CHAPTER 12

SCIENTIFIC EVIDENCE

12.1 GENERALLY

It is important to have a basic understanding of how alcohol affects humans in order to understand issues related to the scientific evidence that may be introduced at trial.

Ethyl alcohol is the chemical name for the type of alcohol that humans consume. Patrick Harding, *Alcohol Toxicology for Prosecutors: Targeting Hardcore Impaired Drivers,* AMERICAN PROSECUTOR'S RESEARCH INSTITUTE, July 2003, at 5. Ethyl alcohol is a small, water-soluble molecule. As ethyl alcohol travels through the body it is absorbed and distributed by the blood to all of the water-containing parts of the body. The body eliminates ethyl alcohol through metabolism, excretion and evaporation. The measured

alcohol concentration of an individual is based on an interaction of these physiological processes. *Id.*

Note: This section reprinted with permission of the Phoenix City, Arizona prosecutor's office and is intended as general reference regarding the science of intoxication.

12.2 THREE PHASES

The human body cycles through three phases after alcohol is consumed. Those phases are absorption, peak, and elimination.

In order to more accurately relate an alcohol concentration back to the time of driving, it may be necessary to determine which phase the defendant was in at both the time of the test and at the time of driving. Obviously, if the defendant was in the absorption phase at the time of driving and in the peak phase at the time of the test, the test result will be higher than the alcohol concentration at the time the driving occurred.

12.2.1 ABSORPTION

Absorption, the first phase, occurs when the consumed alcohol is in the stomach and the small intestine. The blood vessels in the lining of the stomach and small intestine absorb the alcohol. This process continues until no alcohol remains to be absorbed. A defendant in this phase is commonly described as being "on the way up" because the alcohol will increasingly effect an individual in the absorption phase. The alcohol concentration also will increase throughout this phase.

The rate at which a person absorbs alcohol will depend on a number of factors. One of the most significant factors is stomach content. If a heavy or full meal has been consumed recently, the absorption rate will be slower because the food is also being broken down and absorbed. If the stomach is empty, the absorption rate will be faster because alcohol is the only content being absorbed. An accepted absorption time for a full stomach is sixty to ninety minutes. An accepted absorption time for an empty stomach is thirty to forty-five minutes. These times mean that if no other alcohol is consumed, it will take approximately that amount of time for the stomach alcohol to be completely absorbed.

12.2.2 PEAK

The second phase is commonly referred to as the peak phase. During the peak phase the rate alcohol is absorbed and eliminated are equal, or in equilibrium. During this phase a person achieves the highest alcohol concentration and therefore the greatest level of impairment. At this time, most of the alcohol ingested has been absorbed, and the alcohol concentration levels off.

12.2.3 ELIMINATION

The third and final phase is the elimination phase. This is also called the post-absorptive phase. As the body begins to absorb alcohol, the body also begins to eliminate alcohol. After the body peaks, all alcohol has been absorbed and the body will only eliminate alcohol. An individual in this phase is commonly referred to as being "on the way down." As the effects of alcohol and alcohol concentration decrease, the person is often described as "sobering up."
Most of the alcohol is eliminated by the liver. A variety of other bodily functions assist in the elimination of alcohol, including perspiration, urination, and breathing. The elimination rate can also vary from person to person. Generally elimination rates range from 0.015 – 0.018 alcohol concentration per hour. Patrick Harding, *Alcohol Toxicology for Prosecutors: Targeting Hardcore Impaired Drivers,* AMERICAN PROSECUTOR'S RESEARCH INSTITUTE, July 2003, at 16.

12.3 RELATION BACK OF ALCOHOL CONCENTRATION: IN GENERAL

The relation back of alcohol concentration is a calculation that establishes the probable alcohol concentration, or range of alcohol concentrations, at the time of driving based on a subsequent breath or blood test.

A relation back calculation can be useful to a prosecutor to establish that the defendant had a higher alcohol concentration at the time of driving than at the time of the test.

12.4 RELATION BACK METHODS

The methods for *relating back* an alcohol concentration can be divided into two broad categories:

1. methods that result in numerical results derived from a mathematical manipulation of the measured alcohol concentration; and
2. methods which circumstantially establish a person's alcohol concentration to be 0.08 or greater, independent of the measured alcohol concentration.

The first method (mathematical manipulation) is further subdivided into two categories: *retrograde extrapolation and subtractive retrograde*.
The second method (circumstantial) is further subdivided into three categories: *circumstantial retrograde, physical symptoms, and horizontal gaze nystagmus.*

12.4.1 RETROGRADE EXTRAPOLATION

Retrograde extrapolation, despite its name, is a simple concept based on the scientific principle that humans eliminate alcohol from the bloodstream at a generally accepted rate of at least a 0.015 alcohol concentration per hour. Assuming that a subject has attained the highest alcohol concentration at or prior to the time of driving, any subsequent test will be subject to the elimination of alcohol at the rate of 0.015 per hour and, thus, will be lower. To "extrapolate" back to the time of driving, one merely compensates for the alcohol eliminated by multiplying the elimination rate by the number of hours intervening between the driving and the test. This type of relation back will yield the alcohol concentration of the defendant had the chemical test been administered at the time of driving:

> **Reading + (0.015 x number of hours from time of driving to time of test) = alcohol concentration at time of driving.**

Example: Assume an alcohol concentration of 0.12, three hours after driving, and the defendant's alcohol concentration peaked at or before driving:
0.12 + (0.015 x 3 hours) = 0.165
Unfortunately, a simple retrograde extrapolation cannot be done unless the defendant has attained the highest alcohol concentration (peak) at or before the time of driving. Generally, that means that the defendant must not have

consumed any alcohol within thirty to forty-five minutes of driving if the stomach is empty or within sixty to ninety minutes if the stomach is full. Often, a defendant will literally be drinking and driving or no information will be available to establish the necessary drinking history.

Stomach contents may effect the duration of the peak, but no the time it takes to reach the peak. Regardless of stomach contents, alcohol concentration will peak (not increase) within forty-five to fifty minutes of the last drink. The duration of the peak (where alcohol concentration neither increases nor decreases on average) may be affected by stomach contents. The use of the thirty to forty-five minutes for peak absorption with an empty stomach and sixty to ninety minutes for a full stomach for peak absorption should be taken to mean the point at which alcohol concentration enters the elimination curve, that is, when alcohol concentration decreases over time.

12.4.2 SUBTRACTIVE RETROGRADE

A subtractive retrograde is a method to compensate for the alcohol consumed during the thirty to forty-five minutes prior to the driving in the case of the defendant with an empty stomach, or during the sixty to ninety minutes prior to driving in the case of a defendant with a full stomach. This type of relation back will usually underestimate the defendant's alcohol concentration. It is based on the scientific principle that the alcohol contribution of a drink can be determined by reference to the subject's weight. The total contribution of a drink consumed at a time in which it might not have been totally absorbed at the time of driving can be *subtracted* from the measured alcohol concentration at the time of the test. This type of relation back requires information concerning the drinking experience of the defendant during the critical period. If the defendant refuses to answer questions posed by the arresting officer, or has been incapacitated, the necessary information may be unavailable.
The formula employed in determining the alcohol contribution of a standard twelve ounce beer (or a one ounce shot of 100 proof alcohol) to a person of known weight is as follows:

$$\frac{150 \times 0.025}{\text{Defendant's weight}}$$

Example: Assume that defendant's weight is 180 pounds:
150 x 0.025 = 0.020 A.C. per drink

180 pounds
To determine the minimum alcohol concentration possible, assuming none of the drinks consumed in the critical period was absorbed, the following formula is employed:

[Reading + (0.015 x number of hours from time of driving to time of test)] - [Alcohol contribution of each drink x drinks consumed in the critical period]

Example: Assume an alcohol concentration of 0.21 two hours after driving, and the defendant's weight of 150 pounds and only one drink was consumed within forty-five minutes of driving. The defendant had an empty stomach:
(0.21 + 0.03) - (0.025 x 1 drink) = 0.215

An example of the use of the subtractive retrograde can be found in *State v. Garcia*, 165 Ariz. 547, 799 P.2d 888 (App. 1990).

12.4.3 CIRCUMSTANTIAL RETROGRADE

Relation back evidence can include circumstantial evidence to demonstrate the unlikelihood that te defendant was under .08 alcohol concentration at the time driving. In *State v. White*, 155 Ariz. 452, 455-56, 747 P.2d 613, 616-17 (App. 1987), the court noted:

The formula used to determine the number of standard drinks (twelve ounce beers or one ounce 100 proof shots) that would have to be unabsorbed in the defendant's stomach to have the defendant under 0.08 at the time of driving, but result in the measured reading, is as follows:

Reading + (0.015 x number of hours from time of driving to time of test) - 0.079 Alcohol contribution of each drink

Example: Assume the defendant has a weight of 150 pounds, and an alcohol concentration of 0.21. Assume the test was given two hours after driving.

$$0.21 + (0.015 \times 2) - 0.079 = 6.44$$
$$0.025$$

The Utah courts have not ruled on this method, but the Arizona Court of Appeals approved of the use of a circumstantial retrograde for relationship back to the time of driving and the admissibility of the breath test results in *State ex rel. McDougall v. Superior Court* (*Klemencic*, Real Party in Interest), 170 Ariz. 474, 477, 826 P.2d 337, 340 (App. 1991). Klemencic was cited for violations of former ARS §§ 28-692(A) and (B), having registered a 0.22 alcohol concentration. Under the former statutes, case law required the State to relate back a reading to the time of driving before the test result was admissible. See *Desmond v. Superior Court*, 161 Ariz. 522, 779 P.2d 1261 (1989)(This interpretation applied from April 6,1989 to September 30, 1992).The trial court suppressed the reading on the defendant's motion based on the State's alleged inability to relate the reading to the time of driving. The suppression occurred despite the State's avowal that its criminalist would testify that Klemencic would have had to have consumed six and two-thirds standard sized drinks five minutes prior to driving to be at or below 0.10 alcohol concentration at the time of driving. The court of appeals reversed the suppression.

12.4.4 PHYSICAL SYMPTOMS AS CIRCUMSTANTIAL EVIDENCE OF RELATION BACK

Symptoms of intoxication observed at the time of the stop may constitute circumstantial relation back evidence:

Evidence that at that time [of arrest] the person charged smelled strongly of alcohol, was unable to stand without help, suffered from nausea, dizziness or any of the other “symptoms” of intoxication would justify an inference that a test administered some time after arrest probably produced lower readings than that which would have been produced had the test been administered at the moment of arrest.

Likewise evidence including defendant’s erratic driving, bloodshot and watery eyes, odor of alcohol, slurred speech, failed field sobriety tests and difficulty exiting his vehicle may be sufficient to corroborate breath test evidence for establishing that a defendant’s alcohol concentration was at or above the per se limit at the time of driving.

12.5 ADMISSIBILITY OF EVIDENCE BASED ON MEASURED ALCOHOL CONCENTRATION

It is frequently useful to be able to establish the minimum number of drinks consumed based on a measured alcohol concentration. This evidence often impeaches the defendant's reported drinking history (e.g., "two beers").
The formula for determining the minimum number of drinks consumed for a given alcohol concentration (AC) is as follows:

AC
150 x 0.25
weight = # of drinks

Note that the minimum number of drinks consumed is actually the number of drinks fully absorbed but not yet eliminated at the time of the test.

> **Example**: Assume defendant's weight is 180 pounds and that the defendant had an alcohol concentration of 0.24:
> 0.24
> (150 x 0.025) = 11.5 drinks
> 180

Once the minimum number of drinks has been established by expert testimony, the prosecutor may want to have the expert corroborate the signs and symptoms of impairment which were observed by the officer(s), subject to the parameters of tolerance.

Finally, the State may chose to introduce as rebuttal evidence the minimum number of drinks consumed based on the highest alcohol concentration measured. This would be in response to either an attack on the officer's credibility about observed impairment, or to rebut the defendant's claim of drinking less than is scientifically reasonable. Of course the above formula only gives the minimum number of standard drinks in the defendant's system at the time of the test.

If the defendant also gives a drinking history (when drinking began and ended), a criminalist should be able to calculate the total number of drinks that were consumed during the drinking period to achieve the measured amount of alcohol at a time significantly later than the stop drinking time. The total number of drinks that were consumed will greatly exceed the number of

drinks the defendant admitted to the arresting officer, or that was testified to during the defense case.

12.6 BLOOD TO BREATH RATIO

All breath tests rely on a law of physical chemistry first described by William Henry in 1803 as their foundational principle. Henry's Law may be stated as follows:

> The concentration of any volatile substance dissolved in a liquid is directly proportional to the vapor pressure that the volatile substance exerts above the liquid.

Although Henry's work was not concerned with alcohol at the time, his law should be applicable since alcohol is a volatile substance at body temperature and it dissolves readily in blood and other body fluids.

Alcohol has been found to rapidly proportion itself between the breath in depths of the lungs and the blood. This equilibrium between alcohol in the blood and alcohol imparted to the alveolar breath can be expressed in the form of a ratio. For human beings, the operational ratio for the amount of alcohol in a given volume of blood and breath delivered at the mouth is 2100:1. This means that whatever the concentration of alcohol might be in the blood, the concentration in an alveolar breath sample would be 1/2100th as much.

In 1972, a select international group met at Indianapolis, Indiana, and reconsidered the value of the ratio. As a result of that meeting the 2100:1 value was reaffirmed. The 2100:1 ratio still stands, although still under attack by critics. This ratio has been incorporated into the regulations for approval of quantitative breath testing instruments in many states, including Arizona. Additionally, all instruments developed and federally approved are based on this value.

12.7 ALVEOLAR AIR

NOTE: This discussion relates to Frye hearings held in Arizona and is useful when responding to cross-examination and argument from defense counsel who will argue the validity of the intoxilizer 5000.

The methodology used by the Intoxilyzer 5000 to test alveolar (deep lung) air is both an adequate method of measuring alveolar air, and generally accepted in the scientific community. *State v. Esser*, 205 Ariz. 320, 70 P.3d 449 (App. 2003), *rev. denied*. In *Esser*, the defense questioned the underlying theory of respiratory physiology used in alcohol breath testing. The motion "was based on the conclusions of Dr. Michael P. Hlastala, an expert in pulmonary physiology who testified for the defense about alcohol breath tests, and on a Department of Health Services (DHS) regulation that requires breath specimens to be 'alveolar in composition.'" *Id.* at 322, 70 P.3d at 451 (citing Ariz. Admin. Code R9-14-403(B)(1)). Hlastala described an old paradigm in which the alcohol concentration from the exhaled air was initially expected to be very low, then rise as the exhalation incorporates alveolar air and then finally levels out at equilibrium when the exhalation consists of only alveolar air., He described this as the 'alveolar plateau'. *Id.* at 322, 70 P.3d at 451. Hlastala's novel premise is that the alveolar plateau does not exist. His testimony, based on his own research and that of others, was that breath exhaled from the alveolar region shows a gradual, almost linear increase in alcohol concentration which only levels off at the end of the breath. Hlastala also testified "that breath test results can be significantly altered by pretest breathing patterns such as hyperventilation and holding one's breath, anomalies that could not be explained by the old paradigm." The key points of Hlastala's view were summarized by the court as "(1) no significant alcohol is exchanged between the blood and the breath in the alveoli, and (2) the alcohol that is detected by breath-testing devices has not been exchanged in the alveoli, but in the airways via the mucous-bearing tissues found therein." *Id.* at 323, 70 P.3d at 452. Thus, the defense argued the Intoxilyzer 5000 does not and cannot test alveolar air.

The relevant statutes and regulations do not define "alveolar air." However, the court did not accept Hlastala's new definition of alveolar air as "unchanged air from the alveoli," because, assuming Hlastala's paradigm is

correct, to do so would render R9-14-403(B)(1) inoperative. The court instead chose to define alveolar air as "air exhaled from the alveoli." *Id.* The court found this definition to be more appropriate since it would accommodate both the old paradigm and Hlastala's paradigm. Thus, the court found that the Intoxilyzer 5000 does test samples that are 'alveolar in composition.' *Id.* at 324, 70 P.3d at 453.

The *Esser* Court placed the burden on the defense to prove their novel theory that breath testing no longer met the *Frye* standard for admission of scientific evidence. See *Frye v. United States*, 293 F. 1013 (D.C.Cir.1923). The court stated:

> Under *Frye*, the admissibility of novel scientific evidence depends on whether the evidence is derived from a scientific theory or principle that has achieved general acceptance in the relevant scientific community. Arizona follows the *Frye* doctrine. And, as the trial court noted in denying this claim, alcohol breath testing has been found to be generally accepted in the scientific community, thus relieving the state from proving its general acceptance in every prosecution. Accordingly, it was incumbent upon the defense, in challenging evidence as inadmissible under *Frye*, to make a preliminary showing that alcohol breath testing is no longer accorded general scientific acceptance.
> *Id.* at 323, P.3d at 452 (Citations omitted).