Training Procedure for Alcohol Toxicology

1.0 Purpose –This procedure provides a training program for the analysis of alcohol and other volatiles in biological specimens and other dilute solutions. This program shall provide analysts with the theoretical background and the working knowledge to conduct independent casework and present competent expert witness testimony in the field of Forensic Alcohol Toxicology. Quality assurance of all tests performed is a major component of this training program.

2.0 Scope - This procedure applies to trainees in the Toxicology Units of the State Crime Laboratory (SCL).

3.0 Objectives

3.1 Understand the theory of Head-Space Gas Chromatography (HS-GC).

3.2 Perform independent and accurate forensic analysis using HS-GC.

3.3 Perform successful calibrations of a HS-GC.

3.4 Perform preventative maintenance on a HS-GC.

3.5 Understand the pharmacokinetics and pharmacodynamics of alcohol.

3.6 Understand and use retrograde extrapolations and the Widmark Equation.

3.7 Know and understand Laboratory and Section policies and procedures governing evidence handling, note taking, and report writing.

3.8 Know and understand the concerns related to storage of blood alcohol samples.

3.9 Know and understand NC General Statues relating to Blood Alcohol Concentration Analysis.

3.10 Provide expert witness testimony, which includes the presentation of Forensic Alcohol analysis and the defense of analytical conclusions.

3.11 Successfully complete a competency exam.

3.12 Successfully complete a written exam for each section.

3.13 Successfully complete a moot court.

3.14 Obtain a Permit to Perform Chemical Analysis of Blood issued by NCDHHS.

4.0 Procedure

4.1 Training of Experienced Forensic Scientist - In the event a Forensic Scientist with previous training and/or experience in forensic alcohol analysis is hired, the Toxicology Technical Leader shall assess the Forensic Scientist's knowledge, skill, and abilities based on any written training documentation provided by the Forensic Scientist's previous employer. The design of the Forensic Scientist's training program will be based on the Toxicology Technical Leader's assessment.

4.2 Head-Space Gas Chromatography- This section is comprised of the following sub-sections: Sample Preparation and Analysis and Instrumental Theory. There is a list of assigned readings and a required written examination.

4.2.1 Sample Preparation and Analysis

4.2.1.1 The trainee shall read and understand the applicable sections of the Technical Procedure for General Laboratory Equipment and the Technical Procedure for Headspace Gas Chromatography to Quantitate and Identify Volatiles in Liquids.

4.2.1.2 The Toxicology Training Coordinator or designee shall review and discuss with the trainee the applicable sections of the Technical Procedure for General Laboratory Equipment and the Technical Procedure for Headspace Gas Chromatography to Quantitate and Identify Volatiles in Liquids.

4.2.1.3 The Toxicology Training Coordinator or designee shall provide information to the trainee on how to perform the calibration check of the liquid handling systems.

4.2.1.4 The Toxicology Training Coordinator or designee shall provide information to the trainee on how to document the calibration check of the liquid handling systems.

4.2.1.5 The trainee shall successfully perform a calibration check of all Toxicology Liquid Handling Systems in accordance with the Technical Procedure for General Laboratory Equipment.

4.2.1.6 The Toxicology Training Coordinator or designee shall provide information to the trainee on how to prepare all types of samples for blood alcohol analysis using the liquid handling systems.

4.2.1.7 The Toxicology Training Coordinator or designee shall provide information to the trainee on the quality control solutions used throughout the blood alcohol analysis.

4.2.1.8 The Toxicology Training Coordinator or designee shall provide information to the trainee on the documentation required when performing a blood alcohol analysis.

4.2.1.9 The trainee shall observe blood/urine alcohol sample preparation and analysis performed by the Toxicology Training Coordinator or designee.

4.2.1.10 The trainee shall observe alcoholic beverage analysis and analysis for other volatiles performed by the Toxicology Training Coordinator or designee.

4.2.1.11 The trainee shall observe and perform preventative maintenance on a HS-GC with the Toxicology Training Coordinator or designee.

4.2.1.12 The Toxicology Training Coordinator or designee shall familiarize the trainee with the operation and settings of the HS-GC instruments used in the Toxicology Unit.

4.2.1.13 The trainee shall successfully prepare and analyze all the required blood alcohol daily system check samples in accordance with the Technical Procedure for General Laboratory Equipment and the Technical Procedure for Headspace Gas Chromatography to Quantitate and Identify Volatiles in Liquids.

4.2.1.14 The trainee shall successfully prepare and analyze all the required blood alcohol calibration and verification samples and the required documentation in accordance with the Technical Procedure for General Laboratory Equipment and the Technical Procedure for Headspace Gas Chromatography to Quantitate and Identify Volatiles in Liquids.

4.2.1.15 The trainee shall successfully prepare and analyze 50 practice blood/urine alcohol samples in replicate and the required documentation in accordance with the Technical Procedure for General Laboratory Equipment and the Technical Procedure for Headspace Gas Chromatography to Quantitate and Identify Volatiles in Liquids.

4.2.1.16 The trainee shall successfully prepare and analyze alcoholic beverage samples and blood samples containing other volatiles along with the required documentation in accordance with the Technical Procedure for General Laboratory Equipment and the Technical Procedure for Headspace Gas Chromatography to Quantitate and Identify Volatiles in Liquids.

4.2.2 Instrumental Theory

4.2.2.1 The trainee shall attend a lecture, given by the Toxicology Training Coordinator or designee, on Head-Space Gas Chromatographic theory and on how it relates to the approved Laboratory analytical procedure.

4.2.2.2 The trainee shall demonstrate understanding of HS-GC theory by giving a ten minute oral presentation to the Toxicology Training Coordinator.

4.2.2.3 The trainee shall complete all required reading assignments for this block of training.

4.2.3 Required Readings

4.2.3.1 McNair and Bonelli. *Basic Gas Chromatography*, Varian Instruments: 1969.

4.2.3.2 Hewlett Packard/Agilent Technologies. *GC MSD ChemStation and Instrument Operation Student Manual, Vol. I & II, (Manual Part Number H4043-90000)*. Hewlett Packard: April 1997.

4.2.3.3 Garriott, James (Ed.). *Garriott's Medicolegal Aspects of Alcohol*. 5th ed. Tucson, AZ: Lawyers & Judges Publishing Company, Inc., 2008. Chapter 8-9.

4.2.3.4 Moffat, A. C., Osselton, M. D., Widdop, B. (Eds.). *Clarke's Analysis of Drugs and Poisons.* 3rd ed. London, England: Pharmaceutical Press, 2004. Chapter 28.

4.2.3.5 Brown, Daniel and Long, Christopher. "Quality Control in Blood Alcohol Analysis: Simultaneous Quantitation and Confirmation." Journal of Analytical Toxicology. 1988. 12: 279-283.

4.2.3.6 Dubowski, Kurt; Gadsden, Richard; and Poklis, Alphonse. "The Stability of Ethanol in Human Whole Blood Controls: An Interlaboratory Evaluation." Journal of Analytical Toxicology. 1997. 21: 486-491.

4.2.3.7 Macchia, T., Mancinelli, R., et al. "Ethanol in Biological Fluids: Headspace GC Measurement". Journal of Analytical Toxicology. 1995. 19. 241-246.

4.2.3.8 Levine, Barry (Ed.). *Principles of Forensic Toxicology*. 3rd ed. Washington DC: AACC Press, 2010. Chapter 7.

4.3 Written Examination One

4.3.1 The trainee shall complete a written examination covering all the material in the Head-Space Gas Chromatography Section with a minimum score of 85 %.

4.4 Alcohol Pharmacology – This section is comprised of the following sub-sections: Pharmacodynamics, Pharmacokinetics, Retrograde Extrapolations, and Measurement Uncertainty. There is a list of assigned readings and a required written examination.

4.4.1 The trainee shall complete all of the required reading assignments for this block of training.

4.4.2 Pharmacodynamics

4.4.2.1 The trainee shall attend a lecture, given by the Toxicology Training Coordinator or designee, on Alcohol Pharmacodynamics and how it relates to driving impairment and the results of the analyses performed at the North Carolina State Crime Laboratory.

4.4.2.2 The trainee shall demonstrate understanding of Alcohol Pharmacodynamics by giving a ten minute oral presentation to the Toxicology Training Coordinator.

4.4.3 Pharmacokinetics

4.4.3.1 The trainee shall attend a lecture, given by the Toxicology Training Coordinator or designee, on Alcohol Pharmacokinetics, that includes the following: routes of administration, absorption, distribution, metabolism, and elimination of alcohol in the human body.

4.4.3.2 The trainee shall demonstrate understanding of Alcohol Pharmacokinetics by giving a ten minute oral presentation to the Toxicology Training Coordinator.

4.4.4 Retrograde Extrapolations

4.4.4.1 The trainee shall attend a lecture, given by the Toxicology Training Coordinator or designee, on the proper use of retrograde extrapolations to include use of the Widmark equation.

4.4.4.2 The trainee shall demonstrate understanding of retrograde extrapolations by 1) performing a retrograde extrapolation based off of a scenario provided by the Toxicology Training Coordinator and 2) giving an oral presentation of the analysis.

4.4.5 Measurement Uncertainty

4.4.5.1 The trainee shall attend a lecture, given by the Toxicology Training Coordinator or designee, on uncertainty of measurement. This lecture will include a discussion of the basic concepts of uncertainty of measurement and a review of the current BAC uncertainty budget.

4.4.6 Required Readings

4.4.6.1 Garriott, James (Ed.). *Garriott's Medicolegal Aspects of Alcohol*. 5th ed. Tucson, AZ: Lawyers & Judges Publishing Company, Inc., 2008. Chapters 1-5, 11-13.

4.4.6.2 Moffat, A. C., Osselton, M. D., Widdop, B. (Eds.). *Clarke's Analysis of Drugs and Poisons.* 3rd ed. London, England: Pharmaceutical Press, 2004. Chapters 3, 15.

4.4.6.3 Ellenhorn, M., Barceloux, D.G. *Medical Toxicology: Diagnosis and Treatment of Human Poisoning*, New York, NY: Elsevier, 1988. Chapters 7, 33.

4.4.6.4 Levine, Barry (Ed.). *Principles of Forensic Toxicology*. 3rd ed. Washington DC: AACC Press, 2010. Chapter 11.

4.4.6.5 Charlebois, R.C.; Corbett, M.R.; and Wigmore, J.G. "Comparison of Ethanol concentrations in Blood, Serum, and Blood Cells for Forensic Application." Journal of Analytical Toxicology. 1996. 20: 171-178.

4.4.6.6 Cowan, Mack; Weathermon, Alvin; McCutcheon, Rod; and Oliver, Ronald. "Determination of Volume of Distribution for Ethanol in Male and Female Subjects." Journal of Analytical Toxicology. 1996. 20: 287-290.

4.4.6.7 Jones, Alan. "Disappearance Rate of Ethanol from the Blood of Human Subjects: Implications in Forensic Toxicology." Journal of Forensic Sciences. 1993. 38 (1): 104-118.

4.4.6.8 Jones, Alan. "Ethanol Distribution Ratios between Urine and Capillary Blood in Controlled Experiments and in Apprehended Drinking Drivers." Journal of Forensic Sciences. 1992: 37(1): 21-34.

4.4.6.9 Jones, Alan. "Peak Blood-Ethanol Concentration and the Time of Its Occurrence after Rapid Drinking on an Empty Stomach." Journal of Forensic Sciences. 1991. 36 (2): 376-385.

4.4.6.10 Levine, Barry and Smialek, John. "Status of Alcohol Absorption in Drinking Drivers Killed in Traffic Accidents." Journal of Forensic Sciences. 2002. 47(2).

4.4.6.11 Winek, Charles and Carfagna, Mark. "Comparison of Plasma, Serum, and Whole Blood Ethanol Concentrations." Journal of Analytical Toxicology. 1987. 11: 267-268.

4.4.6.12 Barnhill, Matthew; Herbert, Donald; and Wells, David. "Comparison of Hospital Laboratory Serum Alcohol Levels Obtained by an Enzymatic Method with Whole Blood Levels Forensically Determined by Gas Chromatography." Journal of Analytical Toxicology. 2007. 31: 23-30

4.4.6.13 Jones, Alan. "Evidence-based survey of the elimination rates of ethanol from blood with applications in forensic casework." Forensic Science International. 2010. 200: 1-20.

4.4.6.14 Posey, D. and Mozayani, A. "The Estimation of Blood Alcohol Concentration: Widmark Revisited". Forensic Science, Medicine, and Pathology. 2007. 33-39.

4.4.6.15 Borkenstein, R., et al. "The role of the drinking driver in traffic accidents: The Grand Rapids Study" Blutalkohol. 1974. 1-131.

4.4.6.16 State of NC v. Catoe

4.4.6.17 North Carolina State Crime Laboratory Uncertainty Budget for the Quantitation of Ethanol, Methanol, Isopropanol, and Acetone using Headspace Gas Chromatography.

4.4.6.18 Bell, S. "A Beginner's Guide to Uncertainty of Measurement" Measurement Good Practice Guide No 11. 1999. 1-41.

4.5 Written Examination Two

4.5.1 The trainee shall complete a written examination covering all material in the Alcohol Pharmacology Section with a minimum score of 85 %.

4.6 Evidence Handling, Notes, and Report Writing

4.6.1 The trainee shall read and understand the SCL Evidence Guide, Procedure for Evidence Management and the Procedure for Toxicology Evidence Handling.

4.6.2 The trainee shall attend a lecture, given by the Toxicology Training Coordinator or designee, on Laboratory and Section Procedures related to evidence entry and handling.

4.6.3 The trainee shall read and understand the following Evidence Control Unit procedures: Data Entry, Evidence Requirements, Evidence Submissions, and Evidence Transfers.

4.6.4 The trainee shall observe the receipt of evidence into the SCL and witness the application of the Evidence Control Unit procedures regarding the submission, receipt, entry, and storage of toxicology evidence.

4.6.5 The trainee shall review and discuss, with the Toxicology Training Coordinator or designee, the proper way to document notes and generate reports in FA for the types of analysis covered in this training procedure.

4.6.6 The trainee shall observe the Toxicology Training Coordinator or designee document notes and generate reports for cases involving alcohol or volatile analysis.

4.6.7 Required Reading

4.6.7.1 Chang, Randall; Smith, Wanda; Walkin, Elisabeth; and Reynolds, Philip. "The Stability of Ethyl Alcohol in Forensic Blood Specimens." Journal of Analytical Toxicology. 1984. 8: 66-67.

4.6.7.2 Penetar, D., et al. "Comparison among Plasma, Serum, and Whole Blood Ethanol Concentrations: Impact of Storage Conditions on Collection Tubes". Journal of Analytical Toxicology. 2008. 32: 505-510.

4.6.7.3 Zittel, D. and Hardin, G. "Comparison of Blood Ethanol Concentrations in Samples Simultaneously Collected into Expired and Unexpired Venipuncture Tubes". Journal of Analytical Toxicology. 2006. 30: 317-318.

4.7 Quality Assurance/Quality Control

4.7.1 The trainee shall meet with the Quality Manager or designee of the Crime Laboratory for a session on accreditation, audits, and inspections.

4.7.2 The trainee shall read and understand the SCL Quality Manual.

4.7.3 The trainee shall read and understand the Toxicology unit procedure Toxicology Quality Assurance.

4.7.4 The Toxicology Training Coordinator or designee shall review and discuss with the trainee the applicable sections of the Toxicology unit procedure Toxicology Quality Assurance.

4.8 Courtroom Testimony

4.8.1 The trainee shall read and understand the SCL Procedure for Court Orders and Discovery Requests and the Policy on Ethics and Conduct.

4.8.2 The trainee shall attend a lecture, provided by SCL Legal Staff, covering the court system, working with attorneys, courtroom demeanor, and ethical practices.

4.8.3 The trainee shall complete all assigned readings.

4.8.4 The trainee shall attend a lecture, given by the Toxicology Training Coordinator or designee, covering common challenges to blood alcohol analysis.

4.8.5 The trainee shall complete a practice moot court to demonstrate knowledge and ability to defend casework in court.

4.8.6 Required Readings

4.8.6.1 Garriott, James (Ed.). *Garriott's Medicolegal Aspects of Alcohol*. 5th ed. Tucson, AZ: Lawyers & Judges Publishing Company, Inc., 2008. Chapters 14-16.

4.8.6.2 Chang, Joyce and Kollman, Elliot. "The Effect of Temperature on the Formation of Ethanol by Candida Albicans in Blood." Journal of Forensic Sciences. 1989. 34 (1): 105-109.

4.8.6.3 Jones, Alan; Hylen, L.; Svensson, E.; and Helander, A. "Storage of Specimens at 4°C or Addition of Sodium Fluoride (1%) Prevents Formation of Ethanol in Urine Inoculated with Candida albicans." Journal of Analytical Toxicology. 1999. 23: 333-336.

4.8.6.4 Chapter 20 of the North Carolina General Statues

4.8.6.5 Amick, G. and Habben, K. "Inhibition of Ethanol Production by *Saccharomyces cerevisiae* in Human Blood by Sodium Fluoride". Journal of Forensic Sciences. 1997. 42: 690-692.

4.8.6.6 Sulkowski, H. A., Wu, A., and McCarter, Y. "In-vitro Production of Ethanol in Urine by Fermentation". Journal of Forensic Sciences. 1995. 40: 990-692.

4.8.6.7 Logan, B. and Jones, A. W. "Endogenous Ethanol 'Auto-Brewery Syndrome' as a Drunk-Driving Defence Challenge". Medicine, Science, and the Law. 2000. 3: 206-215.

4.8.6.8 Miller, B.A. et al. "Absence of salting-out effects in forensic blood alcohol determination at various concentrations of sodium fluoride using semi-automated headspace gas chromatography". Science & Justice. 2004. 44:73-76.

4.9 Written Examination Three

4.9.1 The trainee shall complete a written examination covering the material in the Evidence Handling, Notes, and Report Writing section, Quality Assurance/Quality Control section and the Courtroom Testimony section with a minimum score of 85 %.

4.10 Competency Test – The trainee shall successfully analyze and report at least five competency tests. Competency tests may include blood, alcoholic beverage analysis, and/or other volatiles.

4.11 Moot Court – The trainee shall successfully complete a moot court by achieving a satisfactory rating for all categories as documented by the Toxicology Training Coordinator in the SCL Moot Court Evaluation.

5.0 References

5.1 North Carolina State Crime Laboratory Lab-Wide Procedures

5.2 Drug Chemistry-Toxicology Unit Administrative and Technical Procedures

5.3 Garriott, James (Ed.). *Garriott's Medicolegal Aspects of Alcohol*. 5th ed. Tucson, AZ: Lawyers & Judges Publishing Company, Inc., 2008.

5.4 Moffat, A. C., Osselton, M. D., Widdop, B. (Eds.). *Clarke's Analysis of Drugs and Poisons*. 3rd ed. London, England: Pharmaceutical Press, 2004.

5.5 Levine, Barry (Ed.). *Principles of Forensic Toxicology*. 3rd ed. Washington DC: AACC Press, 2010.

6.0 Records

Toxicology Blood Alcohol Concentration Training Checklist.

Training Section Completion Summary

7.0 Attachments – N/A

Revision History		
Effective Date	Version Number	Reason
06/19/2015	1	Original Document