs. Please note that the grey areas in the tables draw attention to drug use categories for which oral fluid testing has serious shortcomings with a high likelihood of failure to detect use.

Urine testing provides a useful means of determining whether a person is an infrequent, frequent or chronic user of drugs. This is accomplished by comparing urine levels, corrected for urine output, over time. This has been performed for cannabis (e.g. Carboxy-THC: creatinine).

Importantly, urine levels of drugs detected according to Australian Standard AS/NZS 4308 are consistent among laboratories and are not dependent on the type of collection devices. Absolute levels and ratios of other drugs to creatinine output (benzodiazepines, methamphetamine) can be used as indicators of usage patterns. For example, a person with more than one very high urine level of cannabis metabolite (thousands of micrograms/litre) is not an infrequent user, but a chronic user. In contrast, oral fluid testing cannot provide information as to whether a person is a frequent, infrequent or chronic user of drugs. Firstly, it is difficult to determine an exact concentration of drug in oral fluid. Many devices utilize a diluent/buffer solution into which the oral fluid collected from a collection pad, is placed. It is therefore not possible to know the exact volume of oral fluid collected. If oral fluid is collected by expectoration (spitting), it is also very difficult to measure an exact volume of fluid because of the viscosity (mucous-like nature) of the fluid. Without an exact concentration, one cannot compare levels taken over a period of time. As collection devices produce different recoveries of drugs, again this makes comparisons of sequential testing extremely difficult.

In the context of the risks associated with drug use outlined above, the capacity of oral fluid testing according to AS4760-2006 and urine testing to detect individuals in different risk categories (and the severity of risk) can be summarized as shown below. The tables are constructed in consideration of the likely windows of detection of drug use under the Standard. It should also be noted that benzodiazepines are deemed to fail in these tables because no level is mandated in AS4760-2006). It should also be noted that detection of benzodiazepines in saliva is very problematic as discussed in detail below. The tables below show that AS 4760-2006 is comparable to urine testing for detection of risk of acute impairment for most drugs except cannabis and benzodiazepines. For cannabis, oral fluid testing is insensitive for detection of use during the period of acute impairment, except perhaps during the first one to two hours after consumption, and inadequate for detection of regular, dependent users of the drug unless they are acutely intoxicated at the time of testing. On-site testing for benzodiazepines using oral fluid is not considered in AS4760-2006 and presents similar difficulties to cannabis. Detection of benzodiazepines is also highly problematic because some drugs of this class are detected in oral fluid for a period less than the period of impairment others have not been detected at all using screening tests (Verstraete et al., 2004; Smink et al., 2006). A major problem with these drugs is that only a very small percentage of the drug present in drug is secreted in saliva (generally less than 2%). For other types of risk (hangover, ongoing dependent drug use) urine testing is superior for all drugs. These risks range from moderate to very severe for use of most drugs other than cannabis.

The tables below show that AS 4760-2006 is comparable to urine testing for detection of risk of acute impairment for most drugs except cannabis and benzodiazepines. Shaded areas represent serious failures to detect in terms of the severity of impairment associated with the categories summarized above and inadequacy of the test modality. The detailed reasoning behind this summary is presented below the tables.

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Oral fluid:

Impairment Category Drug class	During intoxication with low to moderate dose	During intoxication with high dose	During hangover-related impairment	Ongoing impairment in chronic or dependent user
Cannabis	Detects some smokers but will often fail. Cannot detect swallowed cannabis	Will detect Some smokers but will often fail. Cannot detect swallowed cannabis	Cannot detect this.	Will detect some but will often fail
Psychostimulants (methamphetamine cocaine)	Will almost always detect	Will almost always detect	Will detect some but will often fail	Will usually but not always detect
MDMA (ecstasy)	Will almost always detect	Will almost always detect	Will detect some but will often fail	Will usually but not always detect
Opioids	Will almost always detect	Will almost always detect	Will detect some but will often fail	Will usually but not always detect
Sedative benzodiazepines	Cannot readily detect this	Cannot readily detect this	Cannot readily detect this	Cannot readily detect this

Urine:

Impairment Category Drug class	During intoxication with low to moderate dose	During intoxication with high dose	During hangover-related impairment	Ongoing impairment in chronic or dependent user
Cannabis	Will usually but not always detect users	Will almost always detect users	Will usually but not always detect	Will almost always detect
Psychostimulants (methamphetamine cocaine)	Will almost always detect	Will almost always detect	Will almost always detect	Will almost always detect
MDMA (ecstasy)	Will almost always detect	Will almost always detect	Will almost always detect	Will almost always detect
Opioids	Will almost always detect	Will almost always detect	Will almost always detect	Will almost always detect
Sedative benzodiazepines	Will almost always detect	Will almost always detect	Will almost always detect	Will almost always detect

Detection of recent use of cannabis: The estimated detection window (time after consumption that positive results are very likely) is very important for drug tests because the best that can be

hoped for in terms of actual impairment is to establish a relationship between time of consumption and a positive test result. This can only be made with reference to the cut-off level of accurate detection provided by a given test, the dose of the drug used and frequency of use. The above analyses indicate that oral fluid tests need to be capable of detecting consumption for at least to six hours after cannabis use to be relied on for detection of impairment after low to moderate doses and probably longer after high doses. Because blood and oral THC concentrations are closely related in the first six hours after smoking (with oral fluid being almost equivalent to blood in one study (Huestis and Cone, 2004) and several-fold higher than blood for Ramaekers et al., 2006a; Toennes et al., 2010) a cut-off value in the vicinity of 5 ng/ml for saliva should therefore provide a reasonable index of high likelihood of impairment. However, the ratios of THC in oral fluid to blood are highly variable because THC in oral fluid is not derived directly from blood (Gjerde et al., 2010). It is therefore reasonable to set lower limits to ensure a reasonable likelihood of detecting cannabis use during the period of impairment (up to six hours), as done by all major international recommendations.

International guidelines for sensitivity when approached will improve detection times and have established evidence based targets for detection of THC in oral fluid. The recommendations are summarized in the following table from Pil & Verstraete (2008). Although the recommended detection thresholds for most drugs are similar to AS4760-2006, the values for cannabis (THC) are substantially lower than the Australian recommendation, which greatly increases the risk that the detection window for cannabis under AS4760-2006 will be much shorter than the likely period of impairment.

TABLE 1. Proposed SAMHSA Cutoffs (ng/mL) for Drugs in Oral Fluid[61] and Optimal Cutoffs Determined in Rosita[62] and Rosita 2[25]

SAMHSA (Screening)		SAMHSA (Confirmation)			Rosita	Rosita 2
THC parent drug and metabolite	4	THC parent drug	2	THC parent drug	1.9	3.6
Cocaine metabolites	20	Cocaine + benzoylecgonine	8	Cocaine + benzoylecgonine	5–10	8.2
Opiate metabolites	40	Morphine	40	Opiates	5–10	3.6
		Codeine	40			
		6-acetylmorphine	4			
Phencyclidine	10	Phencyclidine	10			
Amphetamines	50	Amphetamines	50	Amphetamines	70–90	160.4
				Benzodiazepines		3

SAMHSA, Substance Abuse and Mental Health Services Administration.

Laboratory and field studies comparing oral and blood cannabis, and impairment: The most comprehensive laboratory studies of the relationship between oral and blood THC concentrations, and impairment confirm this conclusion. Huestis and Cone (2004), using nominally low and high doses of smoked cannabis, which have both been shown in a large body of research to produce impairment for 4-6 hours, directly measured oral THC at various times after consumption. At the low, impairing dose the oral THC concentrations of every subject was less than the on-site recommended cut-off of AS4760-2006 within one hour of smoking and, at the high dose, most would have been negative within one hour of smoking, or well within the period of serious impairment.

In another series of studies, Kauert et al. (2007) and Ramaekers et al. (2006b), and Toennes et al (2010) administered much larger doses of smoked cannabis (which should be considered to produce impairment for more than 6 hours, Ramaekers et al., 2006a). The mean concentration of

THC in oral fluid was less than the target recommended in AS4760-2006 (and much lower for the lower dose tested) while individuals were still impaired suggesting that most impaired individuals would not be detected. A concentration of 25 ng/ml or greater (as recommended in AS4760-2006) is therefore not adequate to detect use during the period of intoxication. Similarly using a saliva-wipe technology, after smoking 20-25 mg cannabis (this is a large dose), all experimental subjects had saliva concentrations of THC lower than AS4760-2006, one hour after consumption (Niedbala et al., 2001). This conclusion is borne out both by the published laboratory and field studies of oral fluid testing.

SAMHSA recommended a cut-off of 4 ng/ml (Bush, 2008) and the largest international field study of oral testing devices published to date (Rosita, 2006 and DRUID, 2010 in progress) recommended that a target concentration of less than 4 ng/ml THC for screening tests is essential for acceptable sensitivity and accuracy. It would therefore be prudent to select screening devices that are the most sensitive and accurate available to ensure both optimal deterrence and minimize false negative results (failure to detect impairment) and increase the detection window closer to six hours.

A further complication with oral fluid cut-off levels at screening or confirmation is that adherence to internationally accepted cut-off levels that provide confidence that periods of impairment are detected can lead to false positives arising from passive inhalation of cannabis. Moore et al. (2011) recently reported that concentrations of THC of up to13 ng/ml could be detected in oral fluid after passive exposure to cannabis smoke. It may therefore eventuate that it may not be possible to arrive at cut-off levels that detect most users during the period of impairment while not risking reporting positive results for those passively exposed to cannabis smoke.

Field studies on roadside oral fluid testing in Australia: The poor sensitivity of currently available screening devices for cannabis has been borne out in the field (in addition to the Rosita study) by the data from Victoria and Queensland Police random screening programs. Cannabis is the drug most frequently used by driving drug users in Australia (Davey et al., 2007; Jones et al., 2006) and its frequency of use exceeds by more than 5-9 fold the next most common illicit drug, methamphetamine (ibid.). However, in 13,176 screens on Victorian drivers over a 12-month period, 3.4% of drivers registered positive for methamphetamine-like drugs and only 0.66% were positive for cannabis. The opposite incidences should have been the case on the basis of reported cannabis versus methamphetamine drug-driving. More seriously, of these 87 cannabis positive cases, in 32 cases, neither oral fluid screening device used recorded a positive to cannabis but THC was subsequently detected in the oral fluid during confirmatory testing in the laboratory (median concentration 24 ng/mL, range 5–239 ng/ml). The latter were actually detected only because the oral specimen was first found to be positive to methamphetamine from roadside testing. This confirms that oral screening for cannabis is very insensitive to concentrations of THC expected to be present in intoxicated users. Similarly distorted cannabis-positive incidence data has been reported from oral fluid screening by police in Queensland (Davey et al., 2007).

Detection of benzodiazepines: There are serious difficulties for detection of benzodiazepines in oral fluid so that effectively there is not a detection window. Australian Standard AS4760 does not specifically include benzodiazepines and so is of limited value for comprehensive workplace

drug testing. Benzodiazepines are difficult to detect in oral fluid because they are tightly bound to blood proteins and only the free unbound portion can pass from blood plasma into oral fluid. Thus, oral fluid will contain benzodiazepines but at very low concentrations. Although this complication varies for different benzodiazepines, the oral fluid to saliva ratio for diazepam has been estimated to be between 0.36 and 0.03 for different drugs in the class (Gjerde et al., 2010), ie. the concentration of a variety of these drugs in oral fluid is only a few percent of that found in blood plasma. In order for a screening test to identify the broad spectrum of benzodiazepines in common use in oral fluid within a time frame of pharmacological effect (hours after ingestion) indicates that cut-offs should be less than 1 ng/mL and preferably less than 0.5 ng/mL (Kintz et al., 2004; Samyn et al., 2002; Smink et al., 2008). Although this can readily be achieved in the laboratory it not feasible using currently available on-site screening technology (the best claimed sensitivity is more than ten times higher than this) and will not be in the foreseeable future.

6. *Are there means readily available to persons in the workplace who may be randomly tested for evading detection and, if so, which of the two methods under consideration (oral fluid testing or urine testing) is better suited to dealing with such means?*

There is no doubt that regular and dependent drug users attempt to evade detection in the workplace. Efforts to evade positive urine testing have been ongoing since its introduction, leading to tighter mandated procedures to detect substitution, dilution and masking as strategies to evade detection. AS/NZ4308-2008 has incorporated up to date detection procedures so there can be a high level of confidence in the reliability of samples. Urine can be diluted with water, however strict collection procedures according to AS/NZS 4308 will minimize this. Washing hands prior to producing a specimen reduces the risk of chemical adulteration of a urine specimen.

Oral fluid testing is often assumed to be resistant to evasion because the collection procedure is directly supervised. However, methods and products are available (many are advertised on the internet) to assist with evasion of detection of some drugs. Many of these probably do not work. However, it has been established that rinsing the mouth after smoking cannabis greatly reduces oral cannabis content, presumably because a mild alcoholic rinse extracts cannabis residues from the mouth (Wong et al., 2005). Although concentrations of some drugs may rebound after such rinses, this has not been shown to be the case for cannabis. Similar results were found earlier using beer as the rinse (Maseda et al., 1986). This process is effective because oral fluid testing in accordance AS 4760-2006 almost exclusively detects cannabis that remains in the mouth for a time as particulate residues from cannabis smoke and deposits sequestered into superficial oral soft tissue. Simple procedures such as mouthwashes or alcoholic rinses remove much residual cannabis from the lining of the mouth after smoking. Oral fluid collection can be compromised by a donor ingesting Sudafed in order to produce a dry mouth and reduce saliva production. Chewing lemon flavored sweets will alter the pH (acidity) of saliva which can reduce the amount of cocaine or methamphetamine secreted into saliva (Kato, 1993)

Another serious issue for oral fluid detection arises from the mode of administration which, if known by regular users may lead to near complete evasion of detection. Because oral fluid testing at the level of AS4760-2006 only detects residues from smoked cannabis it is incapable

of detecting cannabis consumed by oral ingestion. Milman et al., (2010) have established that THC is nearly undetectable, and certainly consistently well below the cut-off of AS4760-2006 after 37 continuous oral 20-mg THC doses administered to heavy users over a period of 9 days. Niedbala et al. (2001) administered cannabis in "brownies containing 20-25 mg THC (a relatively high dose). The highest oral fluid concentration in one subject was 7 ng/ml and levels were 1 and 2 ng/ml in the other two subjects less than two hours after consumption. This is of serious concern because oral ingestion of cannabis produces impairment for a more prolonged period than smoking but would not be detected at all at the levels mandated in AS4760-2006.

7. *What, if any laboratories have been accredited to perform oral fluid testing under AS4760-2006?*

There are a number of institutions accredited to AS 4760, however most of these are accredited for collection and dispatch only. Two facilities are accredited for confirmation only, VIFM (Victorian Institute of Forensic Medicine) and QML (Queensland Medical Laboratories). There are three laboratories accredited for both screening (Section 4) and confirmation (Section 5) of AS 4760. These are Queensland Health, Racing Analytical Services and Australian Racing Forensic Laboratory.

8. *Please comment on the state of technology for oral fluid testing in relation to AS4760 and current developments in that technology. Does the AS4760 need to be revised and if so how?*

The technology for oral fluid screening is developing rapidly but evidence on the performance in the field and its confirmation in the laboratory necessarily lags behind this and generally indicates poor performance in the field. Some screening devices are approaching the sensitivity required by international recommendations. AS4760 does not account for these developments and lacks rigor in quality control procedures for screening devices and confirmation samples. We consider that it needs revising with an emphasis on the following.

- Lower cutoffs for both screening and confirmation for all drugs consistent with international recommendations or guidelines.

- Mandatory independent testing of all on-site devices to ensure they meet these cutoffs with an acceptable minimum of false positives and negatives.

- More appropriate values for quality controls. The current Standard allows the positive control to be at or within 50% above the nominated concentrations. We are of the opinion that this value is set too high to be a useful guide as to the reliability of devices used.

- Users of devices to have demonstrated stability data of drugs in the collection tubes used for sending specimens to a laboratory for confirmation or as a referee sample. There are significant losses of some drugs (notably THC) in oral fluid collected in tubes without adequate preservatives.

▪ A maximum time frame in which a second sample can be collected for confirmation/referee sample. Some on-site testing devices do not allow for a split sample collection.

9. **In comparing laboratory oral fluid testing in accordance with AS 4760-2006 (at each stage of the testing, i.e. screening and final confirmatory testing) with urine testing under AS 4308:2008, which test is more likely to produce false negatives and false positives at each stage of the testing?**

From the above discussion of the current state of oral fluid testing technology it is unequivocal that oral fluid tests are considerably more likely to produce false negatives and false positives at each stage of the testing than urine tests. Urine test consistently produce false positive and false negative rates in the range of several percent of tests. Most of the false positives are those that are actually positive but fall just below the threshold for confirmation. As stated above the sensitivity of oral fluid screening tests remains poor (Rosita-2, 2006: Walsh et al.,2007), particularly for cannabis. Until the most recent device was released and field tested (Wille et al., 2009), all devices had sensitivities in the 0-70% range (particularly for cannabis) indicating that false negatives are a serious issue for oral fluid. Of course, these are never detected in the field (because they go unconfirmed) but impaired individuals are also not detected.

As pointed out above, although many devices perform to specification in laboratory tests suggesting false positive may be infrequent, the problems of losses of drug from collection devices before confirmation is performed means that high rates of false negatives at confirmation will be inevitable for oral fluid testing until these limitations are solved.

Urine testing is a mature technology. On-site devices are highly reliable and controlled with reported sensitivity, specificity and accuracy generally well over 90%. By contrast, oral fluid testing is a developing technology and sensitivity and accuracy of on-site testing devices is still improving but there is great variability in the sensitivity and accuracy of on-site oral fluid testing devices. Many commercially available devices do not meet the recommended cut-off levels (particularly for cannabis) of AS4760-2006 but do not actually violate the standard because the screening cut-offs are only recommendations and are not mandated. However, at least one device on the market exceeds the standard for both screening and confirmation and appears to perform well in the field (Wille et al., 2009), with a reported (claimed) cut-off of 5 ng/ml. It must also be noted that any device more sensitive than 10 ng/ml for THC (which would approach international guidelines) would not meet the requirements of AS4760-2006. AS4760-2006 permits screening devices less sensitive than the recommended 25 ng/ml cut-off but mandates that devices more sensitive than the confirmatory concentration of 10 ng/ml not be used for screening. This is because a device more sensitive than 10 ng/ml at screening would often produce false positives because the confirmation test does not match its screening sensitivity.

The Roadside Testing Assessment-2 project (Rosita-2) evaluated nine rapid on-site oral fluid tests analytically from 2003 till 2005. None of these tests were found to be sensitive enough to be used on a large scale (Rosita-2, 2006). Later evaluation of several other tests, for example the Drägar (Laloup et al., 2006), the Cozart® RapiScan System (Wilson et al., 2007) and the Drugwipe 5 (Pehrsson et al., 2008), could not show significant improvement. Published results are beginning to emerge from the current large-scale European Commission project, DRUID

(Driving Under the Influence of Drugs, Alcohol and Medicines). However, the first completed report of that study also found generally poor but variable performance of on-site screening devices (DRUID, 2010 evaluating devices up to 2007). In that study acceptable cut-off criteria of 80% for sensitivity, specificity and accuracy were set (it should be noted that urine tests are more reliable than this, generally with values over 90%). None of the tests reached the target value of 80% for sensitivity, specificity and accuracy for all the separate tests they comprised. These findings suggest that the majority of oral fluid screening devices remain unacceptably insensitive or inaccurate.

For laboratory confirmation testing, both urine and oral fluid confirmation test use a similar, highly reliable technology and are very accurate.

10. ***Does the efficacy or otherwise of different forms of testing undermine the ability for employers to perform accurate on-site screening? Ie. does it mean employers should rely more on lab testing if they want accurate results? If so, does this undermine the ability of performing accurate on-site drug screening and remove flexibility for employers?***

On-site oral fluid tests remain unreliable for some drugs, particularly cannabis but some devices also show poor performance for other drugs. Many devices are insensitive and very unlikely to detect cannabis use during the period of impairment. Others are inaccurate for other drugs and no device achieves a reliable sensitivity for detection of sedative benzodiazepines during the period of impairment. AS4760-2006 does not mandate quality control of screening devices although NATA may do so when accrediting laboratories and collection agencies. Employers would therefore need to rely on laboratory testing for all random tests to have confidence in accuracy of results of oral fluid tests whether or not screening results were positive. This removes flexibility from employers in managing immediate risks of potentially impaired employees from safety sensitive worksites in the mining industry.

Accurate results can be produced by the analytical methods used for laboratory confirmation laboratory testing of both urine and oral fluid. However drug recovery from oral fluid collection devices is very variable and may not provide reliable confirmation for some devices. Urine testing is accurate with sensitivity and reliable both screening and sensitivity of testing devices is controlled under AS/NZ 4308-2008.

11. ***Do shortfalls in particular testing methods, such as increased false negatives arising from some testing methods, deny employees the ability to participate in employer-provided rehabilitation programs at an early stage?***

Employees and member of the general community tend to engage with rehabilitation programs only after an adverse event such as a positive drug or alcohol test result. The low likelihood of detection of regular or dependent drug users by oral fluid testing excludes the highest risk group of employees in terms of safety and likelihood to benefit from assistance. Urine testing quite reliably detects regular/dependent drug users at an early stage.

12. *Are there drugs in common use which cannot be tested in accordance with AS 4760-2006 which can be tested in accordance with AS/NZ 4308-2008?*

Sedative benzodiazepines are widely used and are readily detected by urine screening tests but are very difficult to detect at all using oral fluid screening tests. AS4760-2006 does not specify any procedures for detection of benzodiazepines. Although some oral screening devices can detect benzodiazepines their sensitivity is too poor to have any confidence that they detect these drugs during periods of impairment.

Adherence to AS/NZ 4308 does not preclude testing for drugs not specifically defined in the standard. For example, if opioids such as buprenorphine or oxycodone were considered drugs of concern in particularly circumstances, a laboratory could test for them using similar analytical criteria to those for the defined drugs. The laboratory simply cannot include a statement that these drugs were tested in accordance with AS/NZ 4308. For practical reasons this procedure is very difficult with oral fluid.

13. *Which of the methods of testing (namely, oral fluid testing or urine testing) is more likely to detect a "hang over effect" or the possibility of a "hang over effect"? Is one method of testing more or less likely to provide an indication of the 'depth' or 'severity' of a "hang over effect" and if so which one?*

Hangover effects occur with most of the drugs subject to testing under the policy. Use of some drugs, such as methamphetamine, cocaine and ecstasy (MDMA) produce hangover effects of extreme fatigue or depression after the acute effects have worn off. Other drugs, such as benzodiazepines and opioids produce severe withdrawal effects during periods of abstinence if they are abused for prolonged periods. Urine testing is much more likely to detect such high risk users of drugs than oral fluid testing.

Oral fluid is especially unsuitable for identifying possible hangover effects. Logan (2002) discussed the impairing effects of methamphetamine in drivers and reported that users of methamphetamine were most impaired in the withdrawal phase and when blood levels were extremely low. As there is a highly variable correlation between blood and oral fluid levels of methamphetamine, in some users both blood and oral fluid levels could be extremely low and thus below detection limits. Urine testing is much more likely to detect such users.

14. *Which of the options, namely oral fluid testing or urine testing:*

(a) is more likely to identify a regular or chronic user of illicit drugs,

There is no doubt that urine testing is more likely to identify a regular or chronic user of illicit drugs than is oral fluid testing.

(b) is more likely to identify impairment or potential impairment by reason of the use of such drugs by regular or chronic users,

Urine testing is more likely to identify potential for impairment by the use of such drugs by a regular or chronic user of illicit drugs than is oral fluid testing because regular or chronic users of drugs cycle between periods of acute intoxication and drug withdrawal, both of which produce impairment.

(c) is, if assessment and management of risk of being at work adversely affected by drugs (rather than impairment per se) is important, more likely to provide a better insight into such risk.

Urine testing is more likely to provide insight into risk of being adversely affected by drugs because, in addition to having a higher likelihood of detecting use during intoxication, it has a much higher likelihood of detecting regular, chronic and dependent users of drugs who are at risk more frequently than casual users because of their frequent episodes of intoxication by, and withdrawal from drugs which produce impairment. Arguably, this is the highest risk group of drug users in the workplace, in part because of impairment by frequent cycles of intoxication and withdrawal but also a higher likelihood of attendance at work while acutely intoxicated and impaired by drugs (Jones et al., 2006).

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