BLOOD ALCOHOL ANALYTICAL METHODS

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Revision History

Revision #	Description of Changes
1	Original issue, BLAC analytical methods were consolidated into a single method. Changes were made to: AM#1 sections 3.3.3.1, 4.1.3.1.2, 4.2.1.6, 4.2.2.2, 4.2.2.4, 4.3.6, 4.4.9, 4.5.1.1, AM#2 section 2.8.4.3.1, AM #3 section 3.3.2.2, AM #4 sections 4.5.1.1, 4.5.1.1.1, AM #5 section 5.3.2, 5.3.3.1. The following sections were added: AM #1 section 4.2.2.4.2, 2.9 and AM #3 section 3.3.2.6-8.

AM #1: Analysis for Volatiles by Headspace GC

1.0 Background/References

1.1 Humans have consumed fermented beverages such as beer and wine since prehistoric times.[6] Ethanol abuse is often manifest in driving under the influence (DUI), a problem that plagues every country. The National Highway Traffic Safety Administration (NHTSA) reported that the proportion of drivers involved in fatal crashes that had a BAC of 0.08 or above decreased from 35% in 1982 to 20% in 1997 and leveled off thereafter.[17] Changes in alcohol laws and demographic changes are thought to be responsible for this positive trend. Chronic alcoholism also contributes to ethanol-related deaths. Ethanol consumed on a regular basis can lead to the development of alcoholic hepatitis which can progress into cirrhosis, liver failure, and death.[2,6,7] Chronic excessive ingestion of ethanol is directly associated with serious neurologic and mental disorders such as brain damage, memory loss, sleep disturbances and psychoses.[7] Alcohol is also involved in a high percentage of domestic disputes, many of which result in injury and/or death.

Notwithstanding a common public perception that ethanol is stimulatory, ethanol is classified as a *Central Nervous System Depressant.* Ethanol is a psychoactive drug that is similar in most respects to sedative-hypnotic compounds.[4] The first mental processes to be affected are those that depend on training and previous experience.[7] The individual's memory, concentration, and insight are dulled and subsequently lost. The person may become overly confident and exhibit uncontrolled mood swings and/or emotional outbursts.[7] The effects of ethanol and other central nervous system depressants are additive, resulting in more sedation and a greater degree of impairment in driving ability.[4]

Ethanol is rapidly and completely absorbed from the stomach, small intestine and colon. The mechanism of absorption is a simple diffusion process; alcohol moves from a region of higher concentration to a region of lower concentration.[2,4,6] Alcohol is soluble in both water and fat, a property that facilitates its diffusion through biological membranes.[4] The major amount of absorption takes place in the small intestine due to its large surface area, good blood supply and thin-walled membrane. The time from the last drink to peak concentrations can range between 30 and 90 minutes, depending upon the individual's stomach contents.[4,7] Alcohol absorption is slowed by the presence of food in the stomach. The time period required for gastric emptying is a prime factor that contributes to the wide variety of absorption rates of ingested ethanol observed in different individuals and under different conditions.[2,7] Hence, the extent of absorption in the stomach and small intestine is a function of the amount of ethanol at that site, the vascularity of the site and the surface area in contact with the blood supply.[2] Other factors that affect the absorption of ethanol include the type of beverage, the alcohol content, the rate of consumption and any disease state that affects normal gastric function or blood flow.[2]

Upon absorption, ethanol is distributed to all the water containing regions of the body. Within the blood system, there can be significant differences between arterial and venous blood depending upon the absorption status of the individual.[2] In the absorptive phase, the arterial blood ethanol concentration exceeds the venous blood ethanol concentration. Analysis of venous blood, therefore, underestimates the brain alcohol concentration of the individual at this point. When absorption is complete there is little difference in ethanol concentration between arterial and venous blood.[2]

Ninety to ninety-eight percent of ethanol is completely oxidized in the liver by reacting with the cofactor nicotinamide adenine dinucleotide (NAD) facilitated by alcohol dehydrogenase to produce acetaldehyde. Acetaldehyde is then acted upon by aldehyde dehydrogenase to form acetic acid which goes on to form carbon dioxide and water (figure 1). The amount of ethanol oxidized per unit time is roughly proportional to body weight and probably to liver weight. The remaining (unoxidized) alcohol is excreted unchanged in urine, expired air, saliva and sweat. The average elimination rate of ethanol is 0.015 g/dL/hour from men and 0.018 g/dL/hour for women.[2] In addition to gender, chronic abuse, prescription drugs and certain genetic factors can also influence the elimination rate.[2,6,7]

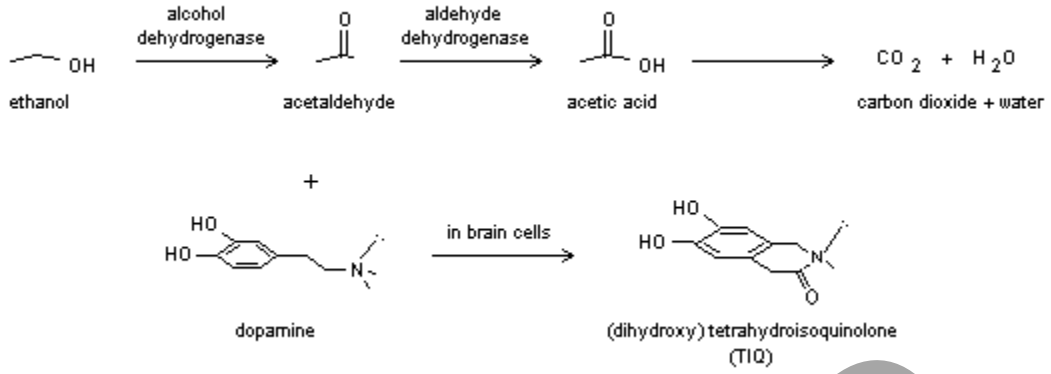

Figure 1. Metabolism of Ethanol.

Other commonly encountered toxic alcohols, alcohols other than ethanol that are not intended to be ingested, such as methanol and isopropanol, produce central nervous system (CNS) depressant effects but vary significantly in the degree.[2,18] Methanol (wood alcohol), commonly a component of model airplane fuel and windshield wiper fluid, causes relatively little intoxication compared to ethanol.[2,6,18] Its harmful effects are due to the direct result of its metabolism to formaldehyde (embalming fluid) and subsequently to formic acid. These metabolites lead to the destruction of neural cells, particularly the optic nerve, which can result in blindness.[2,6] The formic acid leads to metabolic acidosis. Isopropanol (rubbing alcohol) is more toxic than ethanol with more prominent gastritis that includes pain, nausea, vomiting and hemorrhage.[11,19] Isopropanol is metabolized to acetone.[2,4] Note that elevated endogenous acetone may also be detected in the samples from a diabetic or fasting individual.

A variety of volatile chemicals may also be detected in samples from subjects that were inhaled either accidentally or intentionally.[15] For instance, toluene and acetone may be detected in subjects that come into contact with products such as aerosol paint and contact adhesives. The principal metabolite of toluene is benzoic acid. Chronic abuse of toluene and/or acetone can lead to organ and CNS problems that may result in permanent damage.[15] Acetone is metabolized to acetate and formate. Inhaling of electronic cleaning products referred to as computer "dusters" can result in detectable levels of the aerosol propellants 1,1-Difluoroethane (HFC-152a) and 1,1,1,2-Tetrafluoroethane (HFC-134a).[15,21] The primary consequence of abuse is cardiovascular in nature.[15]

The analysis of ethanol and other volatiles in samples of blood, vitreous humor and urine is accomplished with a gas chromatograph (GC) which uses a headspace autosampler (HSA) for sample introduction. An aliquot of sample is placed into a headspace vial along with an aqueous 1-propanol internal standard in 1M Ammonium Sulfate. The sample vials are sealed and heated in a HSA. As described in Henry's Law, in a closed container at a given temperature, a direct (proportional) relationship exists between the amount of a volatile substance dissolved in a liquid and the amount of the volatile substance in the headspace vapor above the solution. The ammonium sulfate serves as a salting- out agent, thus improving the recovery of volatiles from the headspace. [12,13,20] An aliquot of the headspace vapor is injected into a GC with a dual column configuration. The GC serves to separate out the components of the solution as a function of their chemical properties. Separated components are detected by a flame ionization detector (FID). The qualitative identification of ethanol and other common volatiles is based on the retention time determined, relative to the 1-propanol internal standard, for each of the columns. This method also provides for a quantitative determination for ethanol. The quantitative result is based on a calibration curve established by the peak area ratio between ethanol and the 1-propanol internal standard.

The need to establish the ethyl alcohol concentration and/or the presence of other commonly encountered volatiles in a beverage or solution may arise from ABC violations (Idaho Code 23-611, 23-1002, 23-1303, ...), under-age consumption (Idaho Code 23-603, 23-604), open-container violations (Idaho Code 23-505, 23-1333), poisonings and/or an endless variety of situations including questionable samples submitted as blood or other physiological fluid. In addition, ethyl alcohol concentration must be verified in simulator solutions used for breath testing instruments (IDAPA 11.03.01).

1.2 References

- Stafford, D.T., *Chromatography. in:* Principles of Forensic Toxicology, edited by Barry Levine, pp. 91-98, 100-108, 114-118, AACC Press, 2006.
- Levine, B. and Caplan, Y.H., *Alcohol*. *in:* Principles of Forensic Toxicology, edited by Barry Levine, pp. 169-184, AACC Press, 2006.
- Caplan, Y.H., *The Determination of Alcohol in Blood and Breath. in:* Forensic Science Handbook, edited by Richard Saferstein, pp. 594-648, Prentice-Hall New Jersey, 1982.
- Julien, R.M., *Central Nervous System Depressants: Alcohol and the Inhalants of Abuse. in:* Primer of Drug Action, pp. 64-92, Freeman-New York, 1998.
- Saker, E.G., *Screening and Quantitation by Head Space Technique of Some of the Vapors Most Commonly Found in Forensic Toxicology, in*: Current Approaches in Forensic Toxicology, Chapter 11, SOFT Meeting, 1994.
- Perrine, D.M., *Depressants: Alcohol, Benzodiazepines, Barbiturates*. *in:* The Chemistry of Mind-Altering Drugs, pp. 113-129, ACS, Washington, DC, 1996.
- Hobbs, W.R., Rall, T.W. and Verdoorn, T.A., *Drugs Acting on the Central Nervous System - Hypnotics and Sedatives; Ethanol. in:* Goodman and Gilman's The Pharmacological Basis of Therapeutics, pp. 361, 386-393, McGraw-Hill, 1996.
- Idaho Administration Code, IDAPA 11.03.01, Rules Governing Alcohol Testing.
- Jones, A.W., *Disposition and Fate of Ethanol in the Body. in:* Medical-Legal Aspects of Alcohol, edited by J.C. Garriott, pp. 87 - 90, Lawyers & Judges Publishing Co., Inc., 2003.
- Caplan, Y.H., Goldberger, B.A., *Blood, Urine and Other Fluid and Tissue Specimens for Alcohol Analyses. in:* Medical-Legal Aspects of Alcohol, edited by J.C. Garriott, pp. 152-153, Lawyers & Judges Publishing Co., Inc., 2003.
- Anderson, W.H, *Collection and Storage of Specimens for Alcohol Analysis. in:* Medical-Legal Aspects of Alcohol, edited by J.C. Garriott, pp. 241-245, Lawyers & Judges Publishing Co., Inc., 2003.
- Christmore, D.S., Kelly, R.C. and Doshier, L.A. *Improved Recovery and Stability of Ethanol in Automated Headspace Analysis,* J. Forensic Sci. 29(4): 1038-1044; 1984.
- Restek Applications Note #59598, Dual-Column Confirmational GC Analysis of Blood Alcohols Using the Rtx®-BAC1 and Rtx®-BAC2 Columns Optimized for the Perkin-Elmer HS-40 Headspace Autosampler, 1999.
- Klaassen, C.D., *Nonmetallic Environmental Toxicants. in:* Goodman and Gilman's The Pharmacological Basis of Therapeutics, pp. 1681-1682, McGraw-Hill, 1996.
- Broussard, L.A., *Inhalants. in:* Principles of Forensic Toxicology, edited by Barry Levin, pp. 373-380, AACC Press, 2006.
- Baselt, R.C., *Ethanol*. *in*: Disposition of Toxic Drugs and Chemicals in Man, pp. 411-414, Biomedical Publications, 2004.

- Dang, J.N., Statistical Analysis of Alcohol-related Driving Trends, 1982 - 2005, NHTSA Technical Report No. DOT HS 810 942, May 2008.
- Wiener, S.W., *Toxic Alcohols*, *in*: Goldfranks's Toxicologic Emergencies, pp. 1447 - 1457, McGraw-Hill, 2006.
- Pounder, D.J. and Jones, A.W., *Measuring Alcohol Postmortem*, *in*: Drug Abuse Handbook, edited by Steven Karch, pp. 376-389, McGraw-Hill, 2007. Shaw, R.F., *Methods for Fluid Analysis. in:* Medical-Legal Aspects of Alcohol, edited by J.C. Garriott, pp. 220-222, Lawyers & Judges Publishing Co., Inc., 2003.
- Avella, J., Lehrer, M., Zito, S.W., A Validated Method for the Quantitation of 1, 1-Difluoroethane Using a Gas in Equilibrium Method of Calibration, J. Anal. Toxicol. **32(8):** 680-687 (2008).

2.0 Scope

2.1 This method describes the Idaho State Police Forensic Services (ISPFS) procedure for the analysis of blood, vitreous humor, urine and solutions for the presence of volatile compounds. This method provides for the quantitative analysis of ethanol as well as the qualitative analysis of methanol, acetaldehyde, acetone, isopropanol, toluene, fluorinated hydrocarbons and related compounds, via a headspace sampling gas chromatographic method. Note that in this analytical method the terms calibrator and calibration are not used in the ISO/IEC 17025:2005 sense. The words *calibrator* and *calibration* are used to coincide with the terminology in instrument software and manufacturer manuals. The manufacturer's term *calibrator* refers to what is considered by ISP-FS as aqueous reference material that has a certified concentration of ethanol present. This aqueous reference material is used to establish a *calibration curve/table* to establish a response factor between instrument response and reference material concentration.

If this method is applied specifically for the qualitative identification of volatiles other than ethanol, ethanol calibrators and controls need not be included in the analysis run.

3.0 Equipment/Reagents

3.1 Equipment

3.1.1 Agilent 7890A Gas Chromatograph (GC) or equivalent, configured with Flame Ionization Detectors (FIDs)

3.1.2 Agilent G1888, 7697 or equivalent Headspace Sampler

3.1.3 Columns

3.1.3.1 Restek Rtx-BAC1 (#18003: 30 meter X 0.32mm inner diameter (ID), 1.8µm film thickness (FT) or equivalent column)

3.1.3.2 Restek Rtx-BAC2 (#18002: 30 meter X 0.32mm ID, 1.2 µm FT or equivalent column)

3.1.4 Headspace (HS) vials and Closures

3.1.5 Hand Crimper or Bench Top Crimper

3.1.6 Semi-Automatic Dilutor/Pipetter equipped with sample and reagent syringes capable of dispensing 250uL and 2000uL, respectively

3.2 Reagents

3.2.1 Distilled/Deionized water (free from volatiles of interest)

3.2.2 Ammonium Sulfate (Certified ACS Grade)

3.3 Reference Material

3.3.1 Ethanol Aqueous Reference Material

3.3.1.1 Aqueous ethanol reference material used to establish the calibration curve/table or to prepare aqueous ethanol controls can be obtained through a commercial vendor. *Aqueous reference material used to establish the calibration curve must be traceable to NIST standards.*

3.3.2 Multicomponent Volatile Aqueous Solutions

Multicomponent solutions may be purchased or prepared as indicated below.

3.3.2.1 Commercially Obtained Multicomponent Solution

3.3.2.1.1 Solution may include acetone, ethanol, methanol and isopropanol reference materials and/or commonly abused volatiles.

3.3.2.1.2 When the multicomponent solution contains quantitative amounts of ethanol, it may simultaneously serve as an aqueous ethanol control. The GC oven temperature program must provide for baseline separation of all components.

3.3.2.2 Prepared Mixed Volatile Reference Solution

3.3.2.2.1 Add approximately 250 mL of DI water to a flask. Add **one or more** of the following volatiles, as needed for the qualitative identification of volatiles:

Compound	Volume
Acetaldehyde	≅100µL
Acetone	≅100µL
Ethanol	≅100µL
Ethyl Acetate	≅100µL
Methanol	≅500µL
Isopropanol	≅500µL
Toluene	≅50µL

3.3.2.2.2 *Record preparation on reagent log.* Solution is stable indefinitely when stored under refrigeration.

3.3.2.2.3 Additional volatiles of interest may be used singularly or added to the mixed volatile solution.

3.3.2.2.4 The GC oven temperature conditions must provide for baseline separation for all components placed in the mixture.

3.3.2.3 Fluorinated Hydrocarbon Reference Solution

Fluorinated hydrocarbon reference solutions may be prepared from commercially obtained aerosol products. The product's MSDS must be obtained. Solutions may be used for as long as acceptable performance is obtained.

3.3.3 Internal Standard Solution (*~0.03g/dL 1-propanol in 1.0M Ammonium Sulfate)*

3.3.3.1 Add ~132g $(NH_4)_2SO_4$ per L of solution to be prepared and mix with DI water to dissolve. Add ~375µL 1-propanol per L of solution to be prepared. A maximum of 4L may be prepared at a time.

3.3.3.2Record preparation on reagent log. Solution is stable up to 6 months.

3.4 Matrix Control Material

Refer to AM# 2.0 for authentication requirements.

3.4.1 Ethanol or Multicomponent Whole Blood Control Material

3.4.2.1 A minimum of two ethanol whole blood control levels should be available, each falling within the following approximate ranges:

Level	Approximate Ethanol Range (g/100mL)
Low	0.030 – 0.130
High	0.131 – 0.400

3.4.2.2 A whole blood control containing ethanol with other volatiles can serve as a multicomponent control if the GC oven temperature program provides for baseline separation of all components.

3.5 Safety Concerns

Biological samples must be processed and chemicals handled according to safety guidelines in the *Idaho State Police Forensic Services Health and Safety Manual.*

3.6 Quality Assurance

3.6.1 While at the laboratory samples for volatiles testing are to be stored under refrigeration. Urine samples can be either refrigerated or frozen. Urine samples submitted in plastic bottles must be frozen for long-term storage.

3.6.2 The Pipette/Dilutor must be checked for accuracy and precision. This check is performed concurrently with the establishment of the calibration curve and the use of authenticated controls during an analysis run.

3.6.3 Refer to Toxicology Analytical Method for balance intermediate check and calibration requirements.

Note: Balances properly monitored by drug discipline analysts fulfill quality assurance requirements. Additional check need not be performed.

3.6.4 Refer to manufacturer manuals for as-needed instrument maintenance procedures and troubleshooting measures.

3.6.*5 Current source and lot number of controls and reference material must be documented.*

3.6.*6 Refer to AM#2 for reference material authentication requirements.*

3.6.*7 Refer to section 7.0 for quantitative ethanol reporting confidence interval/uncertainty.*

3.6.8 If ethanol is not the analyte in question, a calibration curve for ethanol need not be established.

4.0 Procedure

4.1 Collection Kit Processing

4.1.1 Collection Kit Description and Labeling

4.1.1.1 Record the following information:

4.1.1.1.1 A description of collection kit type.

4.1.1.1.2 A description of type and number of specimen collection container(s).

4.1.1.1.3 If it is apparent that the specimen container does not appear to be the one originally included in collection kit.

4.1.1.1.4 The condition of each specimen container seal.

4.1.1.1.5 The sample type (blood, urine, vitreous humor, other.

4.1.1.2 Laboratory number must be placed on each sample container.

4.1.1.3 When more than one sample is present, label all samples present. Use “A”, “B”, etc. or comparable in addition to the laboratory number

4.1.2 Blood Specimen Collection Container Evaluation

4.1.2.1 Idaho Administrative Code, IDAPA 11.03.01 requires law enforcement agencies to have blood specimens, from living subjects, collected in a container containing *at least ten (10) milligrams of sodium fluoride per cubic centimeter of blood plus an appropriate anticoagulant.*[8]

4.1.2.2 The containers provided in ISPFS kits comply with IDAPA requirements. It must, however, not be assumed that an ISP-FS kit contains the specimen collection tubes it was supplied with.

4.1.2.3 Non-ISP-containers must be evaluated as to compliance. Information from the manufacturer of the container will indicate sodium fluoride concentration as well as the presence of an appropriate anticoagulant.

4.1.2.4 Note compliance of blood specimen container.

4.1.3 Blood Specimen Evaluation

4.1.3.1 IDAPA 11.03.01 requires blood to be reported as grams of alcohol per 100cc of whole blood. Although the absolute determination that the sample is whole blood is beyond the scope of this analytical method, when it is the analyst's opinion that the intended blood sample is serum or otherwise questionable, the analyst has the following options.

4.1.3.1.1 Option One

The sample is not analyzed. A comment "Specimen unsuitable for analysis" is placed on the analysis report.

4.1.3.1.2 Option Two

The sample is analyzed for volatiles, and the report will make no mention of the sample having a biological origin or contain the disclaimer that the "sample(s) appears to be (insert type)".

4.2 Analysis Procedure

4.2.1 Calibration Curve/Table Requirements

4.2.1.1 A minimum of three ethanol aqueous reference solutions must be used to establish calibration/response factor curve.

4.2.1.2 The minimum low calibrator is to be in the nominal range of approximately 0.02 to 0.05g/100mL.

4.2.1.3 The highest calibrator concentration must be 0.30g/100mL or greater.

4.2.1.4 Calibration table may be established in a separate sequence just prior to sequence containing case samples.

4.2.1.5 Ethanol calibrators should be analyzed in order of increasing concentration, and used for the generation of only one calibration curve. Calibrators should not be saved and used to generate future curves. The manufacturer's target value is defined as the manufacturer's "as prepared" certified concentration, and not the "as analyzed" value.

4.2.1.6 The least squares line resulting from the analysis of the ethanol calibrators must have a coefficient of correlation of ≥0.999.

4.2.1.7 Each ethanol calibrator may have more than one replicate.

4.2.1.7.1 In the sequence table, on the Update RF column, select "replace" for each of the first set of calibrators. If a second set of calibrators is run and are to be included in the generation of the calibration curve, the results are to be "averaged". (Software version may differ slightly)

4.2.1.8 If data from a calibrator is not usable, the remaining data can be used to establish the response factor provided that requirements in 4.2.1.1, 4.2.1.2, 4.2.1.3 and 4.2.1.6 have been met.

4.2.1.9 A calibration curve/table is valid for 14 days, provided:

Values for required controls fall within acceptable ranges.

The same preparation of internal standard solution used for the calibration run is used.

4.2.1.10 Once established, analysts not involved in establishing the calibration curve/table may use the established calibration table.

4.2.1.11 The internal standard blank should immediately follow the highest ethanol calibrator.

4.2.2 Analysis Run Control and Blank Requirements

4.2.2.1 Initial Run with Calibration Curve

For a run with a newly established calibration curve, an ethanol containing control must precede the first 10 samples (20 vials). The control must be run in duplicate.

4.2.2.2 Additional Runs with Existing Calibration Curve

For analysis runs utilizing an existing calibration curve, a low and high ethanol-containing control, in duplicate, must bracket the first 10 samples (20 vials) before proceeding with additional samples.

4.2.2.3 All Analysis Runs

4.2.2.3.1 Each analysis run must contain an internal standard blank.

4.2.2.3.2 For analysis runs consisting of more than 10 case samples (20 vials), a minimum of one blood or aqueous ethanol-containing control in duplicate must be run with each additional 10 samples.

4.2.2.3.3 Each analysis run must include either an *aqueous* or *blood* multicomponent volatile mix.

4.2.2.3.4 A commercially obtained **quantitative** *multicomponent* volatile mix may serve as both an aqueous *ethanol control* and a *multicomponent mixture*.

4.2.2.3.5 Each run must contain a blood matrix control in duplicate, as defined in 3.4.2.1.

4.2.2.3.6 Each run, new or previously calibrated, must contain a traceable aqueous control in duplicate at or near the 0.080 level for control charting purposes and for an accuracy QC check. This shall be a newly opened ampoule and will be used to monitor the accuracy of the method and instrumentation over time. This sample is run as if it were a case sample and counts as if it were a case sample for control-bracketing purposes.

4.2.2.3.7 Additional aqueous controls may be run at the end of the run sequence to monitor the overall performance of the instrument, but does not need to meet the acceptance criteria set in 4.3.

4.2.2.3.8 For controls run in duplicate, the samples should contain the -A and -B designators used by the software macro for generation of the data sheet and ease of evaluation. Otherwise, the data must be put into the data sheet manually for evaluation purposes.

4.2.2.3.9 Controls of the same lot number (either aqueous or matrix control), shall not be used for multiple (different) purposes within the same run sequence. (i.e. The 0.080 aqueous control cannot be used as both an aqueous run control and the control charting control during the same run sequence).

4.2.2.4 Qualitative Only Analysis Runs

Sections 4.2.1, and 4.2.2.1 - 4.2.2.3.9 do not apply for an analysis run consisting of only qualitative samples.

4.2.2.4.1 Runs consisting of only qualitative samples need only the sample in duplicate, and the volatile reference standard in question separated by an internal standard blank at a minimum.

4.2.2.4.2 To qualitatively identify a peak in a sample that was run as part of a regular sequence run for alcohol, the analyst needs only to run the qualitative confirmation standard. The standard need to be prepared with the same internal standard solution and run on the same calibration curve as the sample.

4.2.2.5 Aqueous Controls

Lots used in the establishment of the calibration curve must not be used as aqueous controls during a run using said calibration curve.

4.2.3 Sample Preparation

4.2.3.1 Bring calibrators, controls, internal standard and samples to room temperature.

4.2.3.2 Sample preparation must take place in a laminar flow hood or biological safety cabinet.

4.2.3.3 Place blood sample container on rocker for a minimum of two minutes.

4.2.3.4 If a blood sample appears to be coagulated, the sample may require homogenization in a tissue grinder, or equivalent.

4.2.3.5 All case samples must be analyzed in duplicate.

4.2.3.6 Use Pipette/Dilutor to dispense 250µL of case sample, positive control, or calibrator solution, along with 2000µL of internal standard (ISTD), into labeled headspace vial and apply seal.

4.2.3.7 For internal standard blank, dispense 250µL of DI water along with 2000µL of internal standard (ISTD) into labeled headspace vial and apply seal.

4.2.3.8 Dilute alcoholic beverages and unknown solutions as necessary. The sample must be diluted for the value to fall within the upper limits of the calibration curve. Generally, beer and wine should be diluted ~50:1 with DI water and distilled beverages (≥ 16% w/v or 20% v/v) diluted ~100:1. If available, the dilution of unknown solutions should be based on sample history.

4.2.3.8.1 Dilution may be carried out using the autodilutor. If the autodilutor is used, the uncertainty of measurement must reflect the correct number of uses of the autodilutor in the final calculation.

4.2.3.9 Breath testing simulator solutions and samples, which appear to be serum, do not require pre-dilution.

4.2.4 Instrument Run Preparation

4.2.4.1 Open **Sequence Table.** It is recommended that each analyst create, not share, a Sequence Table. This reduces the possibility of the Sequence Table being modified without their knowledge. If a Sequence Table is shared, each analyst must inspect the Sequence prior to analysis.

4.2.4.2 In the Sequence log table, enter the sample case numbers, ethanol calibrators, volatiles single constituent reference material, volatile reference material mixtures, blank(s) and controls.

4.2.4.3 Load samples, calibrators, blank(s), reference material(s) and controls onto the headspace sampler rack as noted in the sequence table.

4.2.4.4 The sequence information should be verified prior to starting the instrument.

4.2.5 Instrument Parameters

4.2.5.1 Refer to current instrument method for gas chromatograph and headspace analyzer analysis parameters.

4.2.5.2 Analysis method must be stored centrally (hardcopy and/or electronically) each time the method parameters are updated.

4.3 Criteria for Acceptance of Data

4.3.1 All sample and control values must have a calibrator greater than or equal to their mean value.

4.3.2 For samples above the highest calibrator used to establish calibration curve/table, the sample must be reanalyzed after dilution. The dilution factor is incorporated into final calculations.

4.3.3 All results obtained from samples bracketed by conforming controls are acceptable for use.

4.3.4 When the overall mean of a control value falls outside of required qualitative, quantitative and/or precision acceptance criteria, the 10 casework samples preceding and following the non-conforming control(s) must be reanalyzed. If only the quantitative criteria are not met, this reanalysis requirement does not apply to samples that are being processed for the qualitative presence of volatiles other than ethanol.

4.3.5 Qualitative Accuracy Criteria

The qualitative presence of ethanol, or other volatile substances, can be established if the retention time for a specimen is within ±0.10 minutes of the retention time of the reference compound in question. This criterion should be designated in the instrument's data station analysis method.

4.3.6 Quantitative Accuracy Criteria

The quantitative ethanol results for a batch of samples can be accepted if the values obtained for control samples fall within ±10% of the established target value.

4.3.6.1 The acceptability criteria for the control from 1.10.2.3.6 will be that the overall reported value (as if it were a casework sample) must fall within the currently accepted level for the process uncertainty of measurement, as established by section 7.0, of the target value.

4.3.7 Column Precision Criteria

4.3.7.1 The ethanol values obtained from column 1 and 2 must agree within 0.0100g/100cc (exclusive of post mortem samples).

4.3.7.1.1 For postmortem samples, if the sample fails to meet the criteria in 4.3.7.1, the analyst shall report the lowest single column result average.

4.3.7.2 If the precision requirement is not met, the sample must be reanalyzed. If upon reanalysis, the column precision requirement is not met, the source of the problem will be pursued. One possible cause is a system leak.

4.3.8 Quantitative Replicate Precision Criteria

4.3.8.1 The mean value for replicate analysis must agree as described in the following table. If the precision requirement is not met, the sample must be reanalyzed.

Results Range (g/100cc)	**Precision (g/100cc)**
0.0200 - 0.1099	0.0100
0.1100 - 0.2299	0.0150
0.2300 - 0.3499	0.0200
0.3500 - 0.5000	0.0300

4.3.8.2 If upon re-analysis, the replicate precision requirement for control sample(s) is not met, troubleshooting must be initiated and documented. Case samples may require additional homogenization.

4.3.8.3 If desired, a macro can be created and installed on the instrument to display the analysis data and populate it to a form/spreadsheet.

4.4 Reporting of Results

4.4.1 General

4.4.1.1 The three decimal place truncated mean ethanol value, as determined by this method, will be reported along with the confidence interval range in the form of the uncertainty of measurement (as established by section 7.0).

4.4.1.2 The uncertainly of measurements shall be reported out to three decimal places rounded up (+/- X.XXX)

4.4.2 Blood Ethanol Results

4.4.2.1 Report over all mean ethanol concentration, as grams of ethanol per 100cc of blood, truncated to three decimal places ± the uncertainty of measurement.

4.4.2.2 Report values <0.020g/100cc, but above 0.000 as "*below reportable limit.*". Results that are 0.000 shall be reported as "none detected".

4.4.2.3 If the sample and/or sample vial clearly does not comply with IDAPA 11.03.01, an appropriate comment must be noted on the analysis report.

4.4.3 Urine Ethanol Results

4.4.3.1 The four decimal place over all mean ethanol value must first be multiplied by 0.67.

4.4.3.2 Report over all mean ethanol value as grams of ethanol per 67mL of urine truncated to three decimal places ± uncertainty of measurement.

4.4.3.3 Report values <0.020g/67ml, but above 0.000 as "*below reportable limit.*". Results that are 0.000 shall be reported as "none detected".

4.4.3.4 A qualifier statement "*Urine results may be of questionable value*" **must** be included in the analysis report for ethyl alcohol determination.[8] The disclaimer is not required for other volatiles reported qualitatively.

4.4.4 Vitreous Humor Ethanol

4.4.4.1 Report over all mean ethanol concentration, as grams of ethanol per 100cc of vitreous humor, truncated to three decimal places (0.000) ± uncertainty of measurement.

4.4.4.2 Report values <0.020g/100cc, but above 0.000 as "*below reportable limit.*". Results that are 0.000 shall be reported as "none detected".

4.4.4.3 No conversion to a blood alcohol value will be made on the report.

4.4.5 Alcohol Beverages

4.4.5.1 To obtain the ethanol concentration value, the overall mean ethanol concentration results are multiplied by the dilution factor (if applicable). This will provide the ethanol concentration in g/100cc (weight per volume (w/v) percent).

4.4.5.2 For volume per volume (v/v) value, divide w/v value by 0.79.

4.4.5.3 Value must be reported as both w/v and v/v percent. The mean value must be truncated and reported out to the tenths decimal place ± the uncertainty of measurement

4.4.6 Unknown Liquids and "Serum" - Ethanol

4.4.6.1 Report ethanol concentration in g/100cc and/or weight per volume (w/v) percent, depending on the sample history.

4.4.6.2 When dilution is necessary, the overall mean results of analysis must be multiplied by the dilution factor.

4.4.6.3 When reporting as g/100cc, report over all mean ethanol concentration, truncated to three decimal places (X.XXX), as grams of ethanol per 100cc of liquid ± the uncertainty of measurement.

4.4.7 Reporting of Qualitative Volatiles Results

The qualitative presence of other volatiles such as acetone, isopropyl alcohol, methyl alcohol, toluene and formaldehyde will be noted on the analysis report following the ethyl alcohol results, if present.

4.4.8 Comments for Analysis Report

As appropriate and/or required, comments outlining actions, discrepancies and/or qualifiers can be included on the analysis report following the results of analysis.

4.4.9 Breath Testing Solutions

Provide results to Discipline Leader for evaluation.

4.4.10 New Blood Matrix Control Evaluation

Provide results to Discipline Leader for evaluation.

4.5 Analysis Documentation

4.5.1 Volatiles Analysis Forms

4.5.1.1 Spreadsheet form for calibrator, controls and case sample can be located on the ISP LIMS system.

4.5.2 Quality Assurance Data

4.5.2.1 A copy of quality assurance data (calibrators and controls) need not be included in individual case files.

4.5.2.2 A packet containing spreadsheets and data for response factor/calibration curve, controls and reference material will be prepared for each analysis run and stored centrally in the location designated for alcohol quality assurance data in the laboratory where the analysis was performed until archiving.

4.5.2.2.1 The storage of central data may be done electronically.

4.5.2.3 When necessary, a copy of the quality assurance data can be prepared from the centrally stored documents or reprinted from electronically stored data.

4.5.2.4 For qualitative only runs, the only QA samples that need to be included are the qualitative reference standard used to identify the peaks of interest and the appropriate blanks (internal standard and optional water blank).

4.6 Maintenance

4.6.1 Consult the instruments maintenance manual for types of maintenance available for this instrument.

4.6.2 It is required that a cleaning or "baking" method be developed in each laboratory that is specific for the instrument. The baking procedure should increase the temperatures of the samples pathway through the instrument.

4.6.2.1 The cleaning method is to be run on an "as needed" basis that is determined by the analyst. The indicators include but are not limited to, changes in the peak shape, baseline noise, column precision, and retention time drift.

4.6.2.1.1 G1888 headspace/7890A GC parameters example:

- *HS Oven Temp: 100ºC*
- *Loop Temp: 200ºC*
- *Transfer Line Temp: 200ºC*
- *Inlet Temp: 220ºC (for BAC1/BAC2 columns)*
- *GC Oven Temp: 220ºC (for BAC1/BAC2 columns)*
- *Detector Temp: 250ºC*

4.6.3 On a yearly basis, all of the data files and calibration curve data will be backed up to permanent media, or equivalent backup device.

Analytical Method #2: Authentication

1.0 Background/References

1.1 Refer to AM# 1, section 1.1

1.2 References:

- Stafford, D.T., *Chromatography. in:* Principles of Forensic Toxicology, edited by Barry Levine, pp. 91-98, 100-108, 114-118, AACC Press, 2006.
- Levine, B. and Caplan, Y.H., *Alcohol. in:* Principles of Forensic Toxicology, edited by Barry Levine, pp. 169-184, AACC Press, 2006.
- Caplan, Y.H., *The Determination of Alcohol in Blood and Breath. in:* Forensic Science Handbook, edited by Richard Saferstein, pp. 594-648, Prentice-Hall New Jersey, 1982.
- Christmore, D.S., Kelly, R.C. and Doshier, L.A. *Improved Recovery and Stability of Ethanol in Automated Headspace Analysis,* J. Forensic Sci. 29(4): 1038-1044; 1984.
- Restek Applications Note #59598, Dual-Column Confirmational GC Analysis of Blood Alcohols Using the Rtx®-BAC1 and Rtx®-BAC2 Columns Optimized for the Perkin-Elmer HS-40 Headspace Autosampler, 1999.

2.0 Scope

2.1 This method describes the Idaho State Police Forensic Services (ISPFS) requirements for the authentication of quality assurance material used to provide confidence in the data collected during the analysis of blood, vitreous humor and urine to establish both the qualitative and quantitative presence of ethanol and other volatiles.

3.0 Equipment/Reagents

3.1 Equipment: Refer to Analytical Method 1, section 1.3

3.2 Reagents: Refer to Analytical Method 1, section 1.4

3.3 Reference Material: Refer to Analytical Method 1, section 1.5

4.0 Procedure

4.1 Authentication of Volatiles Reference Materials

4.1.1 General

4.1.1.1 Refer to AM# 1.0 for GC-HS analysis requirements.

4.1.1.2 **Aqueous** reference material used to establish the calibration curve must be traceable to NIST standards.

4.1.1.3 All available Certificates of Analysis for reference material will be stored centrally (either via hard copy of electronically).

4.1.1.5 Reference materials without certificates of analysis will be authenticated structurally.

4.1.1.4 New lots of reference material must be authenticated prior to an analyst reporting a conclusion in casework in which that reference material was used.

4.1.2 Authentication Analysis

4.1.2.1 Refer to the section 1.0 for analysis of the reference materials.

4.1.2.2 The sample should be run in duplicate in the same manner as a case sample, using the -A and -B designators for use in the data analysis macro spreadsheet.

4.1.3 Qualitative Authentication

4.1.3.1 Evaluate the mean retention time for the analyte using the analysis run data.

4.1.3.2 Compare volatile retention times reported for new reference material lot with retention time obtained from previous data.

4.1.3.3 The new lot can be accepted if the mean retention time for the new lot is ± 0.10 minutes.

4.1.3.4 For analytes of interest that have no previous data for comparison, those substances will be analyzed using structural analysis (GC/MSD, LC/MS, etc). Structural analysis needs to be performed by authorized personnel.

4.1.3.5 A standard will be considered structurally authenticated when the match (Q) is greater than 85 %, as compared to a library search and the analyst confirms that the spectra matches with no significant differences. If the spectra does not have a library match of 85% or greater the spectra may be authenticated by comparing it to a peer reviewed scientific journal, reference standard compendium or a library match that is less than a 85%. For these three options, two analysts trained to use the authentication instrumentation must initial the documentation signifying that it is an appropriate match.

4.1.4 Quantitative Authentication

4.1.4.1 Compare the quantitative data from the analysis of a new lot with the Certificate of Analysis values.

4.1.4.2 The new lot number of volatile reference material can be accepted if the mean concentration obtained falls within the current level of laboratory uncertainty of measurement of the target value (assayed) listed on the Certificate of Analysis.

4.1.4.2.1 The manufacturer's "as prepared" target value will be used as the target value for the lot.

4.1.4.3 Evaluation of data must be such that compliance with concentration requirements is apparent.

4.1.4.4 When a certified volatile reference solution contains components in addition to ethanol, only the ethanol concentration needs to be quantitatively authenticated. For controls that contain other volatiles (e.g. acetone, methanol, isopropanol) in addition to ethanol, the qualitative determination of the components must be established through the comparison of relative retention times.

4.2 Authentication of Matrix Controls

4.2.1 General

4.2.1.1 Refer to section 1.0 for GC-HS analysis requirements.

4.2.1.2 Matrix controls **must** be authenticated prior to being used in sample runs.

4.2.1.3 Each lab will run the new lot of control as if it were a case sample.

4.2.1.4 The data will be sent to the Discipline Leader for evaluation of the results.

4.2.1.5 The matrix control is considered authenticated if the results from all three labs correlate to within the current reported uncertainty measurement (+/-) from the mean of all the obtained values.

4.2.1.6 The mean value obtained from analysis within the lab shall be the target value used for the new lot of matrix control.

4.3 Authentication Documentation

4.3.1 Reference Controls

Original authentication data and documentation of compliance with acceptance criteria will be maintained by the discipline leader. Documentation may be kept electronically.

4.3.2 Reference Material

A copy of all data used to authenticate the quantitative reference materials will be maintained by the alcohol discipline leader. Copies may be maintained in electronic format.

4.4 Safety Concerns

Biological samples must be processed and chemicals handled according to safety guidelines in the *Idaho State Police Forensic Services Health and Safety Manual.*

4.5 Quality Assurance

Refer to Blood Alcohol Analytical Method 1.

Analytical Method #3: Testing Guidelines

1.0 Background/References

1.1 In order to best utilize the resources available to Idaho State Police Forensic Services (ISPFS), whether analysis is performed and the degree of analysis pursued should be guided by all available information. It may not always be necessary and/or appropriate to proceed with sample analysis. For instance, when a valid breath test is obtained for a routine DUI, analysis of a blood sample for ethanol would not provide additional useful information. Another example is when analysis indicates a high blood alcohol value; additional testing for drugs other than ethanol requires extenuating circumstances.

2.0 Scope

2.1 This method addresses the factors to consider when determining the extent of analysis a volatiles case sample requires. The goal of these considerations is for the efficient utilization of resources in order to provide timely ethanol and other volatiles analysis results to user agencies.

3.0 Equipment/Reagents

3.1 None Associated directly with this Analytical Method

4.0 Procedure

4.1 *Post-Blood Alcohol or Valid Breath Testing Analysis*

4.1.1 When ISPFS laboratory analysis indicates that the ethanol concentration is 0.10/100cc or greater, further testing for additional drugs, in either blood or urine, should not be pursued unless justified by case related circumstances. This is in consideration that the legal limit for ethanol is 0.08 grams per 100 cc blood.

4.1.2 If a breath test result is listed on the case submittal form or in pre-log, and no indication of a problem with the test is noted during the submission process, volatiles analysis will not be pursued. It is at the analyst's discretion to contact the agency to ascertain if extenuating circumstances exist when they are not indicated upon submission. If extenuating circumstances are indicated by the submitting agency, testing may be conducted on the sample.

4.1.3 Extenuating circumstances may include the following:

- Fatality or injury accident where additional volatiles use is suspected.
- Drug Recognition Exam (DRE) supports additional volatiles use. The DRE officer is reliant on a confirmation of their observations to maintain their certification.
- Volatiles related paraphernalia recovered from vehicle. Additional analysis could serve to support any additional charges.
- The breath testing instrument malfunctioned after the breath testing, preventing a valid performance verification from being obtained.
- In the case of crashes where the subject is the driver and is deceased and further toxicology testing is requested, testing will be performed on samples that have a blood alcohol content of less than 0.20 grams per 100 cc of blood.

4.1.4 The submitting officer or agency is responsible for providing justification for additional testing. Justification could take the form of a memo, e-mail or letter outlining the situation and a case report.

4.1.5 If the ethanol concentration is 0.10 or lower, future testing for other impairing drugs will not be pursued if the additional testing is not requested in Prelog or on the Evidence Submittal Form.

4.1.6 ISP will not analyze separator tubes, or tubes that appear to be non-homogenous by design.

4.1.7 In the event that IDAPA compliant tubes are submitted for analysis, other tubes submitted subsequent to the original submission will not be analyzed unless the original submission is deemed inadmissible for court purposes. Documentation from the court or prosecutors should be retained within the case record if such an analysis in performed.

4.1.8 When a combination kit containing multiple tubes and samples is submitted, it is as the discretion of the analyst on which sample to test. IDAPA compliance should be the main determining factor.

Analytical Method #4: POVA Intermediate Checks

1.0 Background/References

1.1 Upon receipt of a newly obtained pipette/dilutor and after maintenance, the calibration must be verified to substantiate that the volume delivered is both accurate and precise. This is accomplished by determining the mass of a volume of liquid of known density that has been delivered into a closed vessel.

1.2 References

- ASTM Method E-1154-89 (reapproved 2003), Standard Specification for Piston or Plunger Operated Volumetric Apparatus.
- Curtis, R.H., *Performance Verification of Manual Action Pipets: Part I,* Am. Clin. Lab. 12(7):8-9; 1994.
- Curtis, R.H., *Performance Verification of Manual Action Pipets: Part II,* Am. Clin. Lab. 12(9):16-17; 1994.
- Byer, B.J., How to Use and Check Pipetting Equipment, Scientific Newsletters, Inc., 1977.
- ISO 8655-6:2002, Piston-operated volumetric apparatus – Part 6: Gravimetric method for the determination of measurement error.

2.0 Scope

2.1 The reliability of the volume delivered by POVA is dependent upon verification of calibration. This method sets forth the requirements for both intermediate checks and calibration. The intermediate check is performed to maintain confidence in calibration. This manual weighing technique is an option to evaluate the performance of each POVA. The procedure is most applicable when larger volumes (≥1mL) are employed. This analytical method applies to air displacement pipettes as well as syringes attached to dilutors and dispensers. When warranted, an approved external service provider performs actual POVA calibration.

3.0 Equipment/Reagents

3.1 Equipment

3.1.1 Analytical Balance

- Capable of accurately weighing volumes of interest
- Note: Balance may be used if it has been checked using either the toxicology or controlled substances analytical method.

3.1.2 Thermometer

- Long Solid-Stem
- Traceable to NIST Standards
- Subdivisions of ≤0.5 degree
- Capable of reading 20° - 28°C

3.1.3 Weighing Vessel with Lid

- Nonporous material
- Assorted sizes to accommodate volume under consideration

3.2 Reagents

3.2.1 Deionized/distilled water

4.0 Procedure

4.1 Intermediate Check Procedure

4.1.1 General

NOTE: If an analyst has been approved to use the ARTEL calibration system in toxicology it may be used following the toxicology method

4.1.1.1 Intermediate checks of the POVA's calibration are only required before initial use or after the instrument leaves the lab for maintenance.

4.1.1.1.1 Calibrations done by approved vendors **within the laboratory** do not require an intermediate check prior to use.

4.1.1.2 Each POVA should be tracked by its serial number and/or other unique identifier.

4.1.1.3 Intermediate checks of POVAs by an analyst or laboratory technician will be valid indefinitely.

4.1.1.4 A POVA not in-use must be checked prior to use for an application that requires a calibrated POVA.

4.1.1.5 An intermediate check must be performed any time a POVA is serviced.

4.1.2 Initial set-up

4.1.2.1 The water used for the intermediate check process should be allowed to equilibrate at room temperature for at least two hours prior to the start of this procedure. Verify that the room and water temperature are the same prior to the start of this procedure.

4.1.2.2 Fill out identifying information on the top portion of POVA intermediate check worksheet.

4.1.2.3 For adjustable volume POVA, the volume of interest should be recorded.

4.1.2.4 Determine and record the water temperature on the log sheet at the beginning and at the end of determinations.

4.1.3 POVA Determinations

4.1.3.1 Use designated POVA, to dispense appropriate volume of temperature-equilibrated water into the weighing vessel and cap.

4.1.3.2 A minimum of ten individual repetitions **(W_i)**, along with their corresponding time, should be recorded.

4.1.3.3 Calculate the Mean Delivered Weight **(W),** record on log sheet.

4.1.4 Mean Delivered Volume

4.1.4.1 From the *Table 1* obtain the conversion factor **(Z)** for the mean water temperature.

4.1.4.2 Calculate the Mean Volume Delivered **(V_t)** at the mean recorded temperature.

$$V_t = (\overline{W}) \cdot Z$$

4.1.5 Inaccuracy Calculation

4.1.5.1 Determine inaccuracy by calculating the percent error (E_t) between the expected (V_o) and calculated mean (V_t) volume.

$$E_t = V_t - V_o / V_o \times 100$$

Temperature °C	*Conversion Factor (Z) (µL/mg)*
20.0	1.0029
20.5	1.0030
21.0	1.0031
21.5	1.0032
22.0	1.0033
22.5	1.0034
23.0	1.0035
23.5	1.0036
24.0	1.0038
24.5	1.0039
25.0	1.0040
25.5	1.0041
26.0	1.0043
26.5	1.0044
27.0	1.0045

27.5	1.0047
28.0	1.0048

Table 1

4.1.5.2 Record % error on log sheet.

4.1.6 Imprecision Calculation

4.1.6.1 Calculate the standard deviation (*s*) for the replicate weights.

$$s = \sqrt{\frac{\sum (W_i - \overline{W})^2}{n-1}}$$

n = Total number of repetitions

4.1.6.2 Record '***s'*** on worksheet.

4.1.6.3 Determine the imprecision by calculating the coefficient of variation (CV%). This is also referred to as relative standard deviation (RSD).

$$CV\% = s \cdot 100 / \overline{W}$$

4.1.6.4 Record CV % on worksheet.

4.1.6.5 Worksheet must be centrally stored in the laboratory performing the intermediate check.

4.1.7 Evaluation of Accuracy and Precision

4.1.7.1 Acceptance criteria are listed in the following table.

Imprecision (CV%)	***Inaccuracy***
1.0%	2.0%

4.1.7.2 If the values obtained for a new dilutor dispenser are small, they should remain so. For instance if the initial imprecision value is 0.25%, obtaining a 1% imprecision value on the following intermediate check is a significant departure.

4.2 Calibration

4.2.1 All pipettes and syringes crucial for the quality of quantitative analysis will be calibrated when analytical method quality control values and an intermediate check indicate unacceptable performance.

4.2.2 The calibration will be outsourced to an approved vendor/service provider.

Analytical Method #5: Criteria for Site Approval

1.0 Background/References

1.1 Section four of Idaho Code §18-8004 (Persons under the influence of alcohol, drugs or any other intoxicating substances) states the analysis of blood and urine for the purpose of determining the alcohol concentration shall be performed by a laboratory operated by the Idaho State Police or by a laboratory approved by the Idaho State Police under the provisions of approval and certification standards to be set by that department, or by any other method approved by the Idaho State Police. Idaho Administrative Code IDAPA 11, Title 03, Chapter 01 (11.03.01) outlines the requirements for a laboratory desiring to perform this analysis. IDAPA 11.03.01 states that the laboratory shall participate in approved proficiency testing and pass this proficiency testing according to standards set by the Idaho State Police Forensic Laboratory.

1.2 References

- IDAPA 11.03.01, Rules Governing Alcohol Testing.
- Idaho Statute §18-8004, Persons under the influence of alcohol, drugs or any other intoxicating substances.

2.0 Scope

2.1 As described above, a laboratory must take part in an Idaho State Police Forensic Services (ISP-FS) Laboratory recognized, proficiency testing program and be approved by the ISP-FS for start-up or to continue analysis of samples for alcohol content. This procedure describes the standards applied to this process.

3.0 Equipment/Reagents

3.1 None applicable for this Analytical Method

4.0 Procedure

4.1 PROCEDURE FOR TESTING SITE APPROVAL

4.1.1 Procedures Governing Analysis

IDAPA 11.03.01 requires each laboratory performing analysis for evidentiary purposes to prepare and maintain a written procedure governing its method of analysis, including quality control and proficiency testing guidelines. To verify conformity, a copy of the procedure must be provided to ISP-FS. Whenever protocol changes are adopted, a copy of the updated procedure must be forwarded to ISP-FS.

4.1.2 Proficiency Testing

4.1.2.1 ISP-FS approved providers include National Highway Transportation Safety Administration (NHTSA) and Collaborative Testing Services (CTS). Each test consists of at least four samples spiked with unknown concentration of ethyl alcohol.

4.1.2.1 Laboratories must participate in proficiency testing at least once a year. ISP-FS will only evaluate proficiency test results from approved providers.

4.1.2.2 Participating laboratories must obtain proficiency tests from approved providers and are responsible for all costs associated with obtaining and analyzing such tests.

4.1.2.3 Results from proficiency tests must be provided to the test provider and ISP-FS. Results not submitted to a test provider within the allowed time do not qualify as a proficiency test.

4.1.3 Evaluation of Proficiency Testing Results

4.1.3.1 An alcohol concentration range is determined from the target value as provided by the proficiency test provider. The acceptable range is the target value ± two standard deviations or 10%, whichever is greater. Reported values must fall within this range.

4.1.3.2 If a laboratory submits more than one alcohol value for a given sample the mean value of results will be evaluated.

4.1.4 Approval to Perform Legal Alcohol Testing

4.1.4.1 Upon satisfactory completion of an approved proficiency test, a letter and certificate of approval will be issued by ISP-FS to each participating laboratory.

4.1.4.2 Approval to perform legal blood alcohol determinations is continued until the results of the next proficiency test are reviewed and notification is sent to the respective laboratory by ISP-FS.

4.1.5 Disapproval to Perform Legal Alcohol Testing

4.1.5.1 Disapproval indicates that results are outside the tolerance range established from the accepted mean values.

4.1.5.2 When a laboratory fails to report values within the acceptable range, their approval to perform analysis on legal blood alcohol samples will be revoked.

4.1.5.3 A letter of disapproval will be issued by ISP-FS to the involved laboratory.

4.1.6 Reinstatement Following Disapproval

4.1.6.1 To be reinstated to perform alcohol analysis the laboratory must review their operation and satisfactorily complete a proficiency test approved by ISP-FS. For purposes of reinstatement, an approved test includes those described in section 4.1.2.

4.1.6.2 When a laboratory has successfully completed a second proficiency test, reviewed its operation, and the overall process has been evaluated by ISP-FS, the approval to perform legal alcohol determinations may be reinstated.

Analytical Method #6: Competency and Proficiency

1.0 Background/References

1.1 In accordance with the *Volatiles Analysis Training Plan,* a trainee will complete a competency test consisting of specimens which contain a representation of commonly encountered analytes. Thereafter, the analyst will complete an annual proficiency test. Breath Alcohol proficiency tests may be completed by reanalysis of a single instrument.

2.0 Scope

2.1 This method describes the criteria to be applied to the evaluation of results obtained for both competency and proficiency testing for ethanol and other volatiles analysis.

3.0 Equipment/Reagents

3.1 None Applicable to this Analytical Method Specifically

4.0 Procedure

4.1 Competency Tests

4.1.1 The competency test can be ordered through a reliable vendor or created internally.

4.1.2 The acceptable alcohol concentration range is determined from the target value provided by the manufacturer of the competency test or from internal testing.

4.1.3 Reported values must fall within ±10% of the target value reported by manufacturer.

4.1.4 If all volatiles are not detected and/or the quantitative ethanol value(s) reported does not fall within the allowable range, analysis procedures will be reviewed and additional training may be required as deemed appropriate by the Discipline Leader. The analyst will be required to perform an additional competency test.

4.2 Proficiency Tests

4.2.1 The blood alcohol proficiency test can be ordered through an ASCLD/LAB approved vendor and/or Department of Transportation (DOT).

4.2.1.1 To comply with ASCLD/LAB International proficiency test requirements it is necessary for each laboratory to successfully complete one external test from an ASCLD/LAB International approved provider.

4.2.1.2 As described in Volatiles AM 1.0, in order to comply with IDAPA 11.03.01 (approval to perform alcohol determinations for legal purposes), a laboratory must take part in an Idaho State Police Forensic Services (ISP-FS) recognized proficiency testing program.

4.2.1.3 A single proficiency test can be used to comply with both IDAPA and ASCLD/LAB International requirements as long as it is an ASCLD/LAB approved test.

4.2.1.4 The appropriate tests to be ordered will be evaluated yearly by the Quality Assurance Manager with input from the Discipline Leader.

4.2.1.5 The acceptable alcohol concentration range is determined from the target value provided by the manufacturer of the competency test.

4.2.1.6 The target value will be based only on the compilation of results provided by ASCLD/LAB accredited laboratories.

4.2.1.7 The acceptable range is the target value ± two standard deviations or 10%, whichever is greater.

4.2.1.8 Reported values must fall within this acceptable range.

4.2.1.9 If the value reported does not fall within the allowable range, analysis procedures will be reviewed and additional training may be required as deemed appropriate by the Discipline Leader. The analyst will be required to perform a competency test prior to resuming casework.

4.3 The competency testing and proficiency testing only apply to the training/testing of volatiles analysis in fluids and does not apply to the breath alcohol program portion of the discipline. If an applicable breath testing proficiency/competency test is available through a commercial vendor or in agreement with 4.2.1, then that shall be the approved choice for proficiency testing and competency testing.

4.3.1 Until an approved vendor is available, the proficiency tests shall be created internally.

Analytical Method #7: Uncertainty of Measurement

1.0 Background/References

1.1 Any measurement, no matter how carefully obtained, should not be considered as the true value for the measurement. Whenever any quantitative measurement is performed, the value obtained is only an approximation of the true value.[1] According to JCGM 200:2008, the International vocabulary of metrology – Basic and general concepts and associated terms (VIM),[3] measurement uncertainty is defined as "*A non-negative parameter associated with the result of a measurement/quantity value (*number *and measurement unit used together to express the magnitude of a quantity) that characterizes the dispersion of quantity values that could reasonably be attributed to the measurand (quantity intended to be measured)*." ISO/IEC 17025:2005 clause 5.4.6.2 requires that we make a reasonable estimation of uncertainty that is based on knowledge of the performance of the method and on the measurement scope and shall make use of for example, previous experience and validation data.[2] Clause 5.4.6.2, NOTE 1 goes on to state that the degree of rigor needed in an estimation of uncertainty of measurement depends on factors such as the existence of narrow limits on which decisions on conformity to a specification is based.[2] Paragraph 5.10.3.1 states that when applicable, the test report should include a statement on the estimated uncertainty of measurement.[2] For our purposes, it is applicable due to the uncertainty affecting the application of the test results which are compliant to a specification limit. In the analysis of forensic specimens, we do not know the true value for the specimen; hence this information is not the error associated with the analysis. Rather, it is a range of values likely to be encountered during the measurement process.[7] This information is crucial to the legal system because it impacts if and how an individual will be charged with an offense such as DUI.[4,5]

1.2 References:

- Huber, L., Validation and Qualification in Analytical Laboratories, pp. 146 - 150, Interpharm/CRC, 19910.
- International Organization of Standardization (ISO) / International Electrochemical Commission (IEC), *General requirements for the competence of testing and calibration laboratories*, 2005. (ISO/IEC 17025:2005)
- Joint Committee for Guides in Metrology (JCGM), *International Vocabulary of Basic and General Terms in Metrology (VIM),* 2008. (JCGM 200: 2008)

- Idaho Code §18-8004. Persons under the influence of alcohol, drugs or any other intoxicating substances.
- Idaho Code §18-8004C. Excessive Alcohol Concentration – Penalties.
- ISO/IEC 17025:2005: Section 5.4.6: Estimation of Uncertainty of Measurement Workshop, Presented by J.P. Bono and E.A. Mishalanie, AAFS 61st Annual Meeting, Denver, Colorado, 20010.
- Mason, F., Uncertain About Uncertainty, Quality Digest, Inside Metrology Column, 06-12-2008.

2.0 Scope

2.1 This analytical method will be applied to analytical methods which report quantitative results. This approach to uncertainty uses the standard deviation of matrix matched controls and other known sources of uncertainty. A 99% confidence interval will be created by three standard deviations of data collected during the process. To properly represent the uncertainty, this data will be expressed as the Uncertainty of Measurement on the analysis report. Authentication of ethanol containing blood controls is described in section 2.0

3.0 Equipment/Reagents

3.1 Equipment: Reference section 4.0 of this Analytical Method.

3.2 Reagents: Reference section 4.0 of this Analytical Method

3.3 Quality Assurance Material: Reference section 4.0 of this Analytical Method

4.0 Procedure

4.1 Reporting of Quantitative Ethanol Results

4.1.1 Analytical Methods

Analytical Method #1: Analysis of Volatiles by GC-HS

4.1.2 Determination of Confidence Interval

4.1.2.1 Blood control values obtained during the process are used to establish the UM based on the standard deviation of data as well as incorporating other known sources of uncertainty into the uncertainty budget.

4.1.2.2 Three standard deviations will be calculated for a 99% confidence interval.

4.1.2.3 The mean value as determined by the above analytical method will be reported along with a ± UM.

4.2 Monitoring and Updating the Uncertainty of Measurement

4.2.1 Monitoring

4.2.1.1 The UM for the analysis process will be monitored per the AM 1.0 through the use of certified reference materials. The reference materials shall be run with each batch of samples being analyzed and entered into a spreadsheet.

4.2.1.2 The results of the reference standards shall be reviewed annually. The review will consist of the Discipline Leader checking the results for each lab and issuing a memo to summarize the results of the reference standard analysis.

Note: The memo shall consist of the following summaries at a minimum: Overall system standard deviation, overall system standard error, each regional laboratories overall standard deviation, and a quarterly breakdown of the standard deviation and standard error for each lab to identify trends.

4.2.2 Updating the UM for the system

4.2.2.1 Should a new GC/HS instrument be put into service within the laboratory, the measurement process for the affected laboratory shall be repeated using an available lot of blood control QC samples in the same prescribed manner as the original determination.

4.2.2.2 Should a new analyst be approved to perform volatile substance analysis, the measurement process will be performed by that analyst using an available lot of blood control QC samples in the same prescribed manner as the original determination.

4.2.2.3 Every three years, the process with be reproduced using a different lot of blood QC samples throughout the entire system. Each analyst that is approved and performing volatile substance analysis on blood and other fluids shall produce data used for the determination of the UM for the system. This process shall be substantially the same as the previous determinations and analyses.

4.2.2.4 When the UM is updated, reports that are in progress shall report the UM numbers in accordance with the version that is in effect during the ANALYSIS date found in the case notes, and not with the report issue date.