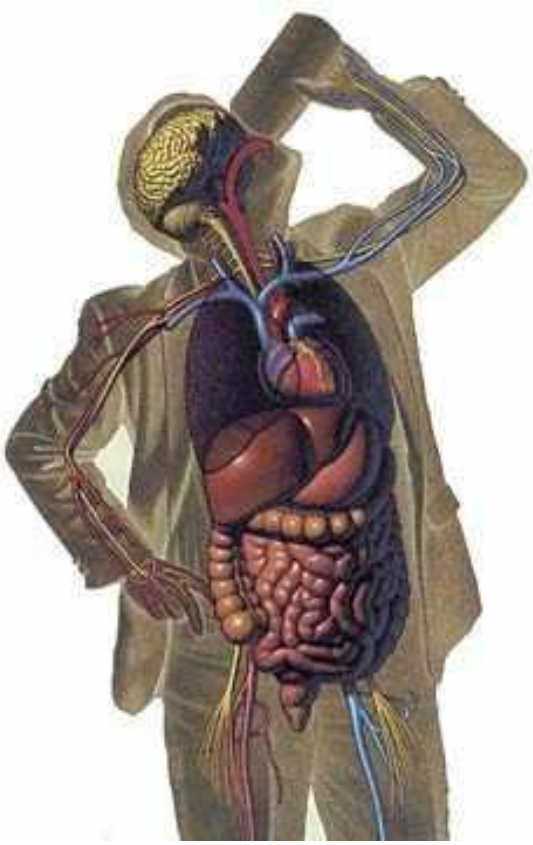
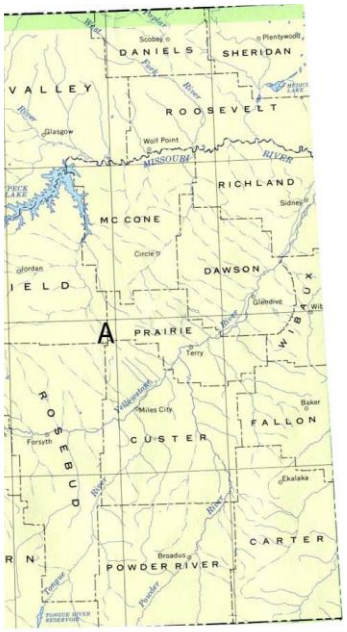
MONTANA DEPARTMENT OF JUSTICE
FORENSIC SCIENCE DIVISION





Breath Test Specialist Operator / Training Manual

Perpetuo Adfla Dum IuBium Te Desinere

Montana Breath Test Specialist Certification Course Manual

Purpose of BTS Manual

This document is intended to serve as a basic reference text to reinforce and supplement the subject material presented in class. As selected topics are introduced in class, the conscientious trainee will do well to review relevant portions of this document, as well as notes and study guide materials taken in class. The trainee should always bring this document or manual to each class section, as certain exhibits herein will be referred to during the course of instruction.

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Forward

"Man has devoted more talent to developing exciting flavors and aromas for his alcoholic beverages than for any other class of food or drink. Since important and basic needs of man, which include social success, the appreciation of good food, and the expeditious relief from life's vicissitudes, are so admirably assisted by alcoholic beverages, it is not surprising that the majority of the population use them to some degree."

Robert B. Forney
Professor Emeritus
Indiana University
School of Medicine

This passage from Dr. Forney's book "The combined Effects of Ethanol and Other Drugs", 1968, succinctly describes why people use alcohol. Alcohol is responsible for more happiness and more misery throughout history than any other drug. Even with increasing use of cocaine, crack, amphetamines, marijuana and other illicit drugs, alcohol is still the most widely used and abused drug in the world. It is still the most "socially acceptable drug" in America today.

As a society we will never be totally "drug free" until people no longer need to escape the problems of day-to-day living. Our society, at best, attempts to control its drug use. The attempt to control alcohol use and today, the alcohol-impaired driver is a time-honored tradition in of our society.

This manual presents tools and information that will assist you in the identification and apprehension of the Alcohol Impaired Driver.

Ethanol

Pharmacology and Toxicology

Alcohol

Before any discussion concerning the effects of alcohol on the human body can be attempted, the chemistry of "alcohol" needs to be explored.

The term alcohol is generic term for a specific class of chemical compounds. All chemical compounds can be grouped into two main categories **"INORGANIC"** and **"ORGANIC."** To be organic, a compound's primary element must be Carbon (C). An organic compound that has Hydrogen (H) atoms as its major secondary element is a **HYDROCARBON**. Hydrocarbon compounds are differentiated from one another by specific **"FUNCTIONAL GROUPS".** A functional group is a combination of atoms which, when attached to a carbon atom or atoms, causes the organic compound to act in a specific manner. All alcohols are hydrocarbon derivatives with a specific functional group attached consisting of two atoms, one Oxygen (O) and one Hydrogen (H). Such a group is called a Hydroxyl Group.

Alcohol is also classified as a **HYDROPHILIC** compound meaning that it is infinitely soluble in water.

In theory there are an infinite number of alcohol compounds. The particular molecular structure of different alcohols results in each compound being absorbed and metabolized by the body into different metabolic substances. It is this difference in metabolites (resulting from the body processing the alcohol) that creates different levels of toxicity for the different compounds.

All alcohols are toxic to the body at a specific amount. If sufficient quantity of any alcohol is consumed, death will result.

The form of alcohol called **ETHANOL** will be the main focus of discussion throughout this manual. However, two other alcohols, **METHANOL** and **ISPROPANOL**, also warrant discussion since they are occasionally consumed by human beings (intentionally or unintentionally). (See Table I)

(Table 1) – Common Alcohols

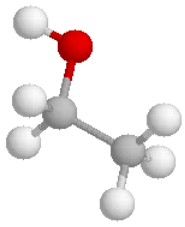
Name	Formula	Uses	Toxicity / Metabolites
Methanol (Wood Alcohol)	CH_3OH	Denaturant Solvent / Fuel Paint Remover	T =0 .075 g/210L Formic Acid
Ethanol (Grain Alcohol)	CH_3CH_2OH	Beverage Solvent/Medicinal Vehicle Fuel	T =0.400-0.450 g/210L Acetaldehyde Acetic Acid / Vinegar
Isopropanol (Rubbing Alcohol)	CH_3CHOH $\vert$ CH_3	Denaturant Solvent	T = 0.250 g/210L Acetone

Methanol

Methanol is an extremely volatile, colorless, odoriferous liquid. The chemical structure is CH_3OH. Methanol typically occurs in two types of individuals, the street derelict, and the small child. Small children usually consume methanol by accidentally drinking household cleaners and other disinfectants kept around the house. The street derelict, on the other hand, will search through trash containers for items that contain methanol. One of the major sources of methanol used to be the "sterno" containers that were used to heat food.

Methanol is extremely toxic to the human body. The metabolic byproducts (metabolites) of methanol are the reason for its toxicity. The first metabolite of methanol is methaldehyde, commonly known as formaldehyde. The body converts this to formic acid. Formic acid will quickly dissolve rods and cones in the retina, resulting in vision impairment or blindness. Buildup of formic acid results in death, by causing the kidneys to cease functioning (renal failure).

Ethanol



Ethanol is a volatile, colorless liquid, which possess an ethereal odor and produces a burning taste sensation. Ethanol is the alcohol that is contained in all alcoholic beverages. Ethanol's chemical formula is CH_3-CH_2-OH. Ethanol is not as toxic to humans as is methanol, because its metabolites generally have a lower toxicity. The first metabolite is ethaldehyde or acetaldehyde, followed by ethanoic acid (more commonly called acetic acid or vinegar).

Isopropanol

Isopropanol is a colorless liquid with a very distinct odor. The chemical formula for isopropanol is CH_3-CH-OH-CH_3. The majority of individuals who intentionally consume isopropanol are "hard core" alcoholics. Prevented from obtaining regular alcoholic beverages they resort to drinking "rubbing" alcohol, which is isopropanol. The danger of Isopropanol consumption is the metabolite acetone.

Lethal dosages are expressed by the term LD^{50}. LD^{50} stands for the dosage that would be lethal to 50% of the population if the amount ingested was within the range indicated. Some individuals can exceed this level, while others may succumb at a much lower level of the drug.

The approximate lethal dosages for the alcohols above are:

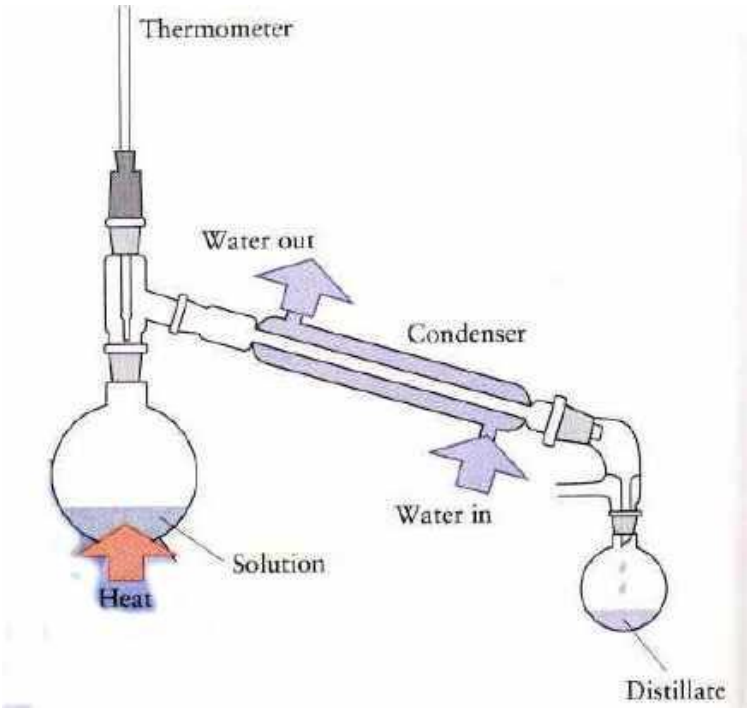
Methanol	.075 g/100ml of blood
Ethanol	.40 -.45 g/100ml of blood
Isopropanol	.25 - .35 g/100ml of blood

Alcohol Beverages

Alcohol beverages can be divided into two classifications: **"DISTILLED"** and **"NON-DISTILLED".** Non-distilled beverages are either beer or wine. Beer and wine are products of natural fermentation and receive no further processing. Natural fermentation of beer is usually carried out in a large vat or container in which a grain (such as corn, wheat, etc.) is combined with malted barley, yeast and water. The barley contains an enzyme, which converts the starch of the grain into sugar. The yeast then consumes the sugar and produces ethanol. This process continues until all of the sugar is consumed or the ethanol concentration reaches a maximum of 15%, inactivating the yeast. Fruit juice is substituted for the grain in wine and due to the high amount of sugar available in the fruit juice no malted barley is required.

Beer normally contains 3-6% ethanol by volume. When the ethanol content exceeds this level the beer must be re-labeled as "Malt Liquor" or "Ale". Wine contains between 12 and 15% ethanol. Wines exceeding this amount are known as "Fortified" wines and are produced by blending the wine with another alcohol product (normally a distilled one, such as brandy).

A distilled beverage starts out as a natural fermentation product and is then heated.



Since ethanol boils at a lower temperature than water, heating this natural fermentation product (or "Mash") causes mainly ethanol to be released in the form of a vapor. These vapors are then collected in a condensation apparatus and cooled, reforming into a liquid. The captured liquid is mostly alcohol with some water and flavors (congeners). It may be placed into charred oak barrels for aging.

The idea of aging a distilled beverage in charred oak barrels is the result of an accident. A man by the name of Reverend Elijah Craig was making a barrel for

shipping whiskey. While heating the barrel staves to form the barrel he was called away and, during his absence, the staves caught fire. Being a frugal minister, Craig decided to continue and cleaned the staves turning the burned side of the staves to the inside. Craig placed his whiskey into the barrel, capped it and left. Several months passed before he returned to the whiskey and upon opening the barrel noticed that the whiskey, which was clear when he poured it in, had changed to a beautiful amber color and the flavor had dramatically improved. Hence the method of aging in charred oak barrels was born.

During the aging process certain chemicals, called congeners, are extracted from the barrel staves, and enter the beverage. It is these congeners that give whiskeys their distinctive color and aroma. Some distilled beverages derive their particular colors and aromas from the products from which they are made, such as rum which is made from the distillation of sugar cane, gin from the distillation of the juniper berries; while others are distinct due to the manufacturing process, such as Scotch, which obtains its distinct flavor and aroma from not only the grains, but from the original usage of peat as the fuel for the distillation process. Fermented fruit juices, when distilled, produce brandies and cognacs. Distilled beverages normally have an ethanol concentration of 40 - 50% by volume.

Proof vs. Percent

In the United States all distilled beverages list their alcohol concentration under the term “PROOF”. All non-distilled beverages are labeled as “PERCENT”. The proof concentration of any beverage is twice its percent alcohol concentration. A 100-proof whiskey contains 50% alcohol; an 86-proof whiskey contains 43% alcohol and so forth. Beer is approximately 5%; therefore, its proof equivalent would be 10-proof.

The term proof derives from folklore. Prior to the process of aging in charred oak barrels, whiskey was a clear liquid. In early frontier days this meant that the seller could water down whiskey and the buyer would not be able to tell the difference visually. To ensure that the buyer was receiving a good product a simple test was developed. The buyer would mix equal parts of whiskey with black gunpowder and strike a match to it. If this mixture burned with a steady, blue flame this was “proof” that the shipment was good.

By knowing the proof or percent concentration of a beverage, one can compute the actual amount of alcohol contained in a drink or series of drinks. By taking the amount of the alcohol beverage (V) and multiplying by the percent alcohol (%) the ounces of ethanol contained in that drink is obtained.

Beer is normally 5% alcohol. To compute the amount of ethanol in one 12 ounce can of beer: V = 12 and % = 5 (which must be converted to its decimal equivalent or 0.05).

V x % = alcohol by volume

12 x 0.05 = 0.60

Therefore, one 12-ounce can of 5% beer will contain 0.60 ounces of ethanol.

To compute the amount of ethanol in 1.5 ounces of 80 proof whiskey you must first convert the proof to percent. 80 proof is equal to 40%, thus, % = 0.40 (decimal convert) and V =1.5.

$$1.5 \times 0.40 = 0.60$$

A 1.5-ounce serving of 80 proof whiskey will contain 0.60 ounces of ethanol.

To determine the amount of ethanol in a typical 5 ounce serving of wine: V = 5, wine is normally 12% or 0.12 in decimal equivalent.

$$5 \times 0.12 = 0.60$$

Therefore a 5-ounce serving of wine will contain 0.60 ounces of ethanol.

Note that a typical serving of beer, wine and 80 proof whiskey have the **same** amount of ethanol.

Alcohol Absorption

Ethanol can enter the body a number of different routes: **Oral Ingestion, Inhalation, Injection, Absorption, or Enema.**

In several different scientific studies, ethanol has never been shown to absorb through the skin with any degree of accumulation. Therefore, absorption through the skin is not a route for alcohol to enter the body.

Dosing oneself by injection of ethanol is extremely dangerous because it can produce localized, high concentrations that can damage the heart and other vital organs. It is very rare to find someone injecting ethanol.

Inhalation of ethanol, whether in vaporous form or nebulized, has not produced a significant alcohol concentration in the body.

The use of alcohol enemas has become a popular method of dosing. This dosing method is extremely dangerous because the colon is designed to absorb water from fecal material. Any ethanol introduced into the colon will combine immediately with fecal water and pass into the body through the colon. The blood absorbs ethanol entering by this route immediately and lethal levels of ethanol can be reached very rapidly.

The time-honored method of ethanol dosing is oral ingestion of an alcoholic beverage. Ethanol can be absorbed into the body in all sections of the gastro-intestinal system (**See Figure 1**). If we follow the oral ingestion route of ethanol dosing, ethanol begins to enter the blood stream immediately in the mouth cavity via absorption through the mucus membranes and the mouth. Some of the ethanol in the beverage mixes with the saliva in the mouth as well. Typically, only 1% of the ethanol in the beverage is

absorbed in the mouth cavity. Ethanol that remains in the mouth cavity is known as "RESIDUAL MOUTH ALCOHOL". This residual ethanol will disappear from the mouth cavity in 9-11 minutes from the last sip of the alcohol beverage. Because ethanol can remain in the mouth this period of time:

> **ALL INDIVIDUALS MUST BE PLACED UNDER OBSERVATION FOR AT LEAST 20 MINUTES, AND NOT ALLOWED TO EAT, DRINK, SMOKE OR TAKE ANYTHING ORALLY PRIOR TO A BREATH ANALYSIS.**

This part of the alcohol test procedure ensures there will be no claim of "RESIDUAL MOUTH ALCOHOL", or any other mouth contamination, as a defense against the result of the breath test. If the subject belches or regurgitates, the deprivation period **must** be restarted, even though recent data suggests that such an event cannot cause enough ethanol to be reintroduced from the stomach into the mouth cavity for significant interference.

Ethanol then passes from the mouth cavity into the stomach via the esophagus. Ethanol can be absorbed through the stomach lining directly into the blood stream. Ethanol is one of few substances that can pass through this protective lining. The stomach can account for approximately 10% of absorbed ethanol. Ethanol entering the stomach stimulates the production of digestive fluids, in direct proportion to the amount of ethanol introduced.

Hydrochloric acid is the primary digestive component, and this often leads to the feeling of 'heartburn' or acid stomach (the morning after). Large amounts of ethanol in the stomach lead to high acid levels that cause irritation of the stomach lining, and the stomach has two mechanisms to prevent this irritation. The stomach secretes

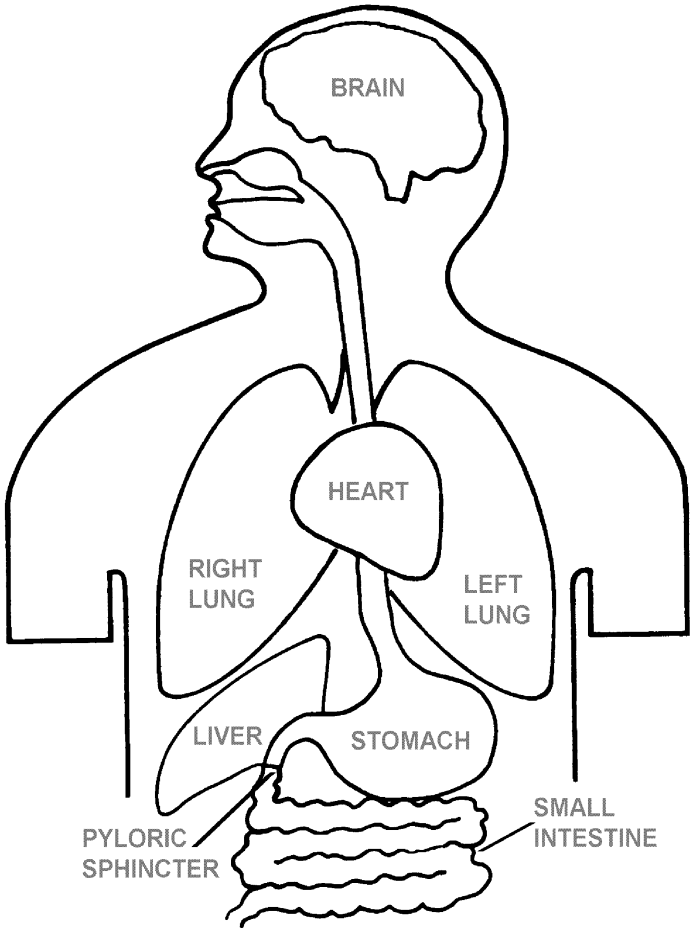


Figure 1 - The Gastro-Intestinal System of the Human Body

mucus that protects the stomach lining and reduces the absorption rate of ethanol. If the irritation continues after the mucus has been activated, an additional defense the body employs is to expel the irritant via vomiting.

The stomach processes ingested food and beverages preparing for further processing and absorption of nutrients by the SMALL INTESTINE. The pyloric sphincter controls the passageway from the stomach into the small intestine. The rate that ethanol is passed into the small intestine is greatly affected by the contents of the stomach. An alcoholic beverage alone receives little processing time in the stomach whereas food receives much greater processing time. If ethanol is mixed with food, it is delayed in its passage into the small intestine. **The most significant factor concerning ethanol absorption is the amount and type of food substance ingested with or prior to the consumption of the alcohol**. Peak ethanol concentration levels in the body differ significantly with the amount of food consumed (**See Figure 2**).

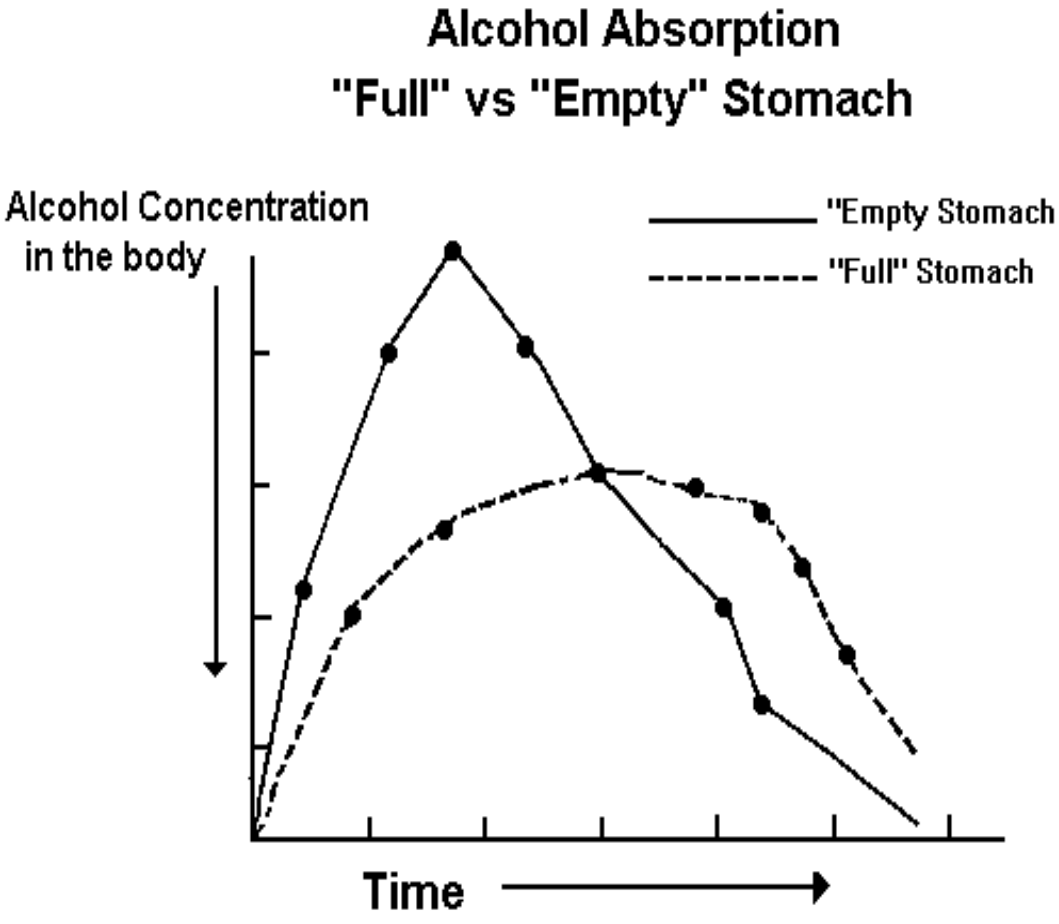
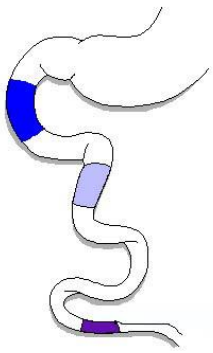


Figure 2 - Empty Vs Full Stomach Absorption Rate and Peak Alcohols

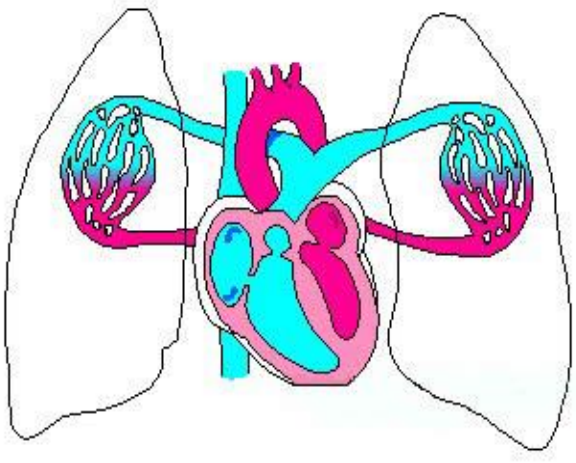


The small intestine accounts for about 80-90% of the absorption of ethanol into the body. Ethanol in the small intestine is rapidly absorbed into the blood and this process occurs in the first 10 - 12 inches of the small intestine. There are very few substances that increase the speed of this absorption. Highly carbonated beverages, such as mixers and champagne, can accelerate absorption by causing the pyloric sphincter to open and close more rapidly. Studies have shown that the human body absorbs most readily from a 20% ethanol concentration in the alcoholic beverage. The reason for this is unknown. Historically, Pharmacists take advantage of this fact by mixing medicines such as cough and cold medicines into liquids with a 20% ethanol concentration.

Alcohol Distribution

Ethanol, similar to all drugs, follows a very specific pathway of distribution once in the blood (**See Figure 3**). This absorption pathway is always the same for a given drug. Ethanol is absorbed from the small intestine into the blood stream via the "PORTAL VEIN". The portal vein transports ethanol to the "LIVER".

The "LIVER" is responsible for the metabolizing (i.e. destroying) of the ethanol. The liver contains an enzyme called the "ALCOHOL DEHYDROGENAZE" (or ADH). ADH is the mechanism of metabolizing ethanol, which is the primary means whereby ethanol is eliminated from the body. Ethanol elimination will be discussed in the next section. Ethanol not metabolized in the passage of the blood through the liver passes on to the right side of the "HEART." From the right side of the heart the ethanol is carried to the "LUNGS". The lungs process the blood flowing through them changing it from "VENOUS" to "ARTERIAL" blood.



Arterial blood is the type of blood that carries nutrients and oxygen to all sections of the body. A small amount of the ethanol entering the lungs is expelled from the body through the breath, but most of the ethanol is carried through the lungs by what is now arterial blood. The arterial blood returns to the left side of the heart and from there is distributed throughout the body along with the ethanol it is carrying. The arterial blood, and the ethanol it is carrying, flow through the "CAROTID ARTERY" and proceeds directly to the brain. Only a short period of time passes from ingestion to the time when ethanol shows up in brain tissue. Studies have demonstrated that **alcohol can be found in the brain within three minutes of the first drink of an alcoholic beverage**.

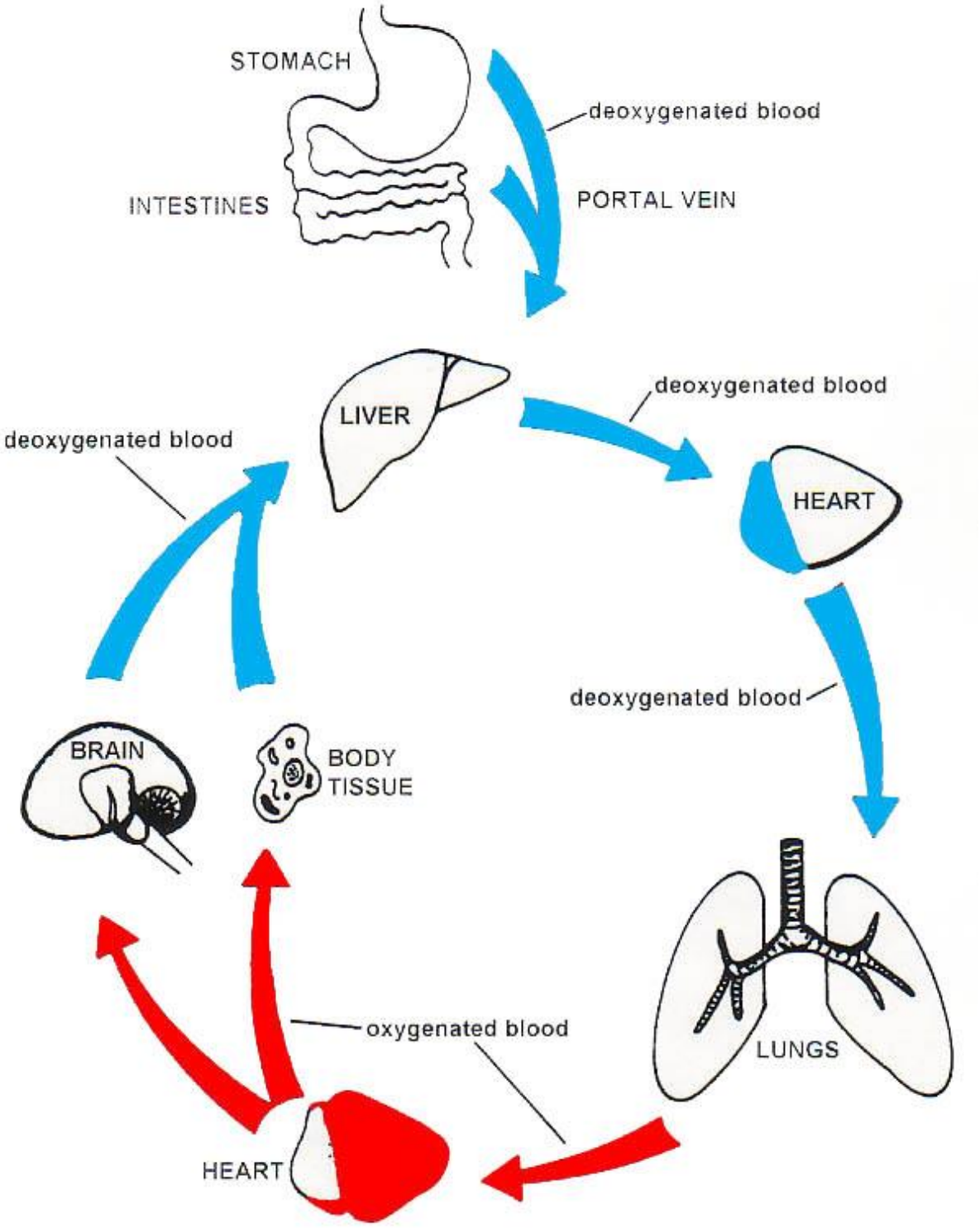
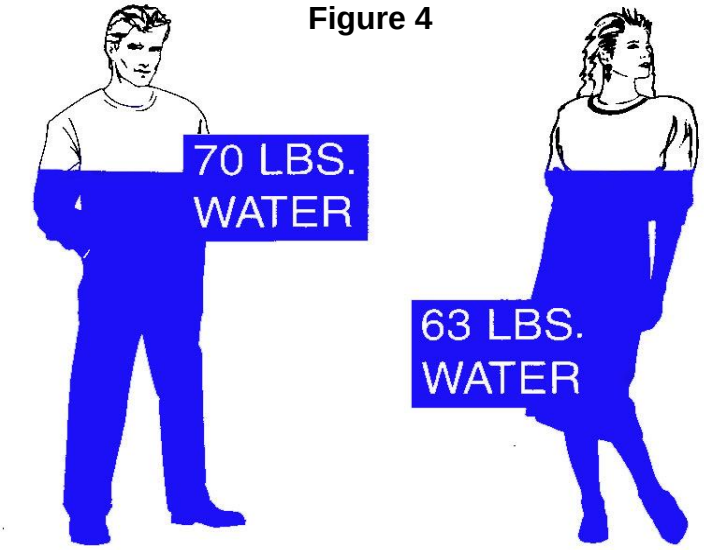


Figure 3 - The Alcohol Pathway

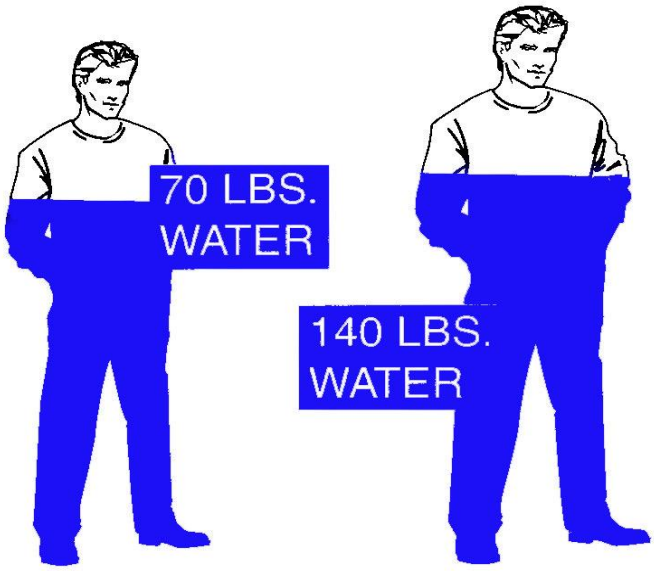
If the person continues drinking an alcoholic beverage, the level of ethanol continues to increase in body tissues. The amount of ethanol in any body tissue is directly proportional the water content of that tissue. Bone, for example, has a very low water content and, therefore, absorbs very little ethanol. The brain, however, is the organ in the body with the highest amount of water. Therefore, there will be ethanol in the brain as long as there is any ethanol circulating in the blood stream.

Since the alcohol concentration is directly proportional to the body water content, the alcohol concentration will also vary with sex and weight **(see Figure 4)**.

Figure 4



A hundred-Pound Male must drink more than a Hundred-Pound Female to reach the same BAC.



A Two Hundred-Pound Male must drink twice as much as a Hundred-Pound male to reach the same BAC.

After the person stops drinking, the body continues to absorb and distribute ethanol until a maximum saturation of the tissues occurs. This maximum saturation level is called the “PEAK ALCOHOL CONCENTRATION” (**See Figure 5**). Prior to reaching the peak, the process of absorption and distribution of ethanol is called “THE ABSORPTION or PRE-PEAK PHASE”. Some ethanol passes from the blood or other body fluids through the skin in the form of vapor. In fact, a cloud of ethanol vapor actually envelops the body during a drinking episode.

Due to the many variables associated with a drinking episode, the time when the peak alcohol concentration is reached can only be estimated. Peak alcohol most often occurs between 30 minutes to 1 hour following the last drink.

Alcohol Elimination

As soon as ethanol is absorbed by the blood stream, elimination of ethanol begins. Elimination is an ongoing process throughout the entire drinking episode. After the alcohol peaks and no more alcohol is entering the system, the individual is in “THE ELIMINATION or POST-PEAK PHASE” (**See Figure 5**). Ethanol is eliminated from the body three ways: metabolization (90-92%), excretion (1-2%) and evaporation/expiration (7-9%).

The metabolization of ethanol is caused by the “alcohol dehydrogenation enzyme”. The ADH enzyme is unique to humans and great apes, and its only function is to eliminate ethanol. For most people the amount of ADH available remains the same throughout

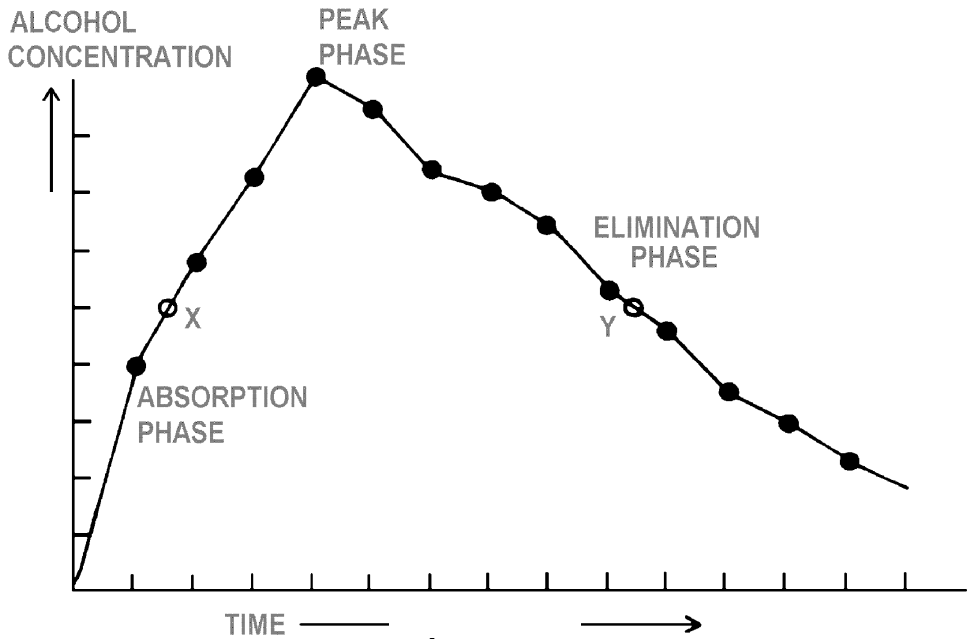


Figure 5

their lives. Studies have shown, however, that under extreme and continued alcohol stress (alcohol addiction) ADH enzyme can increase. Once the alcohol stress is eliminated, or controlled, the enzyme returns to its pre-stress levels.

Metabolization of ethanol by ADH is a chemical reaction and unaffected by the person's activity level. Exercising while drinking, for example, does not increase the elimination rate of ethanol. Increased respiration during exercise may eliminate slightly more ethanol. The increased flow of oxygen into the body during exercise may counteract the depressing effect of ethanol leaving the individual **feeling** less impaired. However, once the individual ceases exercising the depressant effect of the ethanol is quickly felt and the person ends up just as impaired as if he had remained inactive.

A small amount of ethanol is excreted through urination. The amount of ethanol in the urine is proportional, to a degree, to the amount of ethanol in the blood system. Urine is stored in the bladder for some period prior to its elimination from the body. The bladder is poorly supplied with blood and, therefore, ethanol is not reabsorbed into the blood from the urine. Urine output increases during drinking because of the increase of fluid being consumed and the natural diuretic effect of ethanol on the body.

A minute amount of ethanol is eliminated from the body through the skin, in perspiration. A greater amount is eliminated through evaporation and expiration. This phenomenon is the basis of all breath alcohol testing and is discussed in more detail in the chapter concerning Henry's Law.

The rate by which ethanol is metabolized or destroyed was initially investigated by Dr. Widmark in research conducted in Sweden during the 1930's. Dr. Widmark was able to mathematically project the rate of elimination of ethanol and established what is today known as the "WIDMARK BETA FACTOR". The Beta Factor is used as a mathematical constant when calculating ethanol elimination rates for individuals. The beta factor is an average for the entire population. Actual ethanol elimination rates vary from individual to individual. It is generally accepted that the human body eliminates ethanol at the rate 0.015% of concentration per hour. This means that a person with a 0.030% concentration will return to a 0.000% concentration in approximately 2 hours.

It is tempting to use the Widmark Beta Factor to estimate alcohol concentration in an individual at a previous time. This estimation process is called "BACK or RETROGRADE EXTROPOLATION." In back extrapolation, one attempts to determine the ethanol concentration in the person's body at a previous point in time from the current ethanol concentration. **The majority of experts feel that back extrapolation is a scientifically unsound process.**

There are many factors affecting the elimination of alcohol in an individual. A diagram of the falling ethanol concentration during the elimination phase does not produce a straight line.

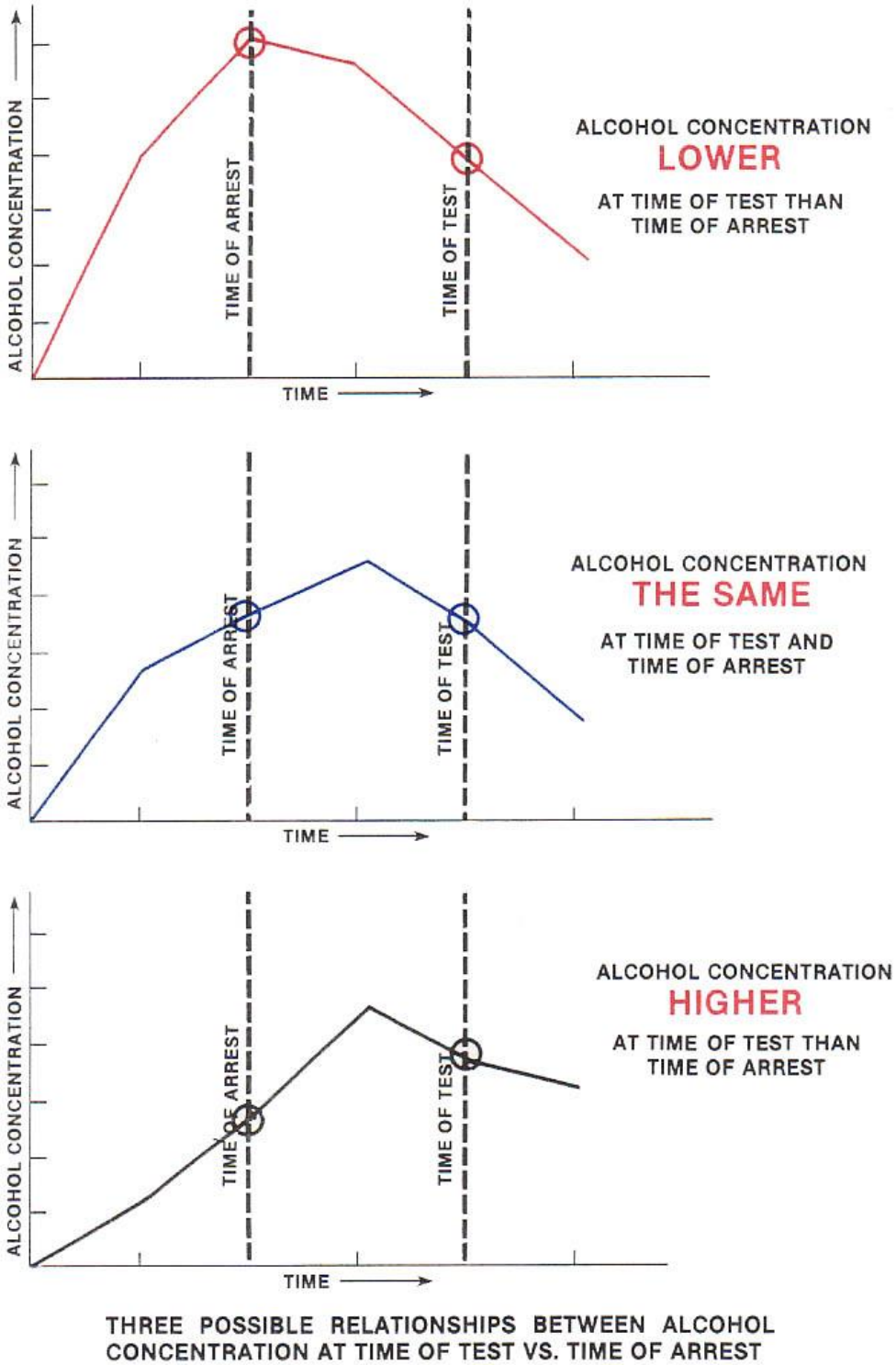
The most common reason for attempting back extrapolation is failure to get a breath or blood sample from an individual immediately after arrest or after an accident occurs. For example, a driver may have been in an accident at noon and may not have been tested for ethanol until 2:00 PM. If the result at 2:00 PM was 0.10%, back extrapolation implies that the concentration at the time of the accident was 0.13%, or the current concentration plus the 0.015% per hour elimination rate times 2 hours. **There is no scientific support for this kind of an estimate.**

There are numerous physiological factors involved in an individual ethanol concentration curve. The most critical factor is when the person reached peak ethanol concentration. Not knowing this one piece of information most likely invalidates any attempt at back extrapolation.

Using the previous example, if the individual involved in the accident had already reached peak alcohol *prior* to the accident, then the back extrapolation figure of 0.13% would be a reasonable estimate of the person's ethanol concentration at the time of the accident. As figure 6 shows however, if the person had *not yet achieved peak concentration* the back extrapolation calculation is invalid.

If the person **did not achieve "peak alcohol"** by the time of the event, but in fact reached his/her peak after the event, then the actual alcohol concentration at the time of the event may have been lower. How much lower would depend on the time at which the individual reached this peak. The closer "peak" occurred to the "time of the analysis" the lower the result would have been at "the time of the event".

The third scenario is that the individual reached his/her peak after the event, but at such a time that the result of the analysis would in fact equal the concentration at the time of the event.



THREE POSSIBLE RELATIONSHIPS BETWEEN ALCOHOL CONCENTRATION AT TIME OF TEST VS. TIME OF ARREST

Figure 6 - Three Possible Scenarios

Whenever there is an excessive delay between an event and the breath analysis or blood sample there are three possible conclusions regarding the concentration measured: (1) the individual could have had a higher concentration of ethanol at the time of the event than at the time the test was given; (2) the individual could have had a lower concentration; or (3) the individual could have had an equal concentration of ethanol at the time of the even compared to the concentration measured in the test. Without the ability to pinpoint the time of "peak alcohol", there is no scientifically reliable evidence (**See Figure 6**). Therefore, an ethanol analysis can only reliably establish the ethanol concentration in the individual **at the time of the analysis**.

The Effects of Alcohol

Alcohol is classified in different ways, depending on who is doing the classification. Generally, alcohol is considered to be a **DRUG,** specifically, a **"CENTRAL NERVOUS SYSTEM DEPRESSANT".** There are other drugs grouped in this category including: **METHADONE, MORPHINE, METHAQUALONE AND BARBITURATES.**

The effects of alcohol can be seen in all the sensory and motor functions of the body. However, in our work we are concerned primarily with the effect of alcohol on the brain. Alcohol depresses the transmissions in the nervous system between the brain and the rest of the body. The disruption of these transmissions has dramatic effects on the mental and physical performance of the body. For our purposes, the brain will be divided into four sectors: "**THE HIGHER CENTER OF LEARNING", "THE SENSORY INPUT FUNCTIONS", "MOTOR SKILLS" and "THE BRAIN STEM".**

Alcohol affects the brain **(see Figure 7)** in the reverse order to the way the brain develops in a fetus. Alcohol initially affects the brain in the **"THE HIGHER CENTER OF LEARNING".** This is where a person's "**JUDGMENT"** functions reside and where we make our decisions. This is where our social behavior is programmed, our religious beliefs reside, our standards and ethics, risk assessment, self-evaluation, inhibitions, and general sense of reality. Alcohol affects this part of the brain at very low concentration levels (0.02 - 0.04%), resulting in loss of the ability to assess one's own impairment, the risk involved in taking certain actions, and the ability to make correct decisions in any given situation or activity.

It is particularly interesting that the **"vomit control center**" is contained in the higher center of learning. The body self monitors levels of substances, which are toxic, and if a toxin exceeds a sufficient quantity the vomit mechanism is activated. Research has shown that the trigger for the vomit mechanism regarding alcohol is an alcohol concentration of 0.12%. In theory, an individual should not be able to exceed the 0.12% concentration level. However, since the vomit control center is part of the higher center of learning, its function can be impaired by the alcohol in the brain and rendered

inoperative before this level can be reached. If the alcohol concentration in the brain increases, more and more of our mental and physical capabilities are affected and, therefore, cannot be relied upon.

As the concentration of alcohol continues to increase, the **SENSORY INPUT FUNCTIONS** are affected. These include the senses of sight, hearing, touch, smell and taste. These senses are affected at alcohol concentrations of 0.06% and greater. For example, alcohol increases the **"acoustical threshold".** This means that as a person continues to drink, sounds must be louder and tones more distinct for the person to hear them. This is a slow process, and few notice the hearing loss. With heavy drinking, the effect is as if the person were driving an automobile through heavy traffic wearing earplugs.

The eye exhibits changes due to increasing alcohol concentration as well. Studies have shown that there can be changes in color and depth perception, blurring of vision, and diplopia (double vision) at concentration levels as low as 0.08%. Visual acuity was affected at concentration levels as small 0.01% in novice drinkers to 0.04% in heavy drinkers. The ability to visually track an object or focus is generally not affected until concentration levels of 0.08% are exceeded. In research looking at both tracking ability and the ability to focus, performance of the eye on both measures was affected at low levels of alcohol. Two of the most dangerous effects of alcohol are the lengthening of time necessary for the eye to recover from a bright light and from light fixation. The amount of time the eye takes to adjust to different levels of light is usually very short. Alcohol in the brain can cause this time to increase by up to a factor of six. For example, in driving, glare blindness caused by the passing of a vehicle in the opposite direction is generally less than a second. This time can increase to 2 to 4 seconds in a person who has been drinking--a very dangerous situation. Light fixation is when an intoxicated person becomes so intently focused on a light source, especially one that is flashing, that the person ignores all other external stimuli. This is why a patrol car on the side of the road with their lights on, is occasionally hit by intoxicated drivers. Another important effect of alcohol in the brain is the distortion in the ability to estimate distances. An individual under the influence of alcohol consistently overestimates the distance between two points. The consequence of such a change is the underestimation of that person's own speed. Even more important, an individual who has been drinking may believe that they have more distance to pass a vehicle than they actually have. A number of head on crashes have been caused by intoxicated drivers attempting to pass other vehicles.

The sense of smell is very quickly dulled by alcohol. Sometimes the sense of smell is an important safety factor. Have you ever stopped your car because something did not smell right? A car that is over heating or burning oil or burning brake fluid creates very distinct odors. If a person's ability to detect these problems is hampered, it is hazardous. Along with the sense of smell, alcohol affects the sense of taste by causing most food to be bland.

The sense of touch changes with increasing alcohol concentration in that increasing pressure is necessary before the person senses the contact. This can result in a change in a person's grip strength for the steering wheel and the pressure the person exerts on the gas or brake pedal. The ability to determine different textures also becomes less efficient.

If alcohol concentration continues to increase "**MOTOR SKILLS**" are affected. There will be less muscular coordination. Nerve transmissions from the brain to a muscle are impeded, affecting the performance of the muscle. This depression of nerve transmissions causes a dramatic change in reaction time. At low levels of alcohol concentration (0.06%), fine muscle (motor) coordination is affected. The person's ability to perform tasks requiring finger dexterity, such as the extraction of a driver's license from a wallet is affected. As alcohol concentration continues to increase, larger muscle groups are affected (gross muscle or motor coordination). At levels of 0.08% and above, the typical visual clues to intoxication begin to manifest themselves, such as staggering walk, problems with balance, hand to eye coordination and slurring speech.

Alcohol acts as a "VASODILATOR". This means that blood vessel walls relax under the influence of alcohol, and more blood is delivered to the extremities (arms, legs, feet and hands). The flushed face observed in some individuals is the result of the vasodilation effect. A consequence of additional blood being sent to extremities can be loss of heat at the body core. Alcohol should never be given to a person suffering from cold exposure since this will result in further lowering of the body's core temperature.

If alcohol concentration continues to increase, the final area of the brain to be affected is the **"BRAIN STEM".** This part of the brain controls all of the body's autonomic functions. If alcohol reaches a level in excess of 0.10% changes are evident in the heartbeat, respiration and body temperature. If alcohol concentration exceeds 0.40% the respiration function can cease. **Death due to alcohol poisoning is usually caused by stoppage of respiration.**

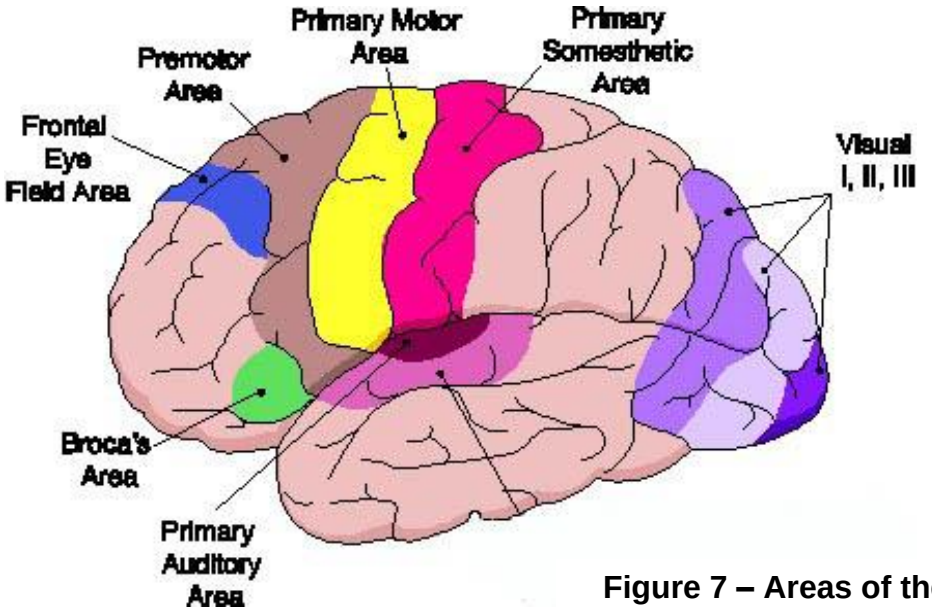


Figure 7 – Areas of the Brain

Alcohol in Combination with Other Drugs

Other drugs, as well as illnesses and diseases, can mimic visual indications of alcohol intoxication. Visual symptoms that can be attributed to alcohol intoxication include slurred speech, staggering, drowsiness, loss of equilibrium, and loss of motor skills. Other drugs such as Valium can have similar affects. In a DUI arrest, these symptoms can be a result of drugs, alcohol, or a combination of both.

Pharmacologically, alcohol produces a feeling of euphoria, or relaxation, and well-being. This feeling normally peaks at an alcohol concentration of approximately 0.04%. At this concentration level there are very few symptoms evident to indicate intoxication. If alcohol concentration increases beyond this point, then the familiar "overdose" symptoms begin to appear.

One of the real dangers of alcohol is its reaction when other drugs are present. Alcohol taken in combination with other drugs can produce "additive" effects or "synergistic" effects. "Additive" effects are when a person's impairment level is simply the sum of the impairing effect of the alcohol and the drug present. Alcohol in combination with Phenobarbital is an example of an additive effect. The synergistic effect of alcohol with Valium is greater than a simple additive effect of alcohol with the Valium. There is no known example of a drug that can decrease the intoxicating effect of alcohol. Therefore, **WHEN ANY DRUG IS COMBINED WITH ALCOHOL, THE ABILITY OF THE INDIVIDUAL IS MORE IMPAIRED THAN WHEN ONLY ALCOHOL OR THE DRUG ARE PRESENT**.

℞ Usage of drugs, whether illicit, prescribed, or over the counter, is common. It is difficult to determine what drug a person has consumed from the visual effects. A breath alcohol analysis cannot detect or determine the presence of drugs. Those people who misuse drugs know this and occasionally attempt to "mask" their use of a drug by consuming a strongly aromatic alcoholic beverage such as whiskey or beer. The odor of an alcoholic beverage can cause the law enforcement officer to investigate the use of alcohol, not thinking that drugs may also be present. In other words, the smell of alcohol can produce an "alcohol mindset" in the officer and limit the investigation before drug use is uncovered. Even though a breath alcohol test cannot detect the presence of drugs, the fact that the **alcohol concentration does not correlate with the symptoms being observed** in the individual is a sign that further investigation is warranted.

Alcohol still remains the number one cause of accidents and motor vehicle fatalities. It has been estimated, however, that drugs may be present in drivers suspected of DUI in over 40% of the cases. Some studies have

indicated that alcohol and drugs are present in approximately 25% of all accidents and 1/3 of these involve two or more drugs. The use of alcohol with drugs is a dangerous development.

Illness or diseases can also mimic the effects of intoxication. Examples include diabetes, epilepsy, and certain types of traumas, especially head trauma.

Alcohol Tolerance

A person's TOLERANCE to alcohol is often misunderstood. With most drugs, tolerance is thought of as the need to increase dosage of a drug to obtain a desired pharmacological result, this is called DOSE TOLERANCE. With alcohol, the person does not develop DOSE TOLERANCE in the normal pharmacological sense due to chronic use of alcohol. Alcohol tolerance is usually seen with regards to the exhibited effects of alcohol consumption. The two distinct categories of tolerance are: "NATURAL" and "LEARNED".

Natural tolerance is further divided into INBORN, PHYSICAL, and STRESS TOLERANCE. Inborn tolerance is the body's own response to a given concentration of alcohol. Inborn tolerance is only effective at relatively low levels of alcohol concentration. In fact, no individual has been shown to have immunity to the effects of alcohol above concentration of 0.08%. Studies have shown inborn tolerance to be most prominent up to concentrations levels of 0.04% to 0.06%.

The term physical tolerance refers to the effect of a given dose of alcohol on a person who is ill. The individual's physical and mental abilities, already diminished by illness, are further diminished by the presence of alcohol. This effect does not work both ways. For example, a person in superb physical health is not less affected by alcohol than the average healthy individual.

Stress tolerance is often encountered by law enforcement officers but sometimes not recognized. A classic example of stress tolerance is an individual's performing poorly in the roadside sobriety test then performing well a few minutes later in a reassessment at the lock-up facility. In high stress situations or when a person has increased anxiety, adrenaline is released in the body. Adrenaline has been shown to cause some intoxicated individuals to appear less intoxicated than they really are. It is not clear whether this effect is due to an increased metabolic rate, which masks the effects of the alcohol, or to the individual becoming more aware of their situation, and an attempt to cover-up the intoxication. Stress tolerance is a temporary phenomenon and lasts for only a few minutes. However, those few minutes can make a great deal of difference in the performance of a field sobriety test.

There are also three forms of Learned Tolerance: "**PSYCHOLOGICAL**, **ACQUIRED** and **ACUTE TOLERANCE**".

Psychological tolerance results from all of a person's life experiences. A person's behavior is controlled by several factors, for example the social setting, our basic ideas of right and wrong, religious training received, current mental state, the people we associate with and many other factors. An individual might normally refrain from certain actions, but the consumption of alcohol can lessen the person's inhibitions. Strong evidence of this is the number of crimes that are committed under the influence of alcohol versus the number of crimes where no alcohol or drugs are present.

The most common type of tolerance observed in law enforcement is acquired tolerance. **Only habitual users of alcohol establish acquired tolerance.** The chronic drinker can learn to compensate for some of the more obvious effects of alcohol intoxication. An individual who can perform field sobriety maneuvers well, with a high alcohol concentration is a classic example of acquired tolerance. It is important to remember that the chronic drinker can compensate for the effect of alcohol on gross motor functions, but cannot compensate in the areas of HGN, judgment, reaction time and perceptions of risk.

Acute tolerance, also referred to as the "**MELLANBY EFFECT**", is the brain's tendency to continually compare its current condition to its condition at a previous time. For example, during the pre-peak phase on the alcohol curve, the individual comparing his current feelings to how he felt when there was no alcohol present will likely overestimate his level of intoxication. Once the individual enters the post-peak phase, however, he begins comparing his current state to a previously higher level of intoxication and consequently will underestimate his level of intoxication. This is a dangerous situation with regards to operating a motor vehicle.

There is no form of tolerance that reverses the effects of alcohol with regard to diminished physical and mental abilities in the operation of a motor vehicle.

Henry's Law
and the
Breath to Blood Ratio

The Basis

In 1803 a British chemist, William Henry, developed a chemical principal concerning the actions of volatile substances when placed in water and brought into contact with air. This discovery is called Henry's Law and is stated as follows:

> **When the water solution of a somewhat volatile chemical compound is brought to equilibrium with air, there is a fixed ratio between the concentration of this compound in the air and its concentration in the water. This ratio is constant for a given temperature and pressure.**

Alcohol and many other substances are considered to be volatile substances, meaning that they have a tendency to rapidly change states (liquid to air; evaporation, or air to liquid; condensation), whether they are alone or in solution. If one places a volatile substance, such as alcohol, in solution with water in a sealed container, the air in the container will become saturated with alcohol vapor. When the amount of alcohol evaporating into the air space above the solution equals the amount of alcohol condensing and returning to the water, equilibrium has been reached. At equilibrium, there is a fixed ratio, or direct proportion, between the alcohol in the water and the alcohol in the air above it. This ratio is dependent on the temperature of the solution and atmospheric pressure.

Applying Henry's Law to the Human Body

Does the human body meet the requirements of Henry's Law? First of all, when we drink alcohol, we have placed a volatile substance in the "container", there is water present with which the alcohol can come into solution. For all intents and purposes, the body is a "closed" container and the volatile substance in the water (blood) does come into contact with air (the lungs). The body is regulated at a fairly constant temperature (98.6 F or 37C) and is self-regulated for any pressure changes. Therefore, the human body very nicely fits

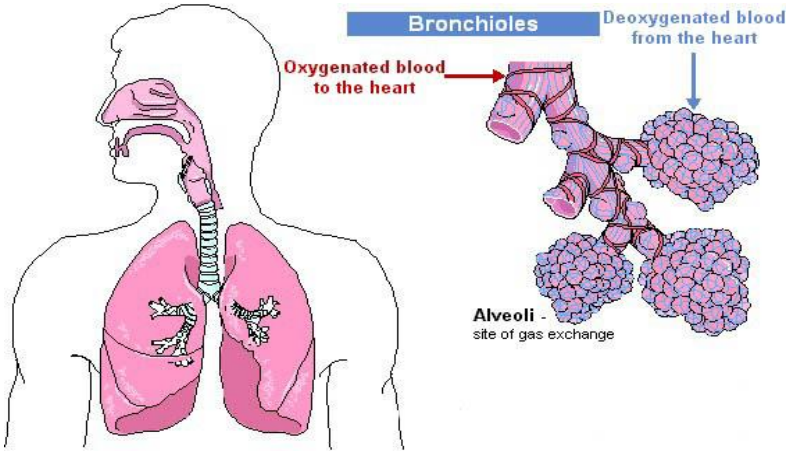


Figure 8

all the requirements for Henry's Law to apply.

Our respiratory system is designed to quickly bring gaseous and volatile substances contained in the blood into equilibrium with the alveolar air of the lungs **(see Figure 8)**. The air passages of the lung may be compared to an inverted tree with the windpipe or "trachea" as the trunk, one large branch or "bronchus" going into each lung, with these branches further dividing into smaller and smaller branches. The smaller branches or

"bronchi" finally become microscopic tubes, each ending in a thin irregular sac. Each sac is composed of several smaller sacs called "alveolus". Each alveolus is approximately 0.1 millimeter in diameter, its walls only two cells in thickness, and it is honeycombed with capillaries. A normal lung will contain about 750 million alveoli, creating a surface area of approximately 600 square feet. It is in the alveolar region that the exchange of all gases, including alcohol, occurs.

Each time we breathe in, we take in oxygen. The oxygen is brought into the alveolar section of the lungs where it passes from the alveolar sacs directly into the blood, creating arterial or oxygenated blood. The blood then travels throughout the body delivering oxygen to all body tissues. The arterial blood delivers oxygen and other nutrients and collects carbon dioxide and other waste products from body tissues. Blood carrying carbon dioxide, now called venous or deoxygenated blood, returns to the alveolar region, passes the carbon dioxide into the alveolar sac and receives new oxygen. Carbon dioxide collected from body tissues is passed from the body when we exhale.

Figure 8 – Alveolar Region

The alcohol in our system follows the same exit route. As blood containing alcohol comes into contact with the alveolar region it passes from the blood into the alveolar sac. This intimate contact between the alcohol-laden blood and air in the alveolar region satisfies the requirements of Henry's Law, not only for alcohol, but also for oxygen, carbon dioxide and many other volatile substances.

It is important to understand and remember that this equilibrium and the ratio of alcohol between the air and the blood will only occur in the alveolar region of the lungs.

The Development of the 2100:1 "Breath to Blood" Ratio

The application of Henry's Law, in an effort to analyze the breath and establish an alcohol concentration, was first conducted by Dr. Rolla Harger. In an attempt to assist the law enforcement communities in combating the intoxicated driver, Dr. Harger began experimenting with methods of quickly and accurately determining alcohol levels without the need for intrusion into the body or waiting for lengthy laboratory analysis.

Initial experiments were done by placing cows' blood, combined with known quantities of alcohol, into a rotating cylinder. By rotating the cylinder Dr. Harger was able to simulate the gas exchange processes occurring in the lung system. Samples were

drawn from the blood and the air until a constant ratio was established. Other types of blood and different concentrations of alcohol were used until Dr. Harger was confident that the correct Breath to Blood ratio had been established. Dr. Harger then published his findings, and the science of breath analysis was born.

It is critical to understand the exact basis of this "Breath to Blood" statement since it is constantly brought into question. Dr. Harger stated:

> **That 2100 ml of alveolar air will contain the same weight of alcohol, as does 1 ml of pulmonary arterial blood.**

This seemingly simple statement has prompted more debate in the arenas of science and law than any other statement to date. Most of the legal debate however is based on a misunderstanding of the statement. In almost every court across the country this is referred to as "The Breath To Blood Ratio", however, this statement does not refer to breath in general, but rather to a *very specific* type of breath, **Alveolar**, and a *very specific* type of blood, **Pulmonary Arterial**.

Just as there are specific types of blood; arterial, venous, and capillary, each having specific characteristics, there are different types of breath. The type of breath where the alcohol is in greatest contact and therefore the prime sample to collect for a breath analysis is the alveolar air. To properly collect this type of sample, all alveolar air must be extracted from the lungs, causing the lung to collapse. Obviously, this type of sample capture cannot be conducted in breath analysis. Breath analysis is mathematically based on the ratio involving the alcohol concentration in the blood and that of the alveolar air. However, the type of breath that is actually captured is not alveolar, but what is referred to as **"Deep Lung".** A Deep Lung breath sample is the closest one can get to the actual sample mathematically required by breath analysis instrumentation. This type of breath is representative of the alcohol concentration ratio between the arterial blood and the alveolar air, but since it is not in as intimate contact with the blood, **analysis of Deep Lung breath will consistently provide a lower analysis than if we could capture and analyze a pure sample of alveolar air**.

The most incredible fact regarding this statement is that it was developed and published in the late 1930's. Furthermore, breath analysis has been recognized by state statute since 1939. This statement and the science of breath analysis has been established, proven reliable and accepted by all major scientific associations and organizations since the 1940's.

The major aspect of its reliability is that after years of study and scrutiny this "Breath to Blood Ratio" is still accepted as the best ratio to date for the accurate analysis of breath in an effort to establish alcohol concentrations in the blood.

Use of the “Breath to Blood” Ratio in Instrumentation

Dr. Harger developed the first breath analysis instrument, known as the “Drunkometer” or “Balloon Test”. The critical basis of the instrument was determining the exact amount of alveolar air contained in the sample since the instrument used “Mixed Expired” air composed of all types of breath. The captured breath was bubbled into a reagent until the reagent had turned a specific color. The amount of breath it took to cause this reaction would vary depending on the alcohol concentration of the subject, the higher the alcohol concentration the smaller the amount of captured sample it took to cause the reaction. The exact amount of alveolar breath then had to be determined. This was done by measuring the weight of carbon dioxide, found only in alveolar air, before and after the test, and applying mathematical formulas assessing exact amounts of alveolar air and correcting the captured amount of alcohol. The instrument was later modified using a “re-breathing” technique whereby the individual would exhale into a balloon, breath the sample back in and then exhale again. By having the subject perform this technique a minimum of four times the sample analyzed was virtually the same composition as alveolar air.

In 1954, Dr. Robert Borkenstein introduced the “Breathalyzer”. The Breathalyzer was designed to capture a specific amount of deep lung air exhaled from the subject. Whereas the Drunkometer would use different amounts of breath, the Breathalyzer would capture only 52.5 cc of the last part of the breath. The basis in this case was not the amount of breath used, but the amount of reagent destroyed based on a constant sample. The alcohol concentration would be proportional to the amount of reagent that reacted with the alcohol. To determine the amount of regent destroyed in the ampoule, a “test” ampoule and a “standard” ampoule were used. The ampoules were placed in front of matched photocells and a movable light source was adjusted until the amount of light able to pass through the ampoules was equal. When the alcohol reacted in the test ampoule a portion of the reagent was destroyed thereby altering its light absorption. The light source was readjusted until the amount of light passing through the ampoules was equal once again. The distance the light source had to move was directly proportional to the alcohol concentration.

In the 1960’s investigations concerning the use of infrared light as a method of alcohol analysis were under way. A company named Omicron introduced the first infrared type of device. Mr. Jack Fritzlen, president of CMI, INC., then purchased this device in 1975. The basis of the infrared unit was to use an infrared light beam which, when brought into contact with the alcohol molecule would absorb some of the infrared light energy. The actual theory of the infrared instrumentation will be discussed in a later chapter; however, the Breath to Blood Ratio is an intricate part of this type of instrument.

Questions Concerning the "Breath to Blood" Ratio

Are There Factors Which Affect the Breath to Blood Ratio?

There are a number of different factors which may influence the conversion of a breath alcohol analysis to that of blood alcohol concentration.

Temperature

The temperature at which the breath leaves the mouth is not constant. The accepted temperature for the exhaled breath is 34º C. However, studies have indicated that this may vary as much as ± 1º C. A change of 1º C may cause a 6.5% change in the breath alcohol level. It is very difficult to monitor an individual's breath temperature during an analysis. The best safeguard for this situation is the required observation period. During the observation period the individual will be breathing air that is maintained at a relatively constant temperature (room temperature); this can help to stabilize the breath temperature. Erroneous results due to major fluctuations in the breath temperature have never been effectively established.

An increase in the body temperature will also create a possible error. An individual who is running a fever will not only disrupt the 2100:1 Breath to Blood Ratio but will cause an elevation in the breath temperature. This situation can effectively be handled by proper questioning of the individual at the time of the analysis. Remember, that an individual who is ill and running a fever will be more affected by the alcohol than an individual who has a normal body temperature.

Pressure

Since the body must compensate for pressure variations whether one is tested at sea level or at 10,000 ft does not appear to influence the accuracy of a breath analysis. It is interesting to note however that individuals consuming alcohol at higher elevations are affected by the alcohol to a greater degree than what the alcohol concentration would indicate.

Gender Differences

Although males and females differ in size, lung capacity and body water content, these factors do not affect the application of Henry's Law or the 2100:1 Breath to Blood Ratio. A breath analysis is equally accurate for both male and female.

What Happens to the "Breath to Blood" Ratio During the Alcohol Curve?

The level of alcohol in the arterial blood controls the level of alcohol in the brain and the breath. For about an hour after the first drink, blood taken from an artery may be as much as 50% higher than blood taken from a vein. The difference becomes smaller as the distribution of the alcohol is completed and will equalize after the distribution is achieved.

Is Everybody 2100:1?

This question is the number one attack of most attorneys concerning breath analysis. The "Breath to Blood" ratio is not the same in every individual. The 2100:1 "Breath to Blood" ratio is the best, and most accepted, biological average that science has yet been able to establish. There are numerous studies that depict this ratio as incorrect or inaccurate, however the majority of these studies either use unacceptable measuring devices or do not follow established protocol for conducting these types of experiments. Of special interest is the misinterpretation of a number of properly conducted studies. For example, there has been a great deal of publicity, and defense questions, concerning an article from a well-known scientist and investigator in the field of breath analysis. In this paper the authors present a listing of various "Breath to Blood" ratios gathered from other individuals who investigated this phenomenon. The studies published range from 1928 to 1976. What has captured the attention of the defense lawyers, expert witnesses and those presenting DUI seminars is one study that set the ratio at 1125:1. If this were in fact true, then an individual having this ratio would, in fact, test extremely high. However, the individuals using this paper and in particular this ratio as a basis of attack, apparently have never read the article since the subject in question was not human, but a **dog**.

Even though all people do not strictly adhere to the 2100:1 ratio, remember that the 2100:1 ratio is merely the mathematical basis of the instrumentation. For this ratio to be "properly" applied we must also collect a **100% sample of the alveolar air**. Collecting a 100% sample of the alveolar air is a **physical impossibility** without harming the subject.

Since a breath analysis device collects only Deep Lung air samples, which at best reaches only an 80% alveolar air concentration, a breath analysis result, regardless of the individual's breath to blood ratio, will be consistently lower than or equal to that of a blood analysis conducted at the same time.

Metrics and Temperature

THE METRIC SYSTEM

Objective

It is the purpose of this chapter to familiarize the operator with metric system nomenclature and scientific measures pertinent to the field of breath alcohol testing.

LENGTH, VOLUME, MASS

Its Beginning

The metric system, a standard method of measuring length, volume, weight, and other values, originated in France in the late eighteenth century. The metric system, adopted by France in 1791, was made mandatory there on July 4, 1837. Sixteen years before the French decree, John Quincy Adams advocated the use of the metric system in the United States. Congress, however, did not pass a law legalizing the system for the public until 1866.

Scientists, however, use metric measurements exclusively. Most of us are familiar with 250 milligram pills, 35-millimeter cameras and film, hypodermics measured in cubic centimeters (cc's) and cars with engine displacement stated in liters. Coca-Cola, 7-Up, Pepsi-Cola, and Dr. Pepper now market their products in liter containers. Wines and spirits are now bottled in metric sizes (the familiar fifth has become 750 milliliters).

DEFINITIONS

Measure of Length

The metric system was originally based on the distance between the North Pole and the Equator. A line running from the North Pole to the Equator can be divided into 10 million equal parts. The meter has since been redefined for even greater accuracy as 1,650,763.73 wavelengths of orange-red light emitted by the Krypton-86 atom. Each part is a meter, or 39.37 inches. It is from this length measurement the meter, that the units of volume and mass are derived. For some common comparisons of length, see **Figure 1**.

Figure 1. Comparisons of Length

(COMPARATIVE SIZES ARE SHOWN)

= 39.37 INCHES

= .914 METERS

(ACTUAL SIZES ARE SHOWN)

= 1 INCHES

= 2.54 CENTIMETERS

= 1 CENTIMETER

= 2 MILLIMETERS

COMPARISONS OF LENGTH

Measures of Volume

The area of space an object takes up is called the volume or its cubic contents. Using a rectangular box, we can find its volume from the inside dimensions. The liter is used to measure volume. A liter is equivalent to 1000 cubic centimeters or milliliters. For some common comparisons of volume, see **Figure 2**.

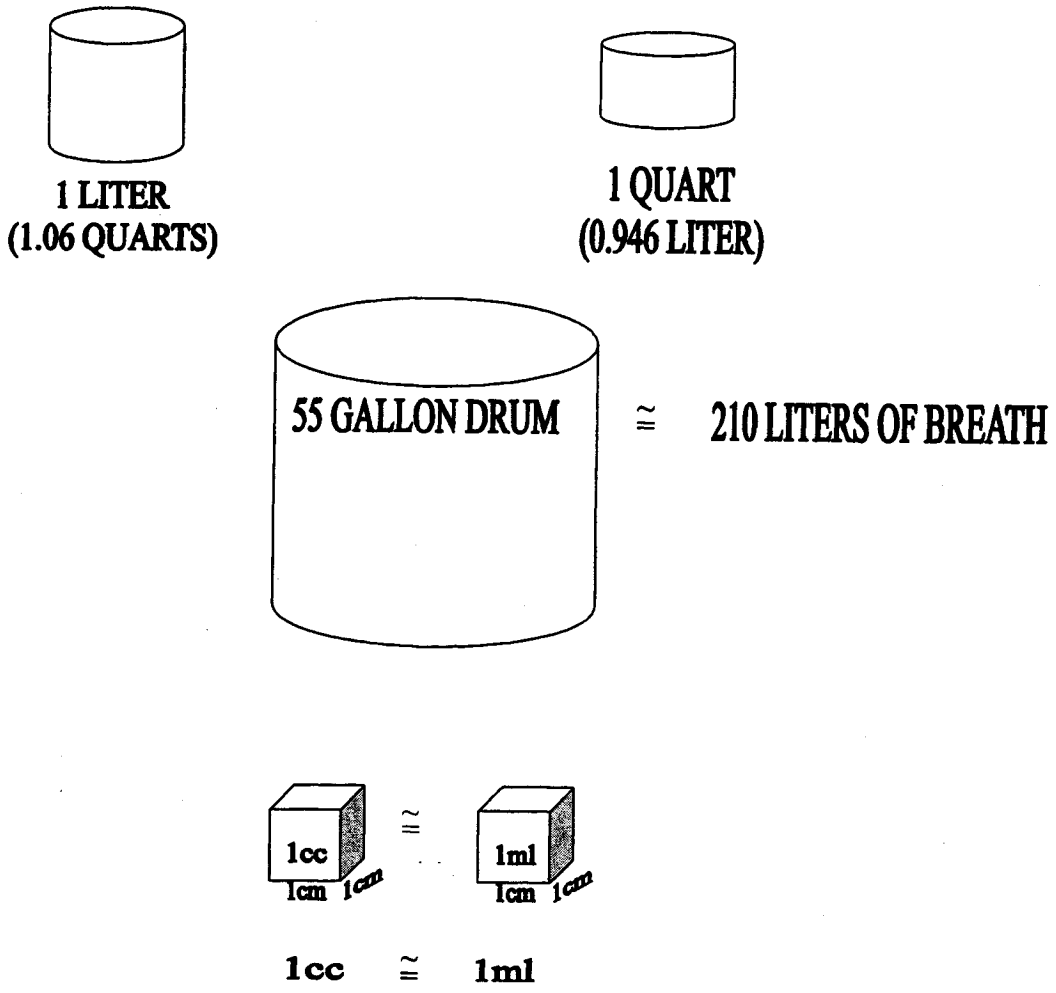


Figure 2. Comparisons of Volume

Measure of Mass

The gram is the mass of one cubic centimeter of distilled water at a temperature of 40C at sea level. For some common comparisons of weight, see **Figure 3**.

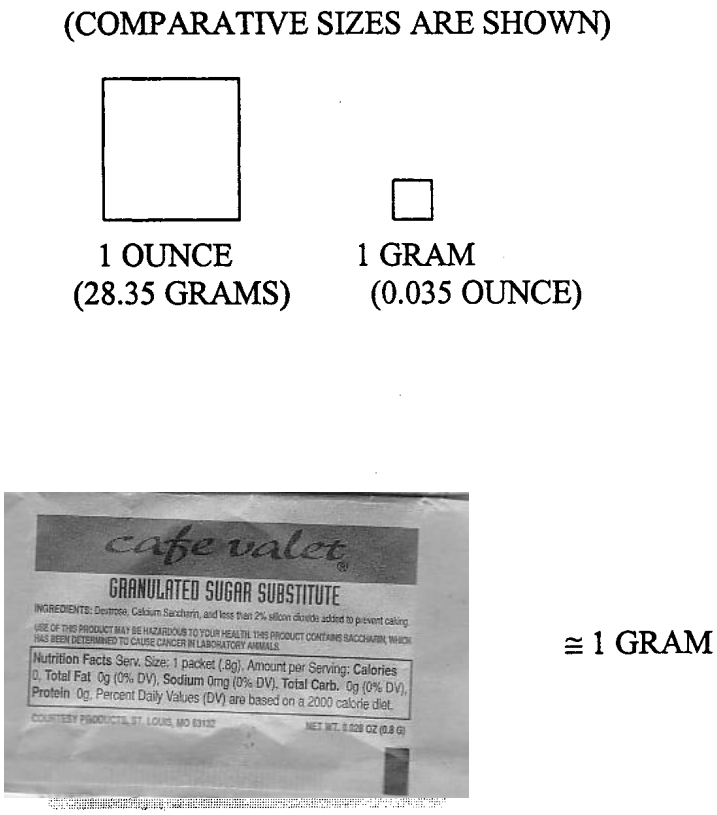


Figure 3. Comparisons of Weight

Units of Measure

By adding Latin prefixes to the basic units (meter, liter, and gram), the names of the units of division (tenths, hundredths, thousandths, etc.) are formed. For example, deci means one-tenth (0.1), centi means one-hundredth (0.01), and milli means one-thousandth (0.001). By adding Greek prefixes to the basic units, the names of the units of multiplication are formed. For example, Deka means 10, Hecto means 100, and Kilo means 1,000. For some of the more common prefixes that are likely to be encountered by operators, refer to **Table 1.**

TABLE II. THE METER.

Unit	Abbreviation	Size	One meter is equal to:
Gigameter	Gm	1,000,000,000 meters	0.000 000 001 Gm
. . . . .	. .	. . . . .	. . . . .
. . . . .	. .	. . . . .	. . . . .
Megameter	Mm	1,000,000 meters	0.000 001 Mm
. . . . .	. .	. . . . .	. . . . .
. . . . .	. .	. . . . .	. . . . .
Kilometer	Km	1,000 meters	0.001 Km
Hectometer	Hm	100 meters	0.01 Hm
Dekameter	Dm	10 meters	0.1 Dm
Meter	**M**	**1 Meter**	**1 M**
decimeter	dm	0.1 meter	10 dm
centimeter	cm	0.01 meter	100 cm
millimeter	mm	0.001 meter	1,000 mm
. . . . .	. .	. . . . .	. . . . .
. . . . .	. .	. . . . .	. . . . .
micrometer	m	0.000 001 meter	1,000,000 m
. . . . .	. .	. . . . .	. . . . .
. . . . .	. .	. . . . .	. . . . .
nanometer	nm	0.000 000 001 meter	1,000,000,000 nm

TABLE III. THE LITER.

Unit	Abbreviation	Size	One liter is equal to:
Kiloliter	Kl	1,000 liters	0.001 Kl
Hectoliter	Hl	100 liters	0.01 Hl
Dekaliter	Dl	10 liters	0.1 Dl
Liter	**L**	**1 Liter**	**1 L**
deciliter	dl	0.1 liter	10 dl
centiliter	cl	0.01 liter	100 cl
milliliter	ml	0.001 liter	1,000 ml

PROBLEMS

The following problems are designed to help you understand the metric system by giving you practical experience in problem solving. Read and solve (refer to Tables II, III and IV). Answers follow.

1. To convert meters to decimeters, one moves the decimal point one place to the _____.Thus, 314.112 meters = _____ decimeters.

2. To convert meters to millimeters, one moves the decimal point _____ places to the _____. Thus, 256.43 meters = _____ millimeters.

3. To convert Hectometers to centimeters, one moves the decimal point _____ places to the _____. Thus, 1.342 Hectometers = _____ centimeters.

4. To convert deciliters to Dekaliters, one moves the decimal point _____ places to the _____. Thus, 6143.56 deciliters = _____ Dekaliters.

5. To convert milliliters to Kiloliters, one moves the decimal point _____ places to the _____. Thus, 3615.43 milliliters = _____ Kiloliters.

6. To convert Dekagrams to decigrams, one moves the decimal point _____ places to the _____. Thus, 86.41 Dekagrams = _____ decigrams.

7. To convert centigrams to Kilograms, one moves the decimal point _____ places to the _____. Thus, 743.46 centigrams = _____ Kilograms.

8. .42 Dekameters = _____ meters.

9. .015 Kilometers = _____ decimeters.

10. 81.4 milliliters = _____ liters.

11. 500 milliliters = _____ centiliters.

12. .8 grams = _____ milligrams.

13. 61.8 decigrams = _____ Kilograms.

14. 39.37 Hectometers = _____ millimeters.

15. 0.000555 Kiloliters = _____ milliliters.

ANSWERS

1. right, 3,141.12
2. three, right, 256,430.0
3. four, right, 13,420.0
4. two, left, 61.4356
5. six, left, .00361543
6. two, right, 8,641.0
7. five, left, .0074346
8. 4.2
9. 150.0
10. .0814
11. 50.0
12. 800.0
13. .00618
14. 3,937,000.0
15. 555.0

TEMPERATURE CONVERSION

Fahrenheit (F)

This is probably the most familiar temperature scale. On this scale, there are 180 degrees between the freezing and boiling points of water. Water freezes at 32 degrees Fahrenheit and it boils at 212 degrees Fahrenheit. See Figure 2.

Centigrade (C)

Scientific measurements of temperature are generally made by using the Centigrade scale. This may also be referred to as the Celsius scale. Water freezes at 0 degrees Centigrade and it boils at 100 degrees Centigrade. Since there are 100 degrees between the freezing and the boiling points of water on this scale, one can see that each degree Centigrade is 1.8 times as large as each degree Fahrenheit. See Figure 2.

Temperature Conversion Formulas

1. F = (9/5 x C) + 32 OR F = (1.8 x C) + 32

2. C = 5/9 (F - 32) OR C = (F - 32) 1.8

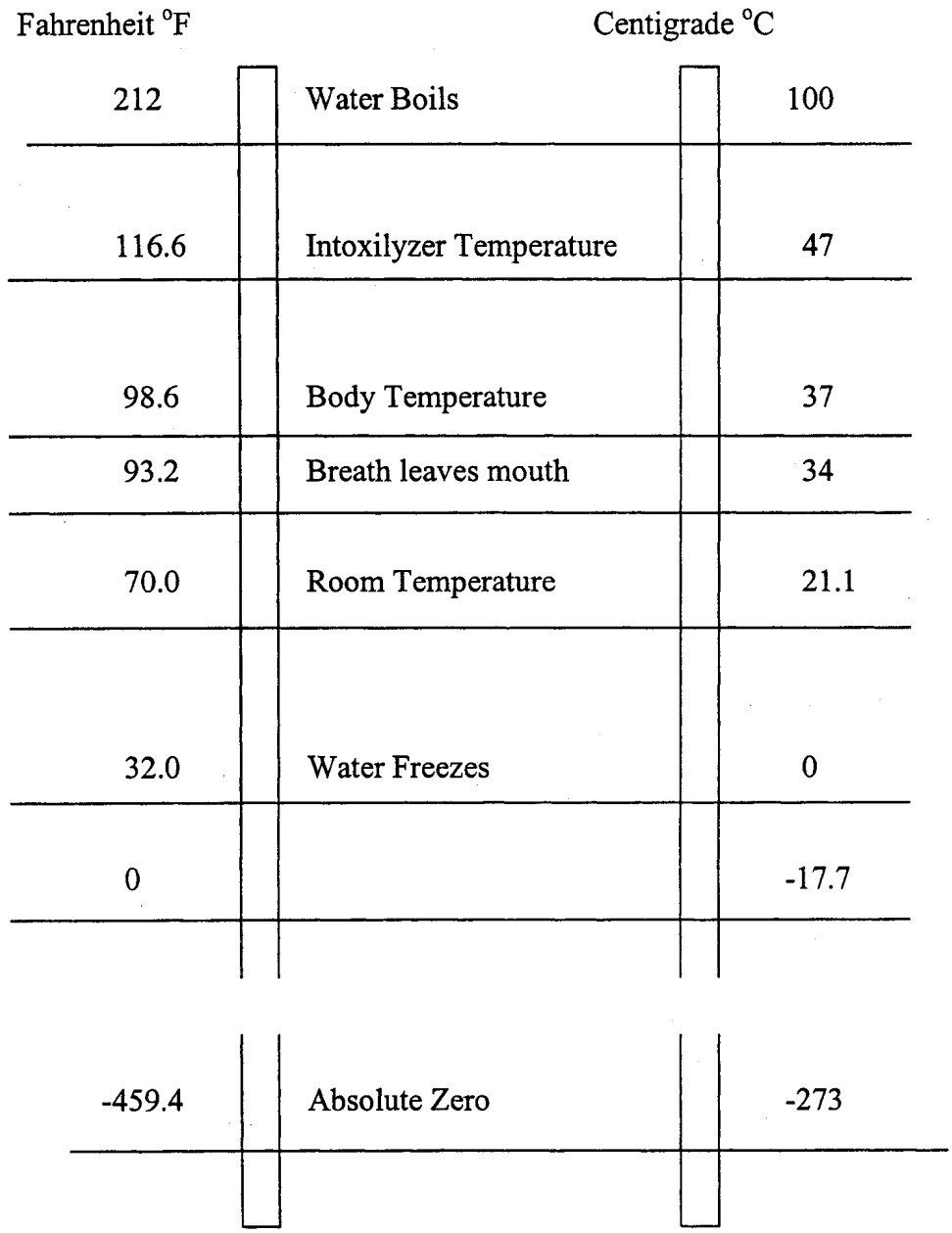
Example: Convert 50 C to degrees Fahrenheit.

F = (9/5 x C) + 32

F = (9/5 x 50) + 32
F = 90 + 32
F = 122.0

Example: Convert 98.6 F to degrees Centigrade.

C = 5/9 (F - 32)
C = 5/9 (98.6 - 32)
C = 5/9 (66.6)
C = 37.0



To Convert:

$°C = 5/9 (°F - 32)$ $°F = (9/5 \times °C) + 32$

Figure 2. The relationships among temperature scales.

Expressing the Breath Alcohol Concentration (BrAC)

Technically, a breath analysis does not determine the exact alcohol concentration of the blood; rather it expresses the relationship of the alcohol concentration within the breath to that of the blood. For this reason, many states have enacted legislation specifically defining a BREATH ALCOHOL CONCENTRATION. By establishing breath analysis as its own recognized entity, it was felt that this would clarify the alcohol levels and curtail the questions raised by defense concerning the 2100:1 breath to blood ratio. The accepted method of expressing the Breath Alcohol Concentration (BrAC) is by the label of grams of alcohol per 210 liters of breath (g/210 L). This label is derived from the 2100:1 breath to blood ratio, but still sets the breath apart from the blood. The manner by which this label was determined is as follows.

The most common way of expressing the blood volume in a blood alcohol concentration is 100 milliliters blood. The breath to blood ratio is based on 1 milliliter of blood. To equate the blood volumes between the labels, multiply the volume of the blood in the breath to blood ratio by 100 (1 ml x 100 = 100 ml). Since the blood volume of the breath to blood ratio has been multiplied by 100, the alveolar air volume must be multiplied by 100. 2100 ml x 100 = 210,000 ml. 210,000 ml = 210 Liters. Therefore, a blood alcohol concentration of 0.10 g/100 ml blood would equal a breath alcohol concentration of 0.10 g/210 L breath.

Alcohol Concentration Formulas

Amount Consumed to Theoretical Alcohol Concentration

To calculate an individual's theoretical alcohol concentration for what that individual consumed we must first establish a mathematical premise.

The basic mathematical premise for all alcohol concentration calculations is as follows:

> **For each ounce of pure ethanol in a 150-pound individual's system, the resulting alcohol concentration will be approximately 0.05%.**

Obviously by increasing the amount of ethanol, the alcohol concentration will increase.

Ounces of Ethanol	Body Weight	Alcohol Concentration
1 oz	150	0.05%
2 oz	150	0.10%
3 oz	150	0.15%
4 oz	150	0.20%

The alcohol concentration is also dependent on the body weight of the individual

Ounces of Ethanol	Body Weight	Alcohol Concentration
4 oz	150	0.20%
4 oz	300	0.10%

As you can see, the greater the individual's body weight, the greater the amount of ethanol which must be consumed to achieve a specific alcohol level. In the example above, the 300-pound individual would have to consume 8 oz. of ethanol to reach a 0.20% alcohol level, or twice as much as the 150-pound person to reach the same alcohol concentration

To calculate an individual's highest theoretical alcohol concentration the following formula is used.

$$\frac{\text{Ounces of pure ethanol} \times .7.5}{\text{Body Weight}} = \textbf{highest theoretical alcohol concentration}$$

The first step is to determine the amount of pure ethanol the individual consumed.

All alcohol beverages contain ethanol, but not pure ethanol.

The concentration level of an alcohol beverage is expressed by two methods. All non-distilled beverages (such as beer and wine) have their alcohol concentration expressed in terms of %. Beer is traditionally 4-5% alcohol and wine is usually considered to be 12% alcohol. Distilled beverages employ the label of "proof" to designate the alcohol concentration. "Proof" is double the %. For example, 100 proof whiskey would be 50% alcohol, 80 proof vodka would be 40% alcohol and so forth.

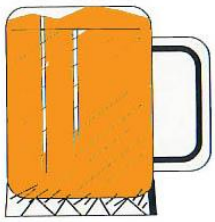
Conversely a non-distilled beverage could be labeled as proof by doubling the alcohol percent, 4% beer would be considered as 8 proof or 12% wine would be 24 proof.

Proof / 2 = Percent (%) Percent (%) x 2 = Proof

To calculate the amount of pure ethanol from the amount of beverage an individual consumed.

One 1½ oz. shot of whiskey

One 5 oz. glass of wine



One 12 oz. mug of beer

Amount of beverage consumed (vol.) x percent of alcohol (%) = ounces of pure ethanol.

For example, determine how much pure ethanol an individual would have to consume if that individual drank "two beers".

1. Determine the amount of beverage.
   2 Beers at 12 ounces per beer
   2 X 12 = 24 ounces of beverage (vol.)

2. Establish the percent alcohol
   For the sake this of calculation beer is considered to be 4%
   4% converted to decimal = 0.04 (12% = 0.12, 50% = 0.50 etc.)

3. Fill in and work the formula
   24 X 0.04 = 0.96 ounces of pure ethanol

Since all alcohol beverages contain ethanol, one can calculate for multi-beverage consumption.

The individual in the prior example consumed not only the two beers just calculated but continued to drink through the evening. At the end of his "evening out" he had consumed 2 – 4% beers, 3 - 8 ounces glasses of 12% wine and 5 whiskeys and coke, each containing 1 ounce of 86 "proof" whiskey.

To determine how much pure ethanol was consumed solve for the amount of ethanol in each drink.

1. 2 x 12 = 24 ounces of beer at 4% = 0.04
   24 X 0.04 = 0.96 ounces of pure ethanol from the beer

2. 3 x 8 = 24 ounces of wine at 12% = 0.12
   24 X 0.12 = 2.88 ounces of pure ethanol from the wine

3. 5 ounces of 86 proof or 43% = 0.43
   5 X 0.43 - 2.15 ounces of pure ethanol from the whiskey and coke

4. Total amount of ethanol consumed
   0.96 + 2.88 + 2.15 = 5.99 ounces of pure ethanol

Using the total amount of ethanol consumed, calculate for the highest theoretical alcohol concentration.

$$\frac{\text{Ounces of ethanol X .7.5}}{\text{Body Weight}} = \text{Highest theoretical alcohol concentration}$$

1. A **220**-pound person consumed 2 -12-ounce cans of beer. What is the highest theoretical alcohol concentration?

   Ounces of ethanol = 0**.96**
   Body weight (B.W.) = **220**

   $$\frac{\textbf{.96} \times 7.5}{\textbf{220}} = 0.032 \text{ g/210L}$$

2. A **220** pound person consumed 2 - 12 ounce cans of beer, 3 - 8 ounce glasses of 12% wine and 5 whiskey and cokes each containing 1 ounce of 86 proof whiskey

   Ounces of ethanol = **5.99**
   Body weight (B.W.) = **220**

   $$\frac{\textbf{5.99} \times 7.5}{\textbf{220}} = 0.204 \text{ g/210L}$$

Remember that this formula calculates for the highest theoretically possible alcohol concentration; **one can never achieve this calculated amount**. The calculation is based on the premise that every milliliter of ethanol was absorbed into the system and that every bit of the alcohol was present when the individual reached peak alcohol, and that the individual was tested at that precise moment in time. If an individual claims that he or she consumed a certain amount (say for example "two beers") and their calculated highest theoretical result is 0.032%, but their test result is 0.198%, **the most probable error is the amount the individual has claimed he or she consumed**.

Alcohol concentration to amount of beverage which must be present in system

To calculate the amount of alcohol that must be present in the system to produce a particular result, the following formula is used:

Alcohol Concentration = A.C.
Body Weight = B.W.
Proof of the Beverage - Proof

The formula is set up as follows:

$$\frac{\text{(A.C.) X (B.W.) X 26.66}}{\text{(PROOF)}} = \text{Amount of Beverage which must be in system}$$

Given the following data solve for the amount of beverage.

Alcohol Concentration (A.C.) = 0.157%
Body Weight (B.W.) - 220 lbs.
Type of beverage was 4% beer (remember the formula requires that the proof equivalent be used, 4% beer - 8 proof beer)

$$0\frac{.157 \text{ X } 220 \text{ X } 26.66}{8} = 115.10 \text{ ounces of beer}$$

For a 220 lb. individual to achieve an alcohol concentration of 0.157% there must have been alcohol from 115.10 ounces of beer in his system at the time of the test. This would then equate to the alcohol from 9.59 12-ounce cans of beer.

The limitation of this formula is that one cannot solve for multiple beverage consumption.

Remember that the results of this calculation provide for the **minimum** amount of beverage from which the amount of alcohol must be derived, or the minimum amount of beverage that must have been consumed, **the actual amount of beverage the individual did consume will always be higher than the calculated amount**.

The Beta Calculations

As discussed earlier, after an individual has achieved “peak alcohol” the body will continue the systematic destruction of the remaining alcohol present in the system. This rate is slightly different for any given individual; however, the most acceptable average for the destruction, referred to as Widmark’s beta factor is 0.015%/Hr.

The only calculations that are scientifically supportable are calculations that project a subject **forward** in time. These calculations or any manipulations of the beta factor are not to be used to try and determine an individual’s alcohol concentration at a point of time in the past (Back Extrapolation).

There are three calculations involving the beta factor

1. Calculating an individual’s alcohol concentration ‘X’ hours later.
2. Calculating the number of hours it will take for an individual to drop from one alcohol (higher) level to another (lower).
3. Calculating the number of hours until an individual would be alcohol free.

Calculating an individual’s alcohol concentration ‘X’ hours after the individual stopped drinking.

Current alcohol concentration = A.C.
Beta Factor = 0.015%
‘X’ Hours = the selected number of hours wished to solve

The formula is as follows:

A.C - (0.015 * ‘X’ Hours) = Alcohol concentration ‘X’ hours later

Given the following data solve for the alcohol concentration.

Current alcohol concentration (A.C.) = 0.20%
Number of hours (X hours) = 6
0.20 - (0.015 * 6) = Alcohol concentration 6 hours later

Anytime a math function is surrounded by ( ) you must perform that calculation first.

0.015 * 6 = 0.09

Then complete the calculation

0.20 - 0.09 = 0.11

If an individual has an alcohol concentration of 0.20% that individual’s alcohol concentration would be 0.11%, 6 hours later.

Calculating the number of hours it will take for an individual to drop from one alcohol (higher) level to another (lower).

Current Alcohol Concentration = A.C.1 (higher)
Projected alcohol concentration = A.C.2 (lower)
Beta Factor = 0.015%

The formula is as follows:

$$\frac{(A.C.1 - A.C.2)}{0.015\%} = \text{Hours from A.C.1 to A.C.2}$$

Given the following data:

A.C.1 = 0.20
A.C.2 = 0.05

Solve for the number of hours

$$\frac{(0.20 - 0.05)}{0.015\%} = 10 \text{ hours to drop from 0.20\% to 0.05\%}$$

Calculating the number of hours until alcohol free

This equation consists of dividing the current alcohol concentration by the beta factor.

$$\frac{A.C.}{0.015\%} = \text{number of hours until alcohol free}$$

$$\frac{0.200}{0.015\%} = 13.33 \text{ hours until alcohol free}$$

Instrument Theory

Introduction to Infrared Light Absorption of the Alcohol Molecule

Infrared light is a form of energy; a specific type of energy known as Electromagnetic Radiation. Electromagnetic radiation can be divided into "groups" whose names are probably familiar: Cosmic Rays, Gamma Rays, X-Rays, Ultraviolet Light, Visible Light, Infrared Light, Microwaves and Radio Waves (see **Figure #1)**. The common denominator of all these groups is that they have the ability to generate heat. The two groups most commonly thought of in this regard are microwaves and infrared light. The area of visible light is further divided into groups of color (see **Figure #2**). As you see from Figure #2, infrared light is outside of the visible light range and is therefore invisible to the human eye. Many animals and insects, however, can see within this range and utilize this ability for survival, food gathering and hunting.

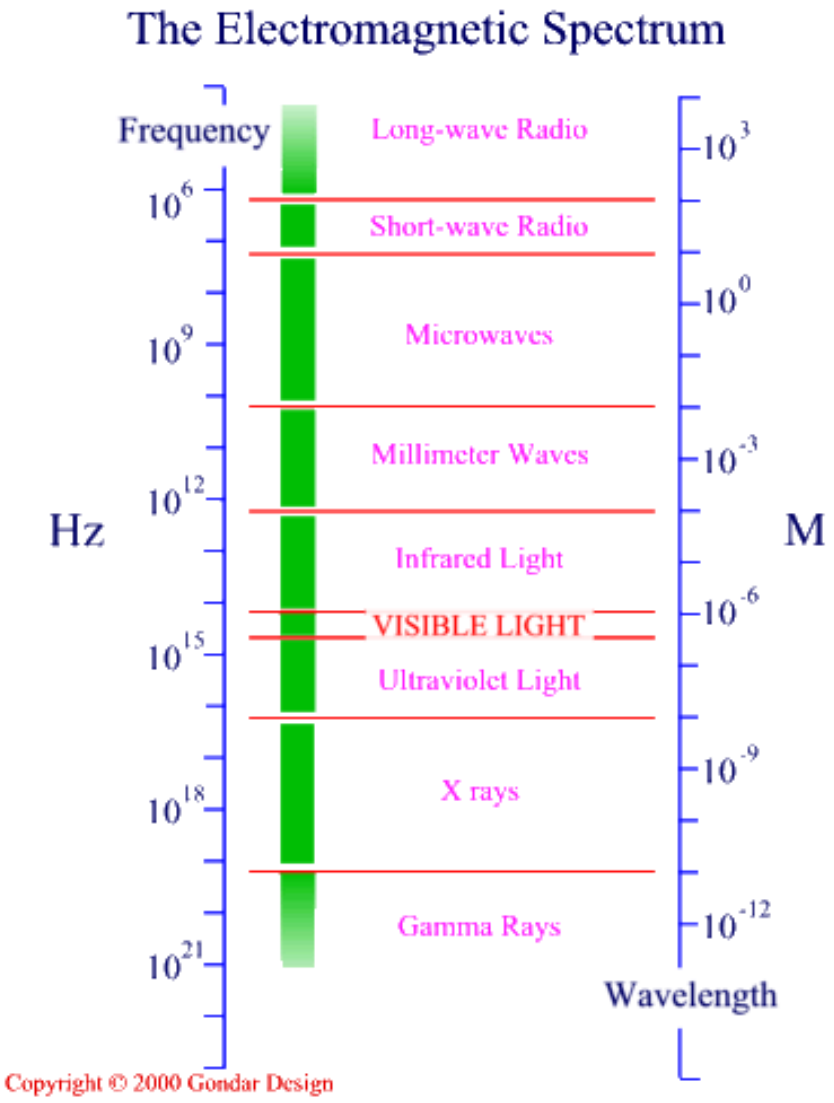
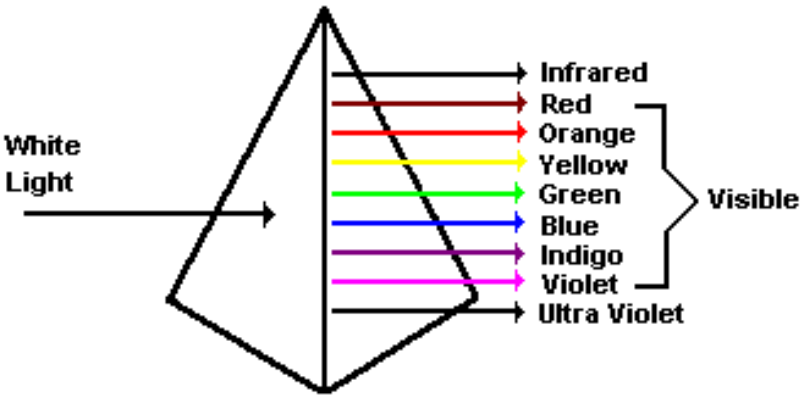


Figure #1



Light Separated into Colors by a Prism

Figure #2

A common application of electromagnetic energy is its use in the microwave oven. Everyone is now familiar with the microwave oven and probably takes what it does for granted. The principal employed in microwave cooking is very closely related to the infrared absorption principal used in the Intoxilyzer 9000.

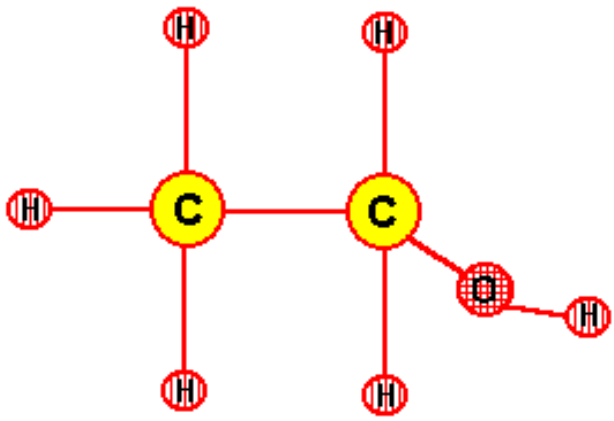
That fundamental principal is: **All things will absorb electromagnetic radiation in a unique and consistent manner**.

The reason that food will cook in the microwave, but the plates or bowls still remain cool to the touch, is due to the fact that the food substances will absorb the microwave energy, creating heat, while the plates or bowls do not. This is also the basis of why a selected wavelength or wavelengths of infrared light can be used to perform a breath alcohol analysis.

The principal behind why substances will absorb the infrared light energy in a unique and consistent manner is due to the fact that **all substances have a unique and consistent molecular structure**. The basis of molecular chemistry is this: all things are made of molecules and all molecules are made of atoms. It is this unique combination of atoms and "bonds" which hold these atoms in their proper position that creates a "specific substance". Furthermore, it is the type of atom, and in particular, the type and position of the "bond between one atom and another which establishes that substances sensitivity to the various wavelengths of electromagnetic radiation and, for our purposes, specifically to infrared light energy.

Shown below is the molecular structure of ethanol.

The Ethanol Molecule



C=Carbon O=Oxygen H=Hydrogen

Since no two substances have the same molecular structure, it is possible to analyze or detect a substance's presence due to the **unique manner in which that substance will absorb infrared light**. This detection process is done using an instrument known as an "Infrared Spectrophotometer", or IR Spec for short.

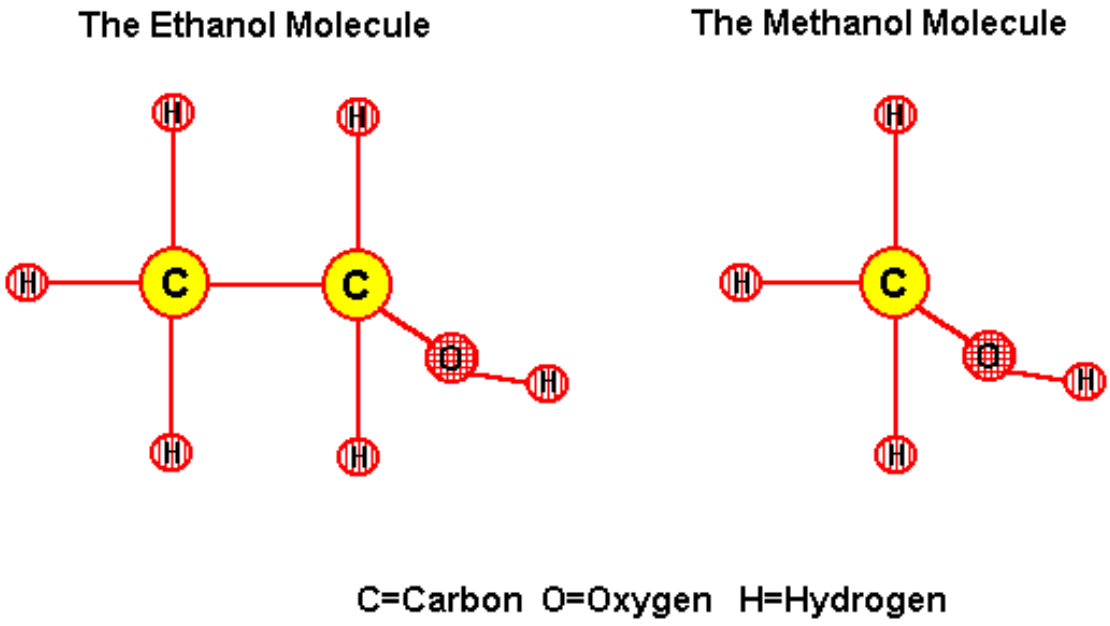
The resonating of the molecular bonds, when exposed to the infrared energy, causes this absorption or "sensitivity". The IR energy is absorbed by these resonating bonds and is depleted. It is therefore possible to measure the amount of energy that is used, due to the **unique and consistent manner** in which it happens.

Since these bonds will resonate to different degrees at different wavelengths of IR light a "fingerprint" of that substance's absorption or sensitivity to those wavelengths is created. This fingerprint is most commonly expressed in percent transmittance, which depicts the loss of IR light able to pass through a molecule.

By knowing a substance's fingerprint, it is possible to select wavelengths which are "in tune" with that molecule. The range of IR energy which exhibits a great degree of sensitivity to the alcohol molecule is the 3.35 to 3.50 micron range.

Selecting just one wavelength of the IR light does have certain drawbacks, for even though a substance will produce its own unique fingerprint across the entire IR spectrum, the fingerprint of a single wavelength may be extremely similar to another substance within the same chemical family.

Look again at the molecular structure of ethanol and compare it to the structure of another molecule within the same family, methanol.



Notice that the only difference between the two structures is that the Ethanol molecule has an additional carbon atom and two additional hydrogen atoms. Of critical importance in both of these structures is the OH group. It is this functional group which establishes the molecule as an alcohol; therefore, all alcohols have this functional group and therefore will react in a similar manner at **certain** wavelengths, but the degree and ratio of absorption at the two wavelengths employed by the Intoxilyzer 9000 is able to **differentiate from even the most closely related alcohols** (methanol and isopropanol) at very low concentrations.

The Basics of Infrared Absorption in Breath Analysis

The rudimentary application of the Infrared absorption theory, in association with the "fingerprint" of alcohol can be explained as follows. When IR light of a particular frequency passing through a chamber with no alcohol present and strikes the voltage detector, a certain voltage level is created. This can be called X. As an alcohol sample is introduced into the chamber some of the IR light is absorbed. As the alcohol level in the chamber **increases**, the amount of light able to pass through the chamber and strike the detector **decreases**. At the end of the sample a very different amount of light is striking the detector creating a different level of voltage. This new level of voltage can be called Y. Infrared absorption theory can, in a nutshell, be stated as follows. **If one can establish the amount if IR light passing through a chamber with no alcohol present: X. Then establish how much of that same IR light is able to pass through the chamber with alcohol present: Y. The difference between the two, or X - Y, will**

represent the concentration of alcohol in the chamber. This analogy demonstrates how the instrument analyzes for the alcohol; however, this must be explained further.

Interferent

In testing human breath samples for alcohol concentration, the probability of a substance other than alcohol being present in the sample and demonstrating the same degree of reactivity at the selected wavelengths, is considered to be **extremely remote**. Most substances that do show reactivity in the area employed by the Intoxilyzer 9000 are highly toxic and severe physical symptoms would be exhibited by an individual that may have ingested one of these substances.

There does exist however, one substance which can be produced naturally by the body and may mimic the outward symptoms of alcohol intoxication. This substance also has a high degree of reactivity in one of the selected IR light ranges. This is the substance Acetone.

Acetone is produced by two types of individuals: those on very restrictive or fasting types of diets and unmedicated diabetics. There has never been reliable scientific documentation of a “fasting” subject producing acetone in sufficient quantities to interfere with a breath analysis. However, unmedicated diabetics, under certain conditions, may produce significant levels of acetone. It is critical to be able to detect if the individual being tested is a diabetic, and is producing high quantities of acetone, so that alcohol can be ruled out a as primary cause of the impairment.

To ensure that an analysis is free from any ingested contaminants or an interferent such as acetone, the Intoxilyzer uses what is called a Multiple Beam Analysis Method. **Figure 3** shows the ethanol fingerprint and the fingerprint of acetone. Notice that acetone has a rather high degree of reactivity with the original wavelength in the 3 micron range but has very little reactivity with the wavelength near 9 microns. That means that acetone will not affect the Intoxilyzer 9000. Further, since all substances will produce their own unique fingerprint each and every time, there is a unique and consistent relationship between all the 9 micron channels. That relationship can be expressed as a ratio. For example, say that every time ethanol is placed into an IR spec the peak height of the 9.5 microns reaches line 10 on the graph paper and the peak height of the 9.2 microns reaches line 5, and this occurs each time a sample containing *ethanol only* is placed into the IR spec. A unique and consistent occurrence is created between the two peak heights and a mathematical ratio (i.e. 10:5) can be established. Note, however, if an ethanol and another substance that absorbs in the 9 micron range (i.e. methanol) are placed into the IR spec that the absorption peak will change due to effect of that substance. This reaction will upset the mathematical peak height ratio between the two wavelengths (i.e. 12:5). The Intoxilyzer is designed to detect this imbalance and immediately abort the analysis. Therefore, the Intoxilyzer uses multiple 9 micron wavelengths for **alcohol** analysis that can also be used as the “monitoring system” for “**Interference**”.

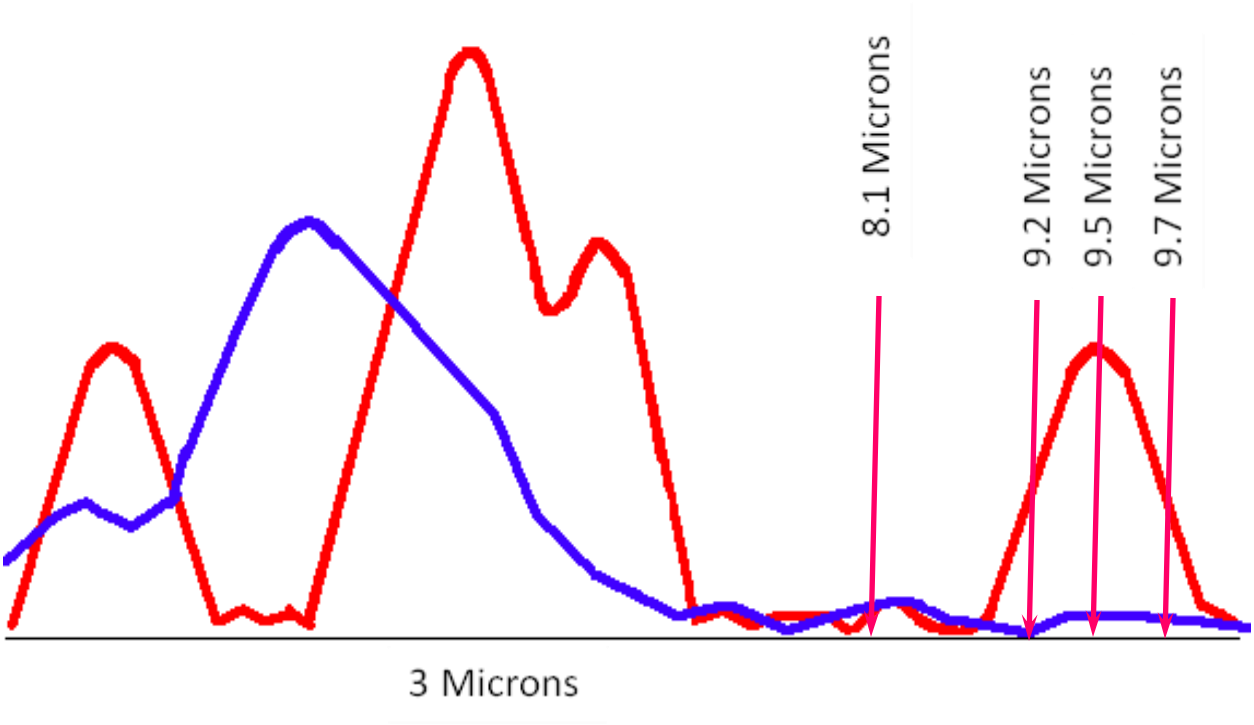


Figure 3

The above explanation is a basic and simple one; and for the average individual it is one that may be easily understood and demonstrated. A more in-depth explanation will follow; however, we first need to “build” an Intoxilyzer.

The Systems of the Intoxilyzer

The design of the Intoxilyzer 9000 can be described in terms of “systems”. There are five basic systems in the instrument: the Optical Bench, the Processor, the Breath/Air Flow System, the Central Processing Unit (CPU), and the Print/Display System.

The Optical Bench

The optical bench is the “heart” of the instrument. It is composed of the following components: the light source, the chamber, the IR filter.

The IR Light Source

As its name indicates this is the source for the generation of the infrared light. The light source must be able to provide adequate IR light of the required wavelengths and must provide a stable output of this energy.

The Intoxilyzer 9000 utilizes a pulsed IR light source. This type of light source produces stable and sufficient quantities of infrared light for our analytical purposes.

The Sample Chamber

This is where the sample will be collected and held for the analysis. There are three basic requirements for the sample chamber. First, the sample chamber must be heated. The temperature of the sample chamber is not critical to the analysis as long as the temperature remains relatively constant throughout the analysis. The chamber must be heated to avoid the development of condensation from the breath/air sample onto the walls of the chamber itself. The chamber must be sealed so that the incoming sample will not leak out and the outside air cannot enter, thus diluting the sample.

The volume of the sample chamber is not a critical issue. The analysis of the breath sample is not volume dependent, but rather “slope dependent”.

Of primary concern is the sample chamber’s resolution. That is, how much light is able to pass through the chamber. The IR light, as it leaves the light source side, will spread throughout the sample chamber so that the entire area of the chamber is flooded with the IR light. This system provides for adequate resolution to occur and provides good contact between the IR light and the breath sample.

The Filter

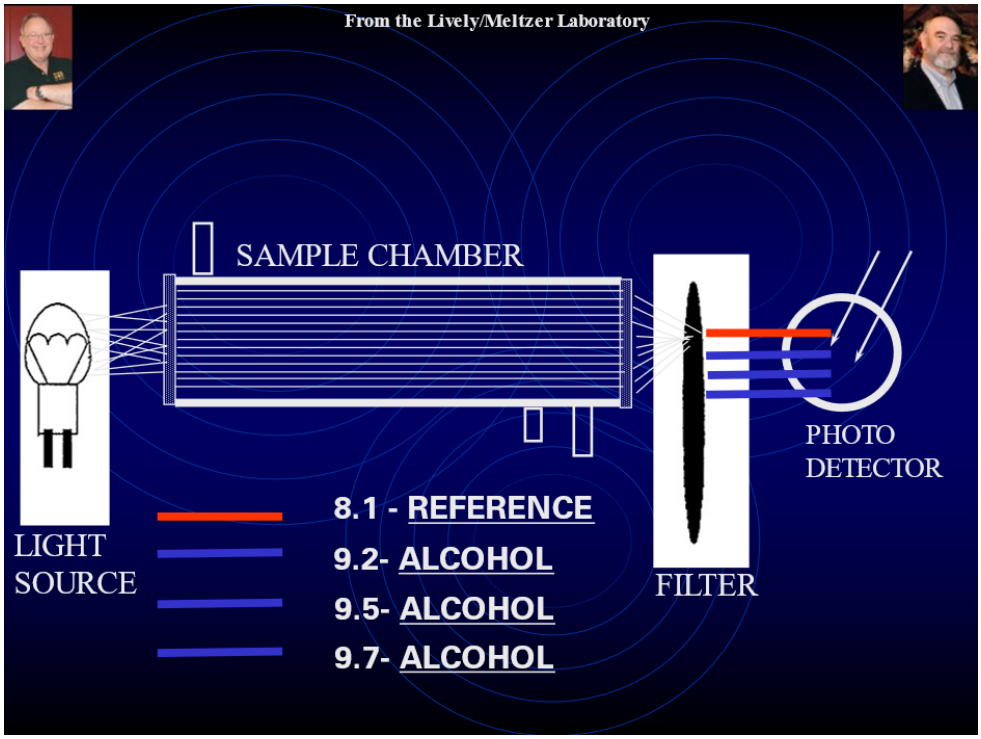
The light exiting the chamber still consists of many various wavelengths of IR; therefore, the light must now be “filtered” so that only the selected wavelengths are allowed to pass. In the original instrument only one wavelength was utilized and therefore a frequency “chopper” was used. In today’s instruments, multiple wavelengths are utilized for analysis and the Intoxilyzer currently employs a four-filter system with specific “narrow band pass” filters mounted in precise locations for the filtering of the IR light.

The four-filter system allows only the IR light wavelengths desired to pass through and strike the detector. They are also used to establish the “Internal Test Procedure (ITP)” of the instrument.

The IR Detector

The endpoint for the light is the Infrared detector. This is a very sophisticated device that does a rather simple job. The IR detector is responsible for converting the filtered IR light into electrical energy. When each of the filtered IR light wavelengths strikes the detector, a certain level of energy or signal is produced for each wavelength. The amount of signal produced is directly proportional to the amount of light able to pass through the sample chamber and strike the detector. These signals generated by the IR detectors are now passed on to the processor.

Before we discuss the processor, let’s put all of the parts of the Optical Bench together and review its function (see diagram below). The IR source is projecting IR energy into and through the sample chamber. This IR energy is gathered and focused onto the four-filter system.



The Internal Test Procedure (ITP)

As alcohol enters the sample chamber it will begin to absorb the IR light, the concentration of the alcohol in the chamber is proportional to the amount of this absorption of IR light. The concept behind the ITP is also based on this same principal.

Each filter on the four-filter system has its own unique and consistent composition which is why a particular filter will only allow passage of a particular band width of the IR light. This process is called attenuation. The IR light passing through the filter is converted to electrical energy via the photo detector. Since each filter is unique, the amount of electrical energy produced is exclusive to that filter.

This process can be demonstrated by taking a flashlight and shining it onto a wall, then placing a piece of glass in front of the beam. Each time the glass is placed in front of the beam a certain amount of the light is attenuated, or blocked, and the exact same amount of light will be attenuated each time the same piece of glass is placed in that position. By knowing the amount of attenuation this piece of glass creates, it could then be used to cross check calibration of the flashlight, just as the individual filters are used to cross check calibration in the instrument.

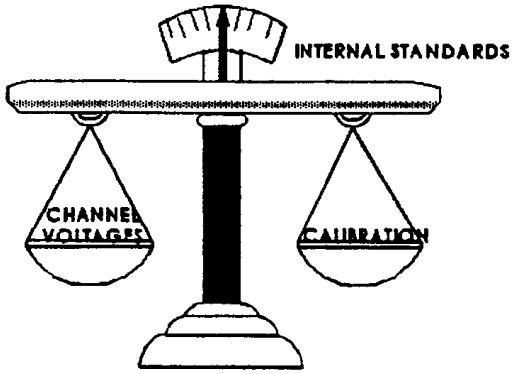
The voltage levels produced by the filters are converted into a simulated alcohol concentration via the processor board. This simulated concentration is then fed through the calibration section of the Central Processing Unit (CPU). The instrument monitors the final output from the CPU in order to insure proper calibration has been maintained.

The most attractive advantage of the ITP is the direct connection between the voltage levels produced by the individual filters, and the calibration setting of the instrument. One could describe the ITP by using a set of Pan Scales, with one of the pans

containing the channel voltages, the other containing the calibration setting, and the pointer of the scales being the ITP.

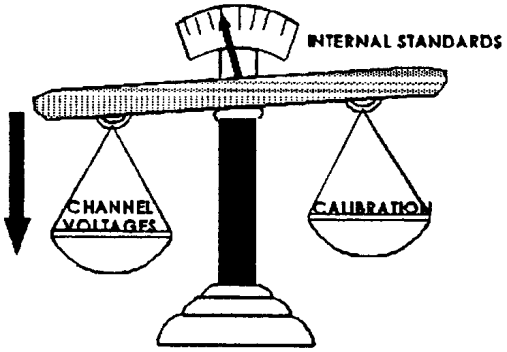
When the instrument is properly adjusted and calibrated, the ITP's are automatically "tuned" to the voltage and calibration settings. During the ITP program mode of the analysis, if any of the ITP settings have changed more than 5% from the required setting, the instrument will abort the analysis and indicate the error by displaying and printing "ITP Failed". An error of this nature is indicative of either a change in the channel voltage levels or a change in the calibration setting. The end result is a method by which one can ensure that the channel voltages *and* the calibration settings cannot change without the operator being notified

The following diagram represents a system with the voltages, calibration and ITP in sync:

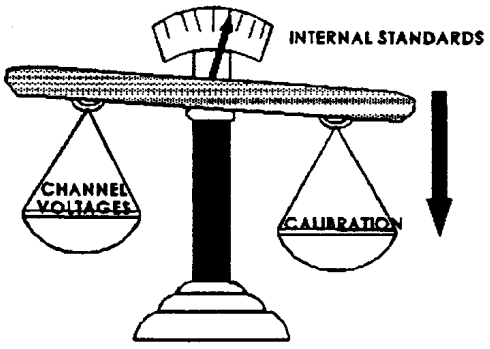


CHANNEL VOLTAGES, CALIBRATION AND INTERNAL STANDARDS IN SYNC

The next two diagrams demonstrate what effect any change in the voltage levels or the calibration setting would have on the ITP.



SHIFT IN CHANNEL VOLTAGES CAUSES CAUSES A SHIFT IN INTERNAL STANDARDS



SHIFT IN CALIBRATION CAUSES A SHIFT IN INTERNAL STANDARDS

The ITP provides an excellent method of confirming that all channel voltages are still within their proper working parameters and there has been no alteration or change in the calibration setting. The ITP is an outstanding accompaniment to the use of an external standard for confirming and ensuring accurate alcohol analyses.

Radio Frequency Interference

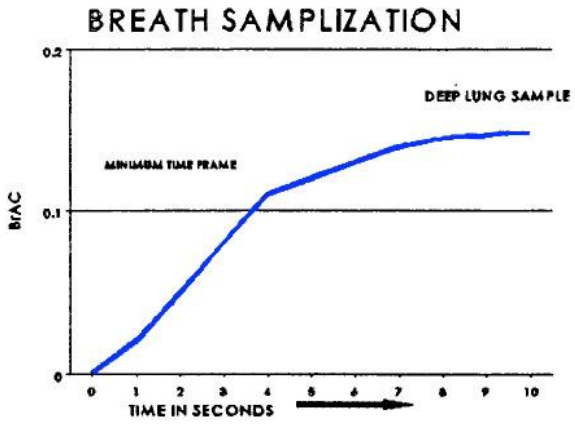
In the mid-1980's there was speculation that certain radio frequencies could interfere with a breath analysis and cause a false high result. Even though it has never been proven that a radio frequency ever affected a breath alcohol result, the U.S. Department of Transportation, National Highway Traffic Safety Administration instituted research into the matter. The result was a set of criteria, which all instruments must be subjected prior to being approved for use in the breath analysis field. The Intoxilyzer 9000 was subject to this testing and satisfied all conditions.

The RFI protection mechanism of the Intoxilyzer is three tiered: First, the interior of the case is coated with metal and every vent opening or area which does not have metal shielding is covered with wire mesh. This creates what is called a Faraday cage, which is designed to prohibit the entrance of radio frequency by grounding out the radio wave before it can enter the instrument. Second, the incoming power line has an Electromagnetic Interference Filter in place, which protects from any electromagnetic signals (radio frequencies are this type) from entering the instrument through the power lines. Third, the instrument has a specifically design circuit that monitors the area around the instrument for any radio frequencies with a sufficient field strength and, if detected, will abort the test and notify the operator of the RFI presence. With these safeguards in place the question of RFI affecting a test is eliminated.

The Breath Sampling Process

To assure that the breath sample is proper, sufficient and complete; and that no contamination is present due to residual mouth alcohol, is paramount to the science of breath analysis.

The Intoxilyzer 9000 uses four criteria to determine a proper sample. This instrument is equipped with a flow detection device, which measures the pressure and volume of the sample at the same time. This is why the Intoxilyzer 9000 can print the sample volume, which can be useful in court, on the breath analysis report form.



The first breath sample requirement of the Intoxilyzer 9000 is the subject must blow hard enough to deliver 0.15 Liters per second. After the subject has reached this flow output, the tone will be initiated.

Once the tone has been activated, the second breath sample requirement must be met. The Intoxilyzer 9000 makes sure that the subject blows beyond a minimum set time frame. In this case, the time frame is greater than 1 second.

The third condition guarantees a minimum sample has been collected. The Intoxilyzer 9000 needs a minimum of 1.5 Liters of breath before it will accept a sample.

Finally, the Intoxilyzer 9000 also uses a Level Slope Detection system as the last sample requirement. This calculation is done using several different data points along the breath curve and constantly comparing those data points to each other. The slope of the alcohol curve must level off before the instrument will accept any sample.

This process is repeated for the second subject sample; however, the subject volume is now based on how much breath the subject provided in sample one. As long as the volume of sample one is greater than 1.5L, the instrument will require 80% of the volume of sample one as the new minimum volume for sample two. For example, sample one volume is 2.8L of breath. The new minimum volume of sample two is now 2.24L (80% of 2.8L) or greater of breath. All other requirements are the same.

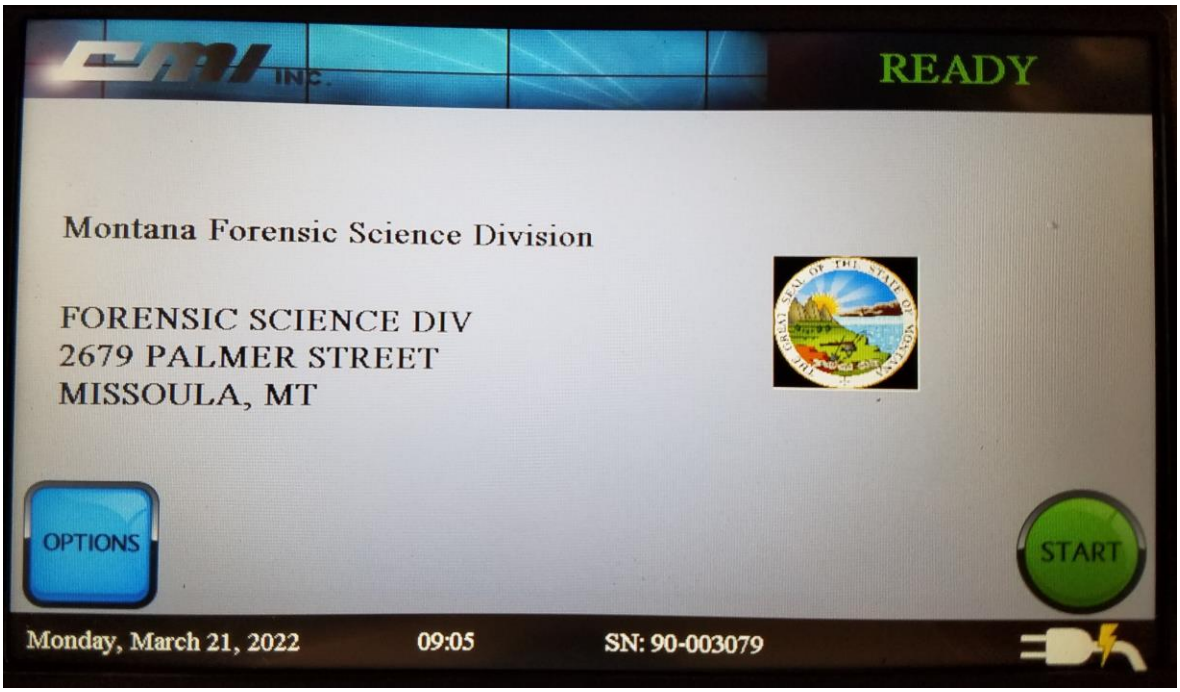
REQUIREMENTS FOR ACCEPTANCE OF A BREATH SAMPLE IN THE INTOXILYER:

FLOW:	THE SUBJECT MUST DELIVER MORE THAN .15 LITERS/SECOND.
TIME:	THE SUBJECT MUST DELIVER FOR GREATER THAN 1 SECOND.
MINIMUM SAMPLE:	THE SUBJECT MUST DELIVER GREATER THAN 1.5 LITERS OF BREATH.
LEVEL SLOPE DETECTION:	THE ALCOHOL SLOPE MUST NOT BE RISING FASTER THAN THE ALLOWED RATE.

INSTRUMENT OPERATION

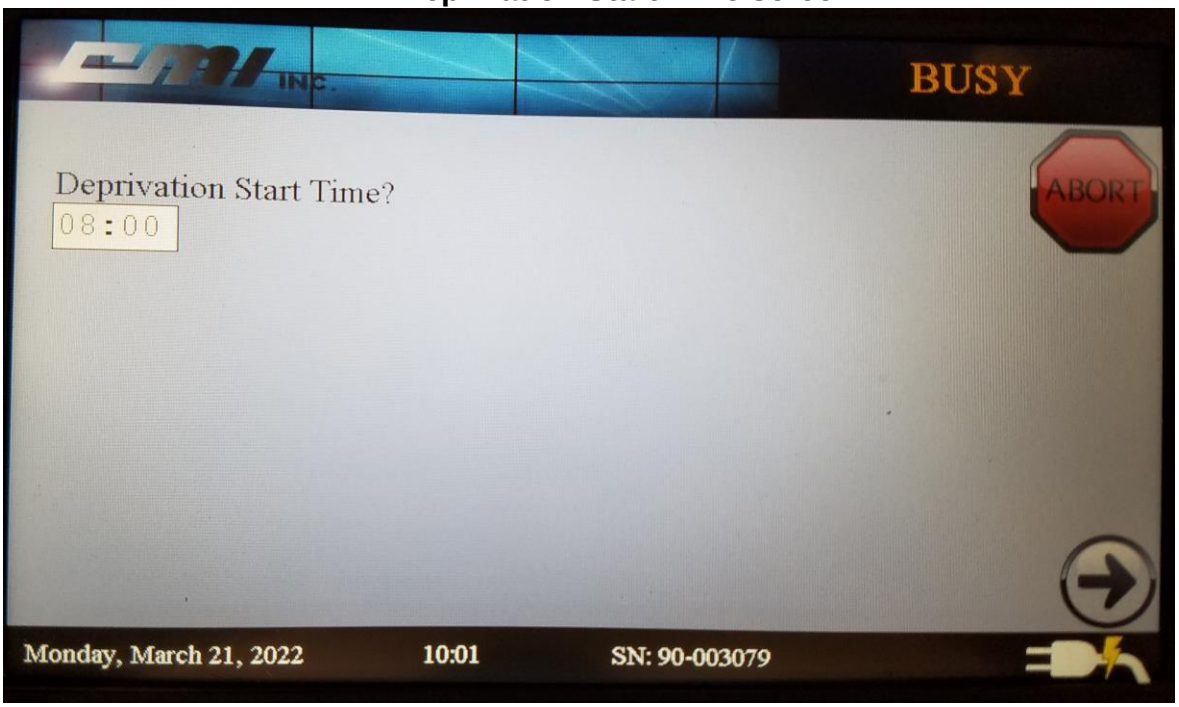
Data Entry Questions for

Breath Analysis Report Form
(Subject Test)



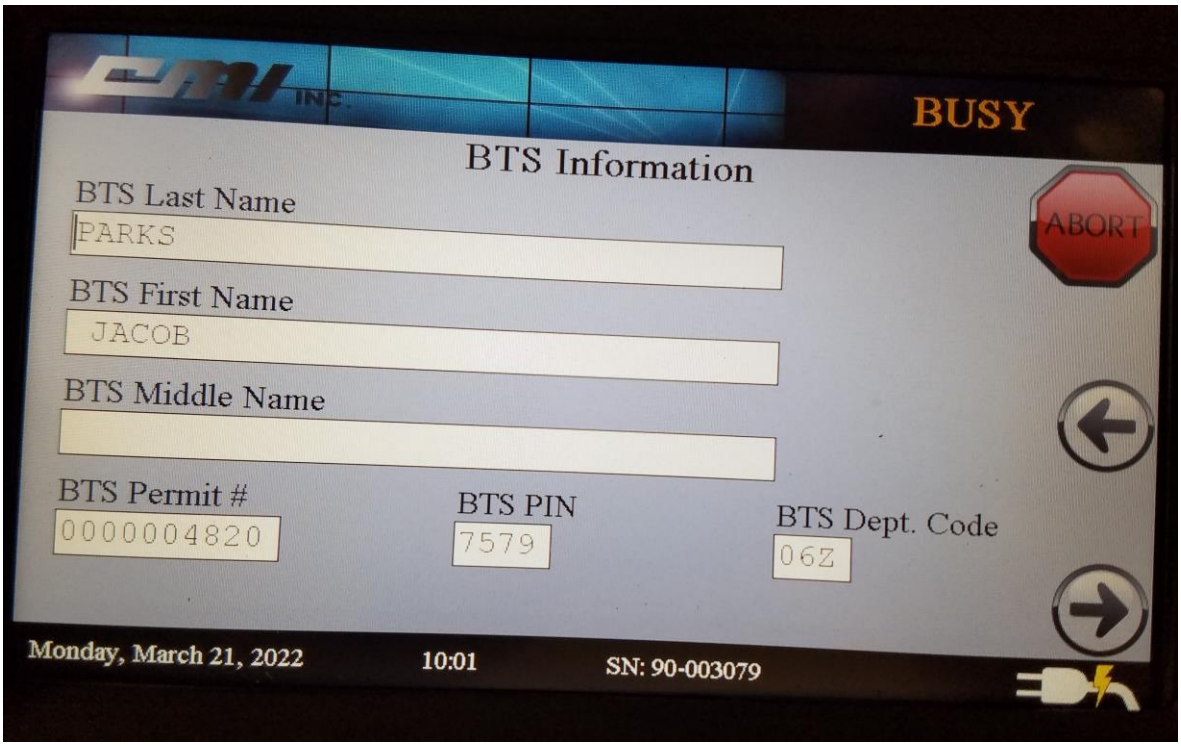
Before beginning a test, the Operator should check the Date/Time on the screen. If either is incorrect, contact the Senior Operator to reset them. To begin a Subject Test, press the Green **Start** button. Choose either the **Keyboard** button to enter data through the keyboard or the **Barcode** button to enter data with the 2D barcode scanner (this is the preferred method, if available). After pressing the **Barcode** button, scan the BTS card and enter the PIN. Note: if using the keyboard for data entry the Operator must type in all the leading 0s in the Permit Number. If the Operator is currently certified, the instrument will continue to the next screen. If the Operator is not current, the instrument will not allow any testing.

Deprivation Start Time screen



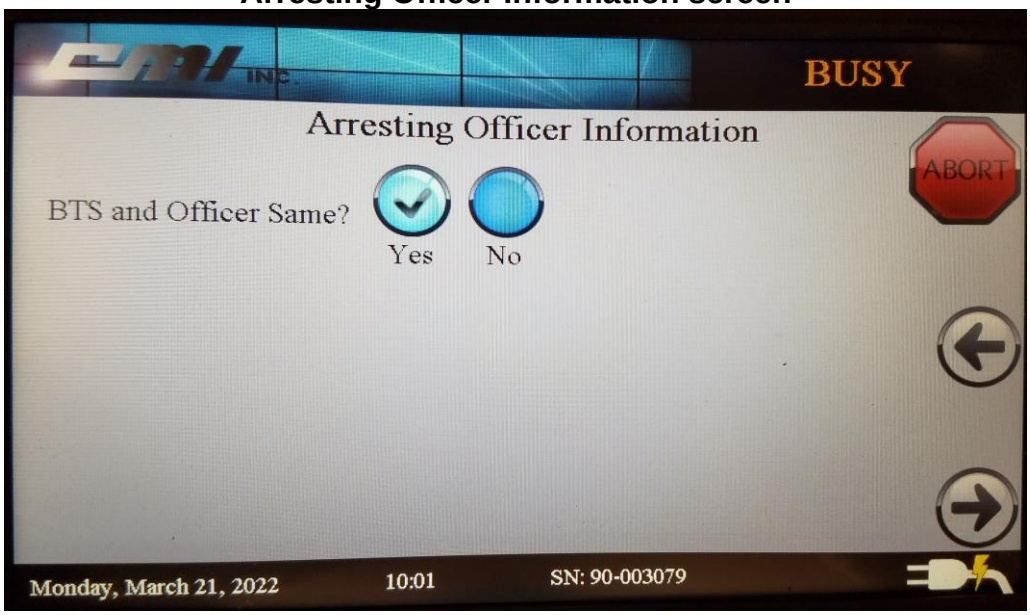
Deprivation Start Time? appears. The Operator must enter the beginning of the deprivation start time (Note: this must be at least 20 minutes prior to current time or a "wait screen" will appear).

BTS Information screen



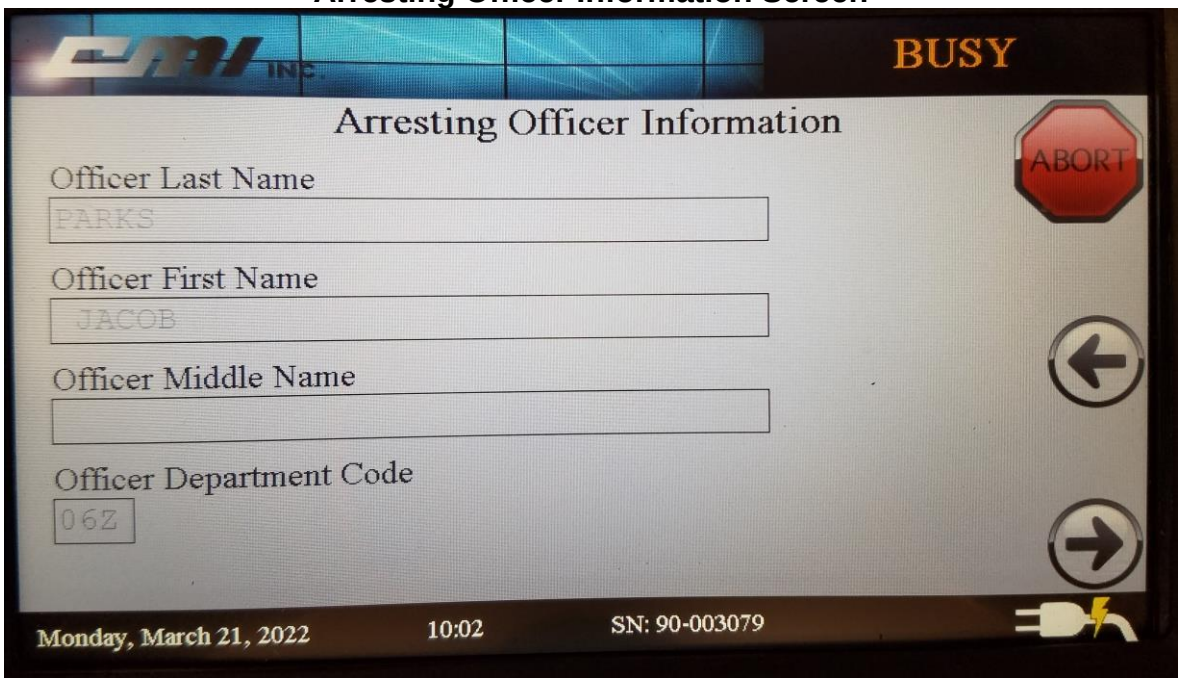
The Operator must confirm **BTS Last Name**, **BTS First Name**, **BTS Middle Name** (usually blank), **BTS Permit #** (with all leading 0s), **BTS PIN** and **BTS Dept. Code** (see page 80 for all Dept. Codes). If all data is correct the Operator must press the right arrow button. If any data is incorrect, the Operator must choose the field and correct the data.

Arresting Officer Information screen



The screen displays **BTS and Officer Same?** The check box for "Yes" is already chosen. If this is correct, the Operator must press the right arrow button. If this is incorrect (i.e., another officer has made the arrest), the Operator must choose "No" and press the right arrow button.

Arresting Officer Information Screen

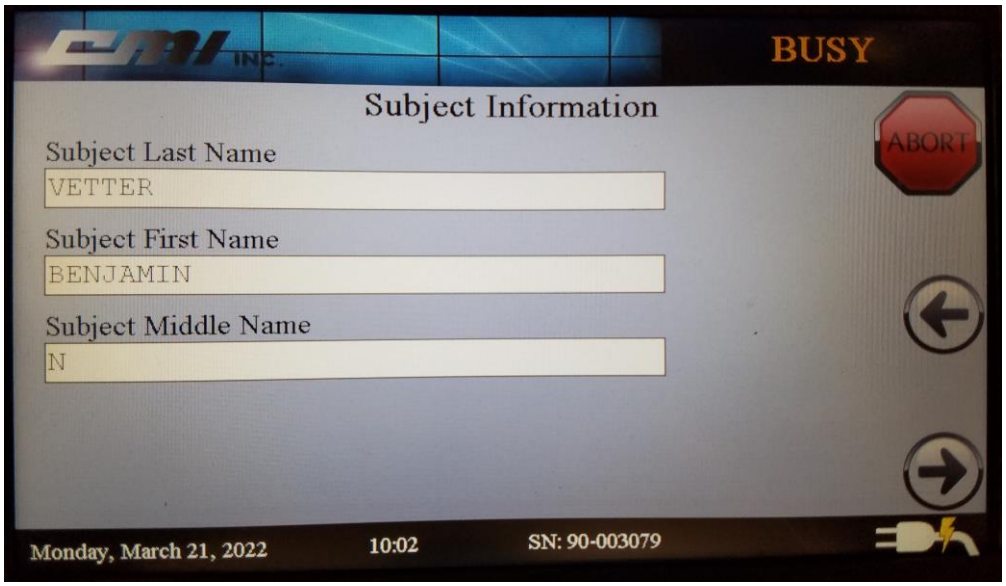


If BTS and Arresting Officer are the same person, the Operator must verify all fields are correct and press the right arrow button. Note: these fields are not editable at this time. If BTS and Arresting Officer are different, the Operator must enter the correct Arresting Officer Information in the fields provided and press the right arrow button.

Driver's License screen

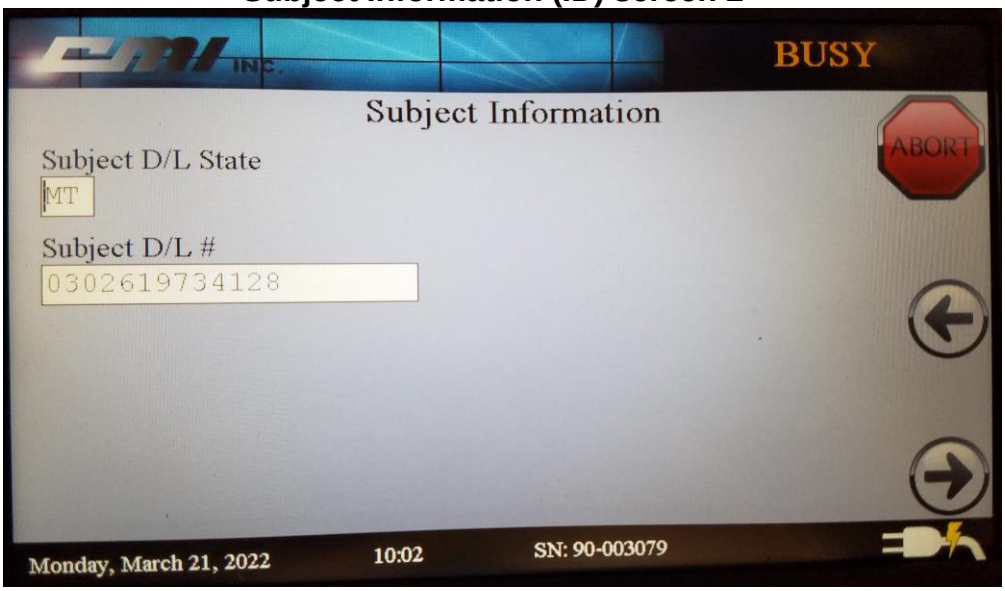
The Operator must choose the **Keyboard** button or the **Barcode** button (the **Barcode** button is preferred, if available). The Operator can scan the subject's driver's license using the 2D barcode on the back (Note: if this is an out-of-state license the Operator may try to scan the driver's license, but the keyboard may have to be used). If there is no driver's license to scan, the Operator can use the keyboard to enter the subject data, if available.

Subject Information (Name) screen 1



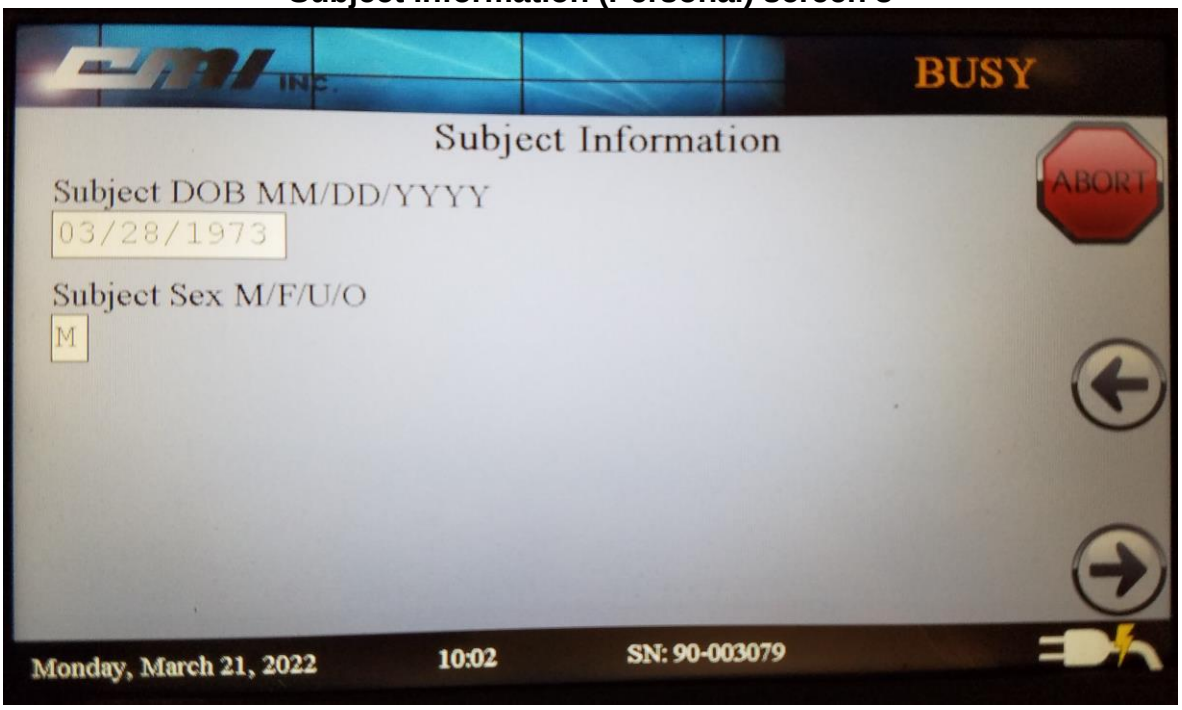
The Operator must verify all scanned fields are correct (or enter fields through the keyboard). If any fields are incorrect, the Operator must choose the field and correct the data. The Operator then must press the right arrow key.

Subject Information (ID) screen 2



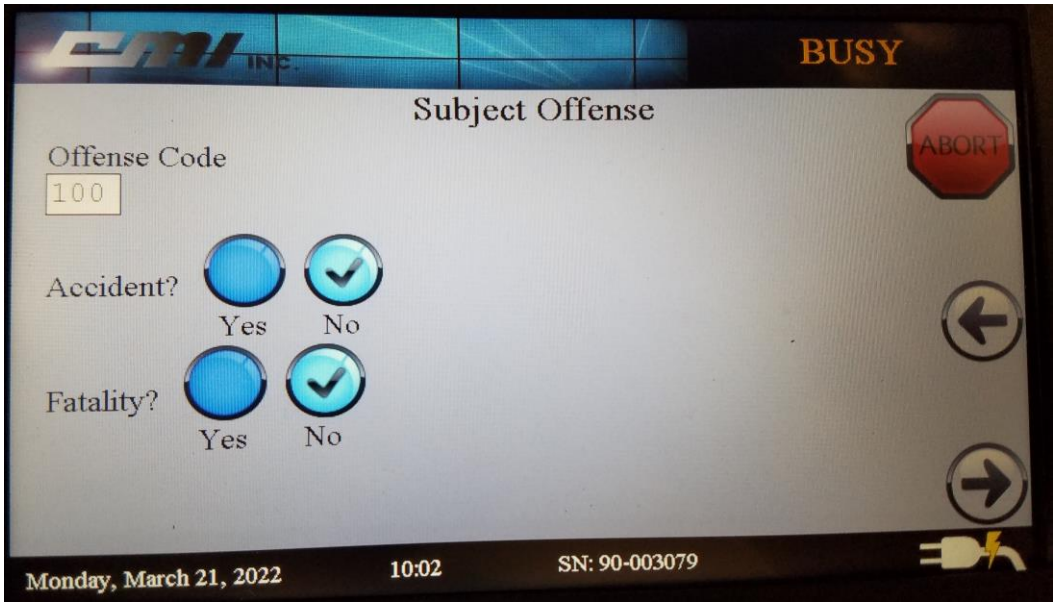
The Operator must verify all scanned fields are correct (or enter fields through the keyboard). If any fields are incorrect, the Operator must choose the field and correct the data. The Operator then must press the right arrow key.

Subject Information (Personal) screen 3



The Operator must verify all scanned fields are correct (or enter fields through the keyboard). If any fields are incorrect, the Operator must choose the field and correct the data. The Operator then must press the right arrow key.

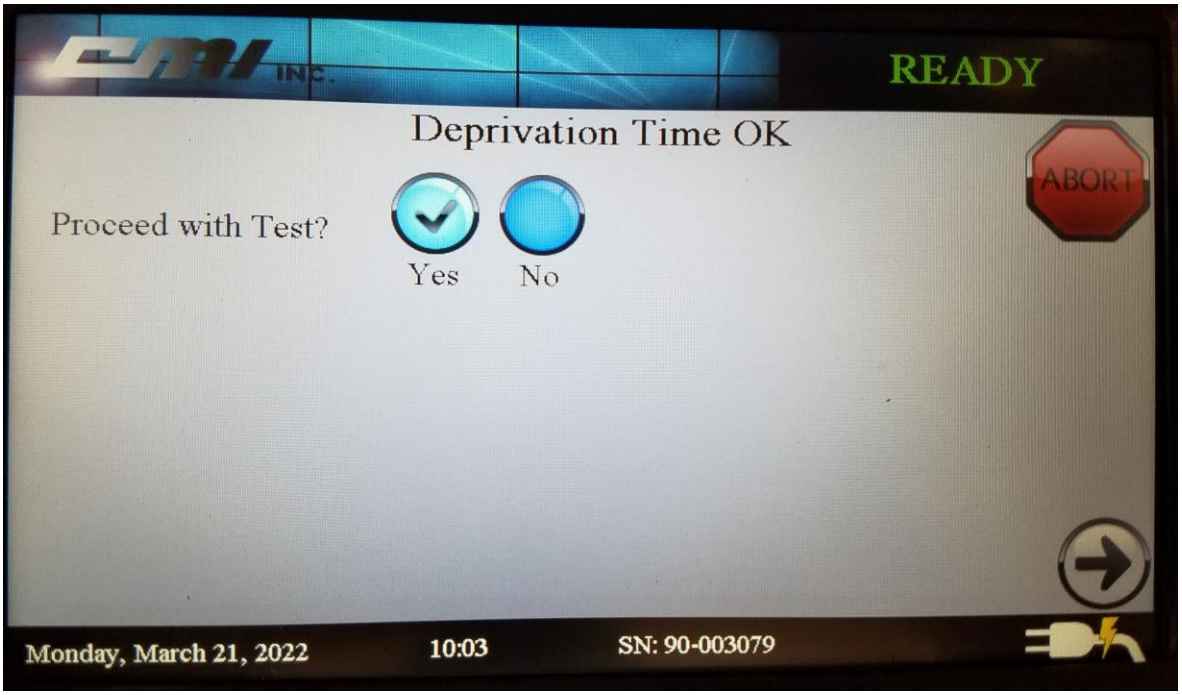
Subject Offense screen



The Operator must enter an **Offense Code** in the field (see page 80 for all Offense Codes). The Operator must answer if there was an **Accident?** "No" is already checked but can be changed to "Yes" if needed. The Operator must answer if there was a **Fatality?** "No" is already checked but can be changed to "Yes" if needed. The Operator must press the right arrow button.

The Operator must choose **Review** or **Continue**. **Review** is chosen if the Operator wants to review all Officer and Subject data. **Continue** is chosen to start the testing sequence.

Deprivation Time OK screen



If there has been a proper deprivation time (at least 20 minutes prior to current time), the instrument will display **Proceed with Test?** The "Yes" box is already checked. The Operator must press the right arrow key. If the 20-minute deprivation period has not been met, the instrument will display a countdown to meet the 20-minute deprivation period.

Testing Sequence

The instrument begins the automatic testing sequence. During this time, the Operator should keep the subject away from the instrument until it is time to provide a breath sample. If any portion of the sequence is outside of specifications (see page 32 for examples of Exception Messages), the instrument will sound an alarm and give a printout of the issue. The Operator may, depending on the nature of the issue, choose to start another testing sequence.

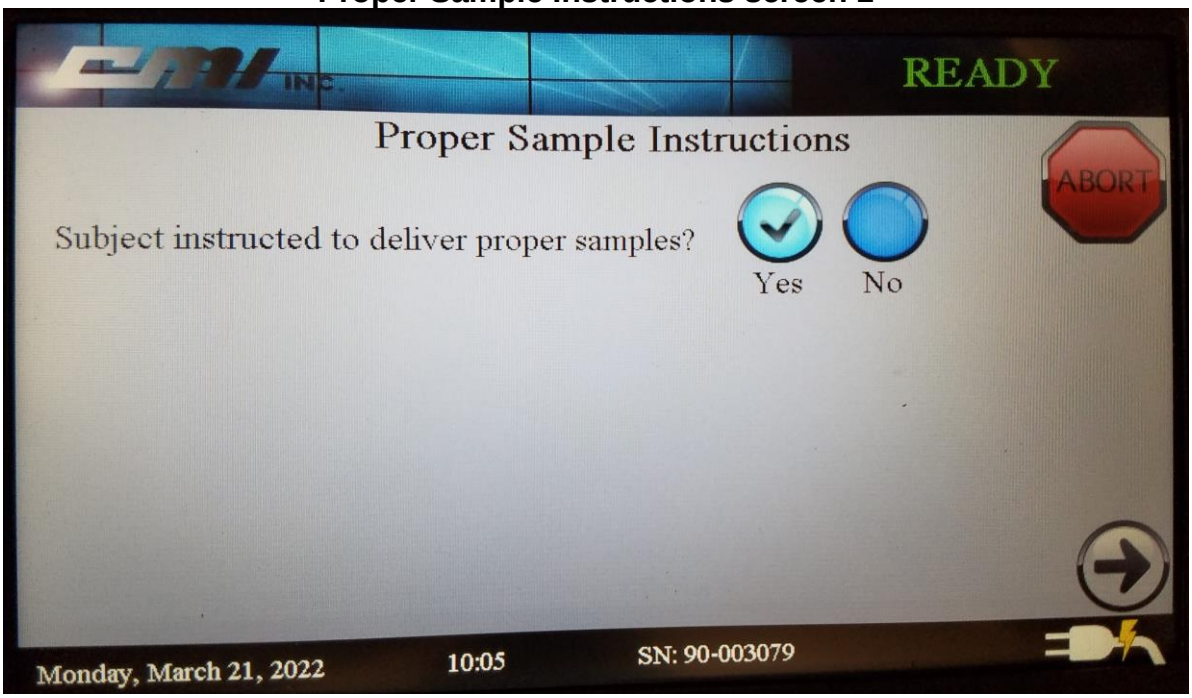
Air Blank: The instrument is clearing the tubing and chamber of any residual alcohol and setting 0.000 g/210L.

Diagnostics: The instrument is doing a self-check of mechanical and analytical functions.

Air Blank: The instrument is clearing the tubing and chamber of any residual alcohol and setting 0.000 g/210L.

Calibration Check: The instrument is checking the 0.080 g/210L Gas Standard to make sure it is reading within +/- 0.005 of 0.080 g/210L.

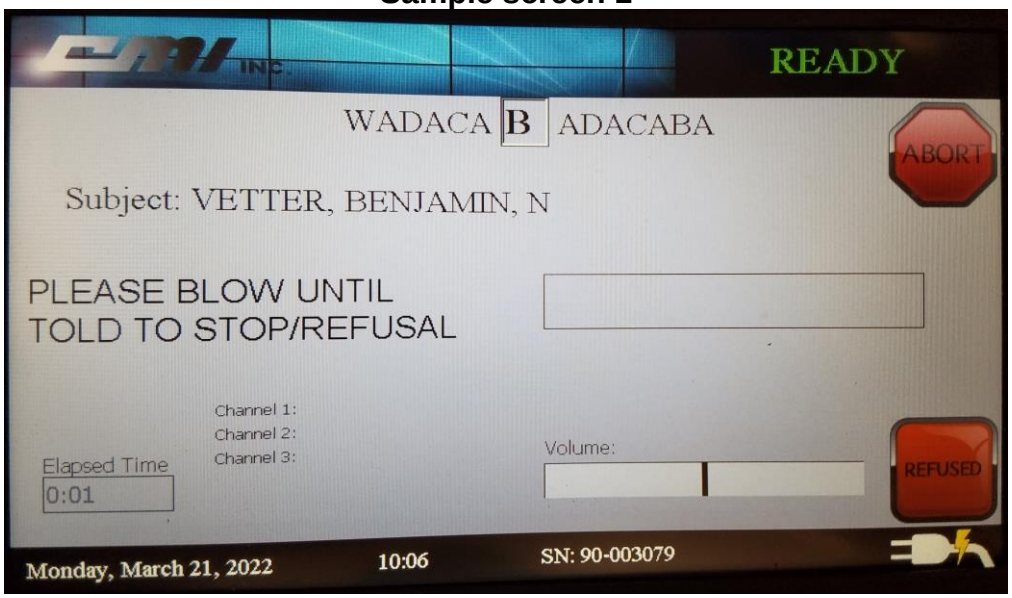
Proper Sample Instructions screen 1



The instrument displays **Subject instructed to deliver a proper sample?** The “Yes” box is already checked. The Operator must give the subject proper instructions for a breath sample (see BTS Manual for subject instruction example), then press the right arrow button.

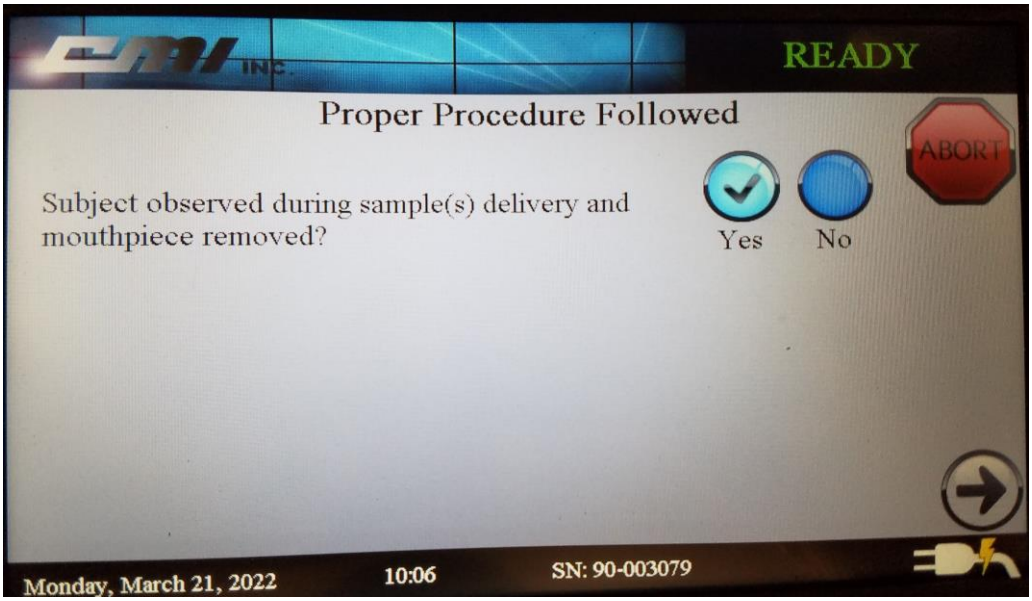
Air Blank: The instrument is clearing the tubing and chamber of any residual alcohol and setting 0.000 g/210L.

Sample screen 1



The instrument displays the subject's name and PLEASE BLOW UNTIL TOLD TO STOP/REFUSAL. If the subject is refusing the breath test, the Operator must press the **REFUSAL** button and the instrument will print *Subject Test Refused on the Breath Analysis Report Form. If the subject is cooperating, the Operator must attach a mouthpiece to the breath hose and have the subject provide a proper sample (see BTS Manual). During the sample delivery, the Operator will notice the subject's breath volume accruing on the screen in liters and a graphic indicating the minimum-subject-volume-required line. Once the subject has met all breath sample requirements (see BTS Manual), the instrument will triple beep and finish with the sample process. The Operator must be sure to remove and dispose of the mouthpiece. The Operator must again be sure to place the subject away from the instrument.

Proper Procedure Followed screen 1



The instrument displays **Subject observed during sample(s) delivery and mouthpiece removed?** The check box is already set to “Yes”. If these conditions were met the Operator must press the right arrow button.

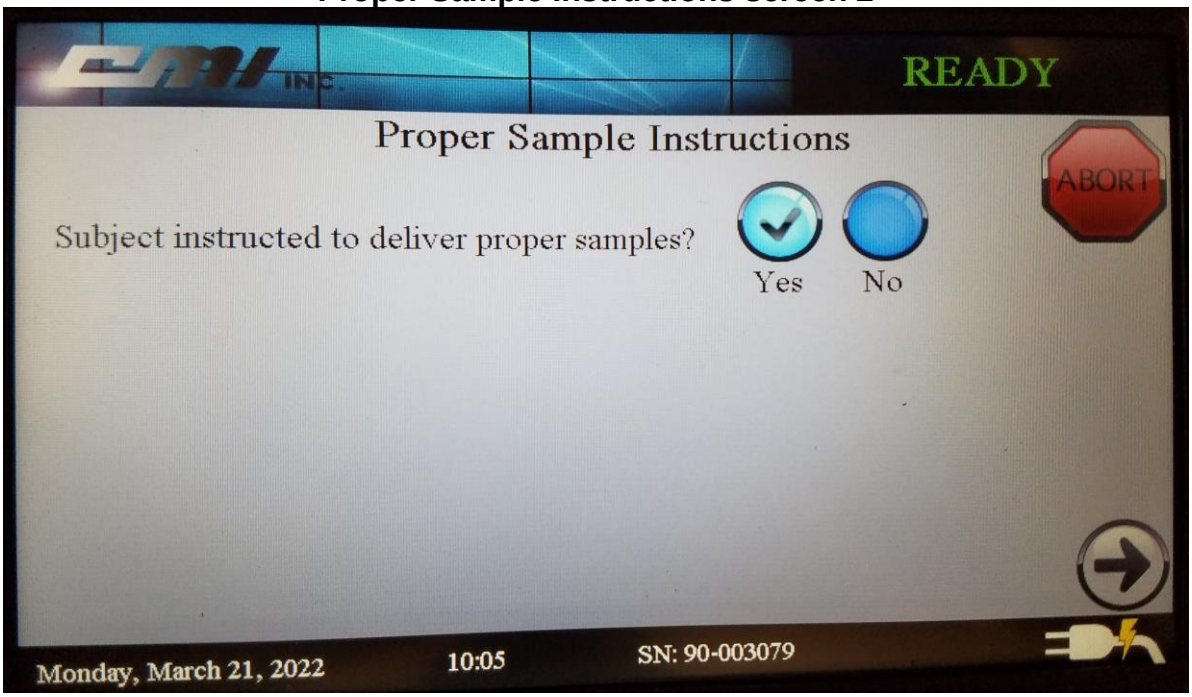
Air Blank: The instrument is clearing the tubing and chamber of any residual alcohol and setting 0.000 g/210L.

Diagnostics: The instrument is doing a self-check of mechanical and analytical functions.

Air Blank: The instrument is clearing the tubing and chamber of any residual alcohol and setting 0.000 g/210L.

Calibration Check: The instrument is checking the 0.080 g/210L Gas Standard to make sure it is reading within +/- 0.005 of 0.080 g/210L.

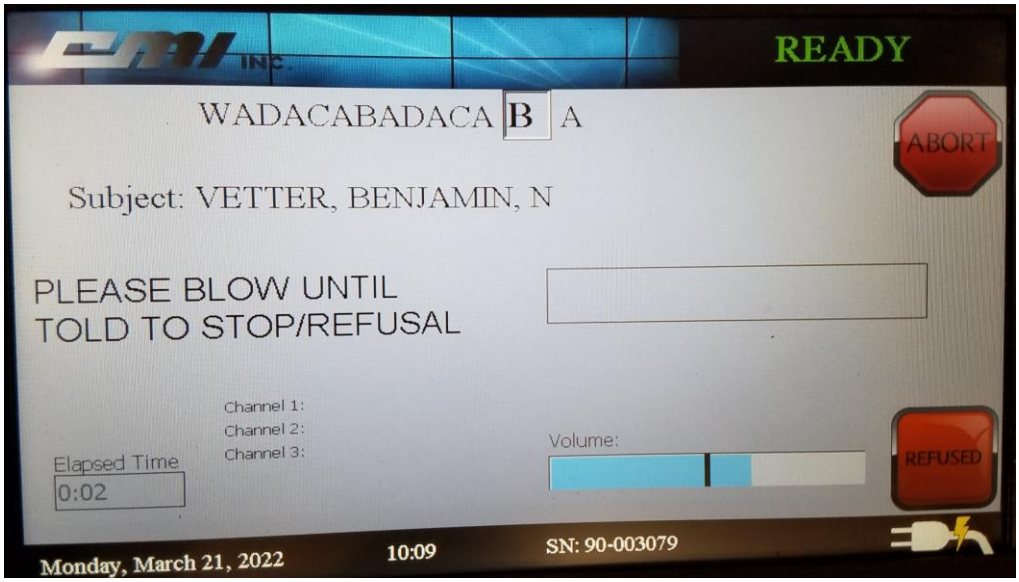
Proper Sample Instructions screen 2



The instrument displays **Subject instructed to deliver a proper sample?** The “Yes” box is already checked. The Operator must give the subject proper instructions for a breath sample (see BTS Manual for subject instruction example), then press the right arrow button.

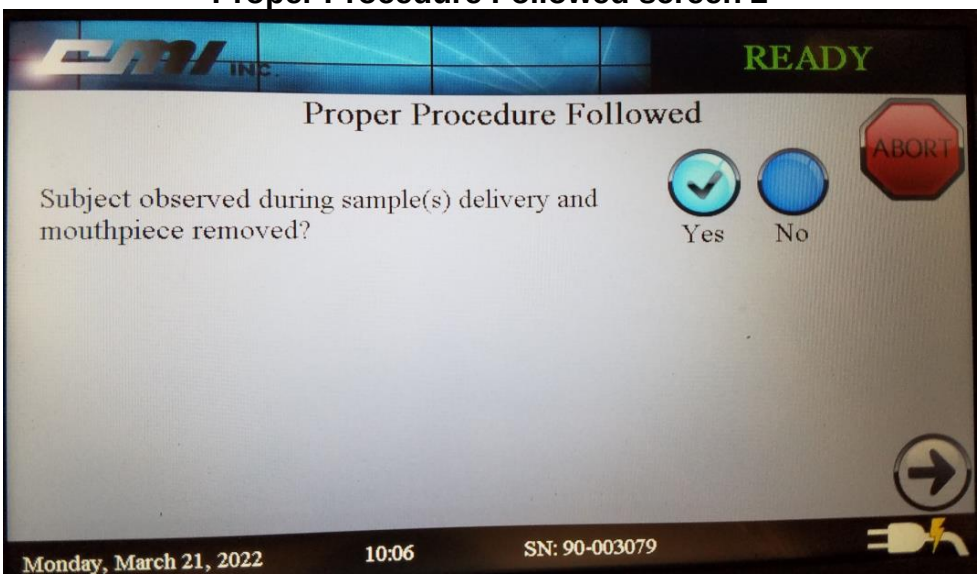
Air Blank: The instrument is clearing the tubing and chamber of any residual alcohol and setting 0.000 g/210L.

Sample screen 2



The instrument displays the subject's name and PLEASE BLOW UNTIL TOLD TO STOP/REFUSAL. If the subject is refusing the breath test, the Operator must press the **REFUSAL** button and the instrument will print *Subject Test Refused on the Breath Analysis Report Form. If the subject is cooperating, the Operator must attach a mouthpiece to the breath hose and have the subject provide a proper sample (see BTS Manual). During the sample delivery, the Operator will notice the subject's breath volume accruing and a graphic indicating the minimum subject volume required line. For the second sample the Operator will see a very light blue bar on the breath volume graphic. This bar indicates the subject's breath volume from the first sample. The Operator should encourage the subject to at least fill the graphic to the end of the light blue bar. Once the subject has met all breath sample requirements (see BTS Manual), the instrument will triple beep and finish with the sample process. The Operator again must be sure to place the subject away from the instrument. The Operator must be sure to remove and dispose of the mouthpiece.

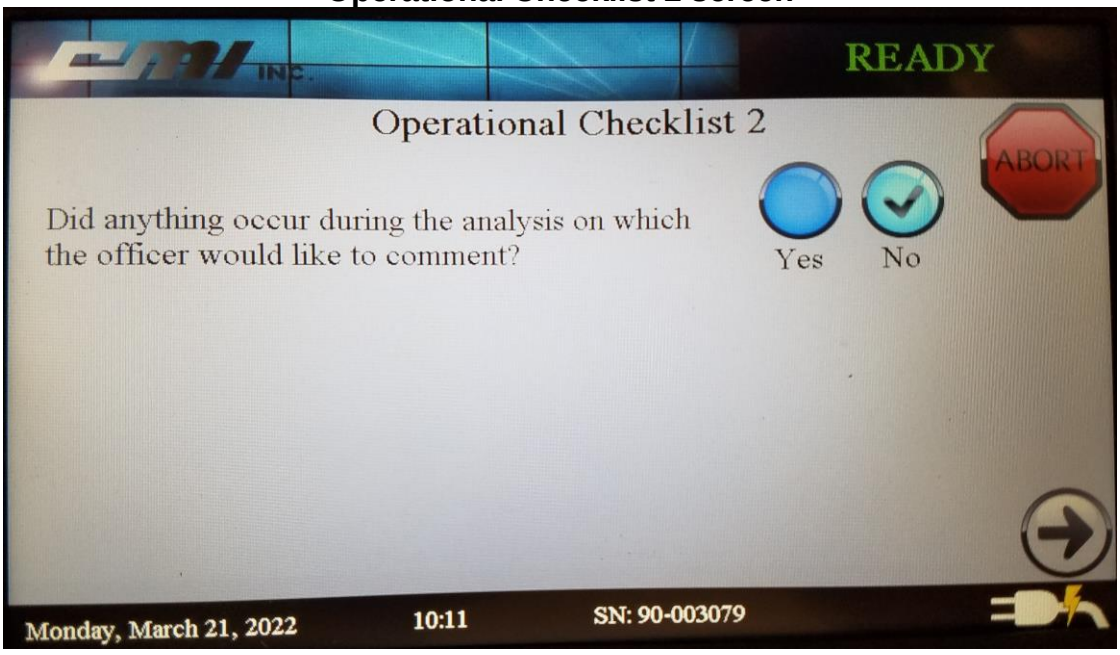
Proper Procedure Followed screen 2



The instrument displays **Subject observed during sample(s) delivery and mouthpiece removed?** The check box is already set to “Yes”. If these conditions were met, the Operator must press the right arrow button.

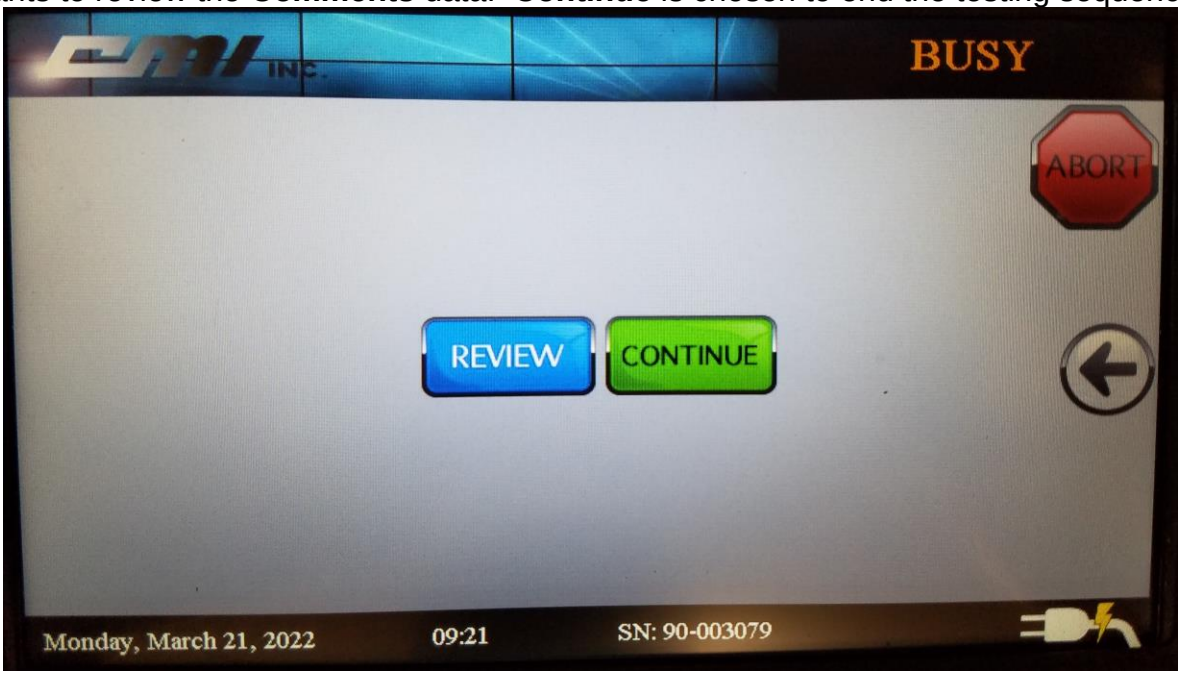
Note: the instrument is looking to ensure that sample one and sample two agree within +/- 5% of their mean. If this condition is not met, the instrument will automatically ask for a third subject sample. While the likelihood of this occurring is very low, if it does occur, the Operator should proceed with the third subject sample exactly as was done for the first two samples.

Operational Checklist 2 screen

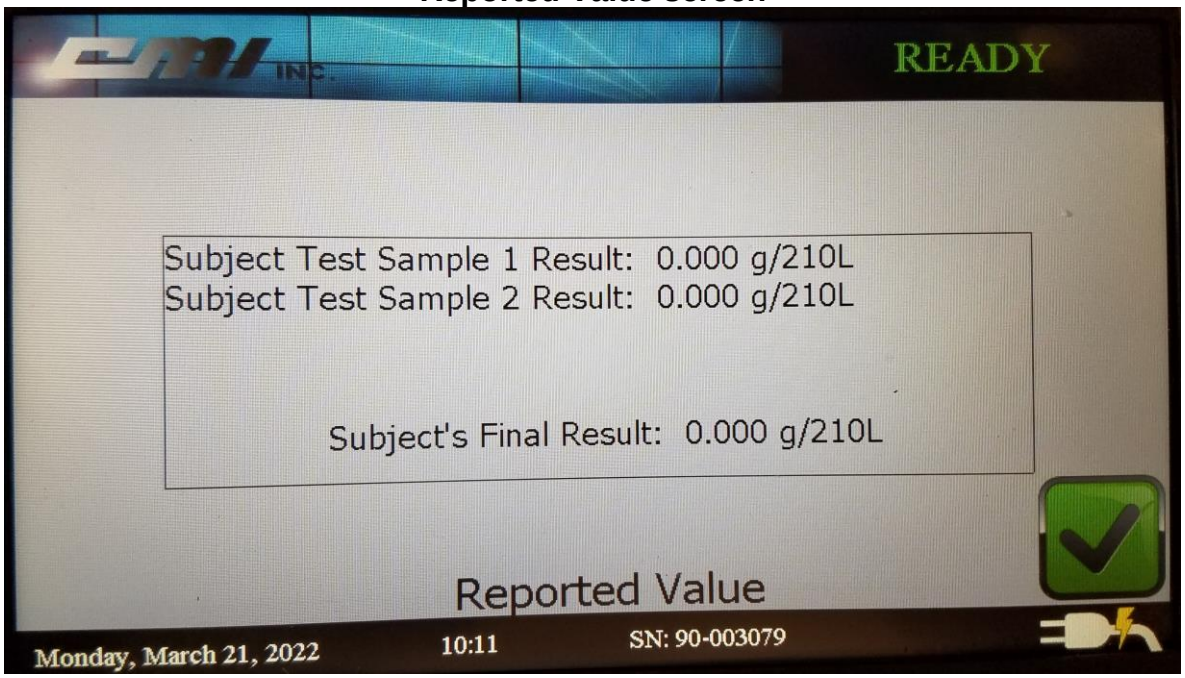


The instrument displays **Did anything occur during the analysis on which the officer would like to comment?** The “No” checkbox is already marked, if there is no comment the Operator must press the right arrow button. If there is a comment, the Operator must choose “Yes”, and the instrument displays a text box in which the Operator can add any comments.

The Operator must choose **Review** or **Continue**. **Review** is chosen if the Operator wants to review the **Comments** data. **Continue** is chosen to end the testing sequence.

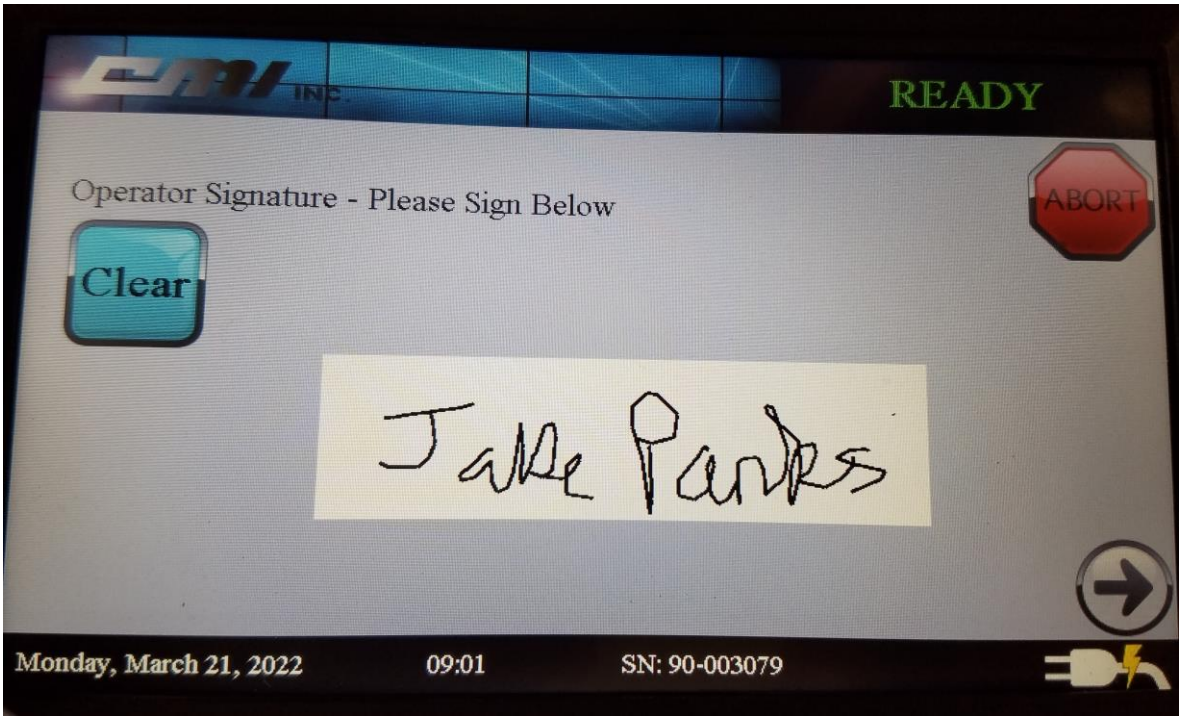


Reported Value screen



The instrument displays the reported Breath Alcohol results from each subject sample, with the Subject's Final Result being the lower of the two results that agree. The Operator must press the green ✅ button.

Signature screen



The Operator must use a capped pen, a finger, or any non-sharp object to sign their name in the signature box. If the signature is not acceptable, the Operator may press the **Clear** button twice quickly and re-sign the box.

The instrument will now print all three copies of the Breath Analysis Report Form. The Operator should check the Breath Analysis Report Form for accuracy and make any corrections as needed (i.e., misspellings, etc.).

Breath Analysis Report Form Example:

FORENSIC SCIENCE DIVISION
DEPARTMENT OF JUSTICE
STATE OF MONTANA
2679 PALMER STREET
MISSOULA, MT 59808
(406) 728-4970

BREATH ANALYSIS REPORT FORM

Copy 1 of 3

FSD
Intoxilizer - Alcohol Analyzer
Model 9000 SN 90-003079
02/14/2022 17:59

Deprivation Start Time =16:56
Subject Name = SHORT, JESSE, LEE
Driver's License = 0711819864104 /MT
Arresting Officer = OLIVER, JOSEPH,
Calibration Standard Value = 0.080 g/210L Lot # = 07220080A3

Offense Code = 700
DOB = 07/04/1986
Sex = M
Dept. Code = 06Z
Expiration Date = 05/05/2022

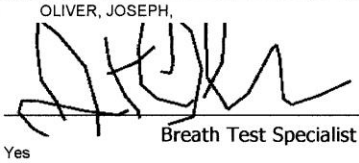
Test	g/210L	Time
Air Blank	0.000	17:51
Diagnostic/ITP	PASS	17:52
Air Blank	0.000	17:52
Calibration Check		17:53
Channel 1	0.079	
Channel 2	0.078	
Channel 3	0.081	
Air Blank	0.000	17:53
Subject Test	0.132	17:54
Breath Volume	4.35 liters	
Channel 1	0.133	
Channel 2	0.132	
Channel 3	0.133	
Air Blank	0.000	17:55
Diagnostic/ITP	PASS	17:56
Air Blank	0.000	17:56
Calibration Check		17:57
Channel 1	0.079	
Channel 2	0.078	
Channel 3	0.079	
Air Blank	0.000	17:58
Subject Test	0.139	17:58
Breath Volume	4.42 liters	
Channel 1	0.141	
Channel 2	0.139	
Channel 3	0.140	
Air Blank	0.000	17:59

Reported A/C 0.132

Operational Checklist

* Deprivation occurred for a minimum of 20 minutes prior to the test without oral ingestion of any material? = Yes
* Subject instructed to deliver proper samples? = Yes
* Subject observed during sample(s) delivery and mouthpiece changed? = Yes
* Did anything occur during the analysis on which the officer would like to comment? = No

Breath Test Spec. = OLIVER, JOSEPH, Dept. Code = 06Z



Breath Test Specialist Signature

Accident Involved = Yes Fatality Involved =No

Comments:

Copy 1 - Attach to Arrest Report Copy 2 - To be sent to Forensic Science Division Copy 3 - For BTS Senior Operator

The following Department Code Sheet is to be used during DATA ENTRY for the different required fields, such as “Dept Code” or “Offense Code”.

DEPARTMENT CODE SHEET

REGION 1
01A COLUMBIA FALLS PD
01B FLATHEAD COUNTY SHERIFF
01C FLATHEAD TRIBAL POLICE
01D GLACIER NPS – WG
01E KALISPELL POLICE
01F LAKE COUNTY SHERIFF
01G LINCOLN COUNTY SHERIFF
01H SANDERS COUNTY SHERIFF
01I WHITEFISH POLICE
01J EUREKA POLICE
01K HOT SPRINGS POLICE
01L PLAINS POLICE
01M POLSON POLICE
01N RONAN POLICE
01O ST. IGNATIUS POLICE
01P THOMPSON FALLS POLICE
01Q TROY POLICE

REGION 2
02A BLACKFEET LEA
02B CONRAD POLICE
02C GLACIER COUNTY SHERIFF
02D GLACIER NPS SM
02E TOOLE COUNTY SHERIFF
02F CHOTEAU POLICE
02G CUT BANK POLICE
02H FAIRFIELD POLICE
02I LIBERTY COUNTY SHERIFF
02J PONDERA COUNTY SHERIFF
02K TETON COUNTY SHERIFF

REGION 3
03A BLAINE COUNTY SHERIFF
03B CHOUTEAU COUNTY SHERIFF
03C FORT BELKNAP POLICE
03D HAVRE POLICE
03E PHILLIPS COUNTY SHERIFF
03F ROCKY BOY AGENCY LEA
03G CHINOOK POLICE
03H HARLEM POLICE
03I MALTA POLICE
03J SACO POLICE
03K HILL COUNTY SHERIFF
03L FORT BENTON POLICE

REGION 4
04A FORT PECK AGENCY LEA
04B GLASGOW POLICE
04C ROOSEVELT SHERIFF WP
04D ROOSEVELT SHERIFF CU
04E SHERIDAN COUNTY SHERIFF
04F SIDNEY POLICE
04G CIRCLE POLICE
04H MEDICINE LAKE POLICE
04I NASHUA POLICE
04J OPHEIM POLICE
04K PLENTYWOOD POLICE
04L POPLAR POLICE
04M SCOBEY POLICE
04N DANIELS COUNTY SHERIFF
04O McCONE COUNTY SHERIFF
04P RICHLAND COUNTY SHERIFF
04Q VALLEY COUNTY SHERIFF
04R FAIRVIEW POLICE
04S FORT PECK POLICE
04T WOLF POINT POLICE

REGION 5
05A GRANITE COUNTY SHERIFF
05B MINERAL COUNTY SHERIFF
05C MISSOULA POLICE
05D RAVALLI COUNTY SHERIFF
05E DARBY POLICE
05F HAMILTON POLICE
05H STEVENSVILLE POLICE
05I MISSOULA COUNTY SHERIFF
05J U OF M POLICE
05K MISSOULA CO AIRPORT PD
05L SEELEY LAKE

REGION 6
06A BROADWATER CO SHERIFF
06B GREAT FALLS POLICE
06C JEFFERSON CO SHERIFF
06D JUDITH BASIN SHERIFF
06E LEWIS & CLARK SHERIFF
06F MALMSTROM AFB
06G MEAGHER CO SHERIFF
06H POWELL CO SHERIFF
06I BOULDER POLICE
06K EAST HELENA POLICE
06L HELENA POLICE
06M CASCADE CO SHERIFF
06N DEPT OF FISH/WILDLIFE
06O DEERLODGE POLICE
06P HELENA AIRPORT PD
06Q DEPT OF LIVESTOCK
06R DEPT OF JUSTICE MVD
06S MT AIR NAT'L GUARD
06T BELT POLICE
06U WHITHALL POLICE

REGION 7
07A LEWISTOWN POLICE
07B MUSSELSHELL CO SHERIFF
07C WHEATLAND CO SHERIFF
07D FERGUS COUNTY SHERIFF
07E GOLDEN VALLEY CO SHERIFF
07F PETROLEUM CO SHERIFF

REGION 8
08A FALLON CO SHERIFF
08B GLENDIVE POLICE
08C MILES CITY POLICE
08D POWDER RIVER SHERIFF
08E ROSEBUD SHERIFF FO
08F BAKER POLICE
08G EKALAKA POLICE
08H RICHEY POLICE
08I TERRY POLICE
08J WIBAUX POLICE
08K CARTER CO SHERIFF
08L CUSTER CO SHERIFF
08M DAWSON CO SHERIFF
08N GARFIELD CO SHERIFF
08O PRARIE CO SHERIFF
08P WIBAUX CO SHERIFF
08Q NORTHERN CHEYENNE PD
08R ROSEBUD SHERIFF CO

REGION 9
09A ANACONDA/DEERLODGE LEA
09B BUTTE/SILVER BOW LEA
09C DILLON POLICE
09D MADISON CO SHERIFF
09E WHITEHALL POLICE
09F BEAVERHEAD CO SHERIFF
09G ENNIS POLICE
09H BUTTE AIRPORT POLICE

REGION 10
10A GALLATIN CO SHERIFF
10B LIVINGSTON POLICE
10C SWEETGRASS CO SHERIFF
10D WEST YELLOWSTONE PD
10E YELLOWSTONE NPS LAKE
10F YELLOWSTONE NPS OF
10G BELGRADE POLICE
10H BOZEMAN POLICE
10I THREE FORKS POLICE
10J PARK CO SHERIFF
10K MSU POLICE
10L MANHATTAN POLICE
10M YELLOWSTONE NPS MAM

REGION 11
11A BILLINGS POLICE
11B CARBON CO SHERIFF
11C CROW AGENCY LEA
11D LAUREL POLICE
11E STILLWATER CO SHERIFF
11F TREASURE CO SHERIFF
11G YELLOWSTONE SHERIFF
11I COLUMBUS POLICE
11J RED LODGE POLICE
11K BIG HORN CO SHERIFF
11L JOLIET POLICE
11M BRIDGER POLICE

06Z MT HIGHWAY PATROL

MISCELLANEOUS

12A U.S. FOREST SERVICE
12B F.B.I.
12C PROBATION/PAROLE
12D COURT ORDERED
12E OTHER

OFFENSE CODES FOR INTOXILYZER

DUI	**100**
PER SE VIOLATION	101
DUI/PER SE COMBINATION	102
MINOR IN POSESSION	103
.04 CDL VIOLATION	104
UNDER 21 YOA OVER .02	**105**
NEGLIGENT HOMICIDE	200
DELIBERATE HOMICIDE	201
MIT. DELIBERATE HOMICIDE	202
ENDANGERMENT	203
ASSAULT	300
NEG. VEHICULAR ASSAULT	301
DOMESTIC ABUSE	302
SEXUAL ASSAULT	400
SEX W/O CONSENT	401
DEV. SEX. CONDUCT	403
DISORDERLY CONDUCT	500
COURT ORDERED TEST	600
PROBATION/PAROLE TEST	601
OFFICER INVOLVED	602
TRAINING	700
OTHER	800

RACE CODES

WHITE (CAUCASIAN)	01
NATIVE AMERICAN	02
BLACK	03
HISPANIC	04
ASIAN	05
OTHER	06

THE FUEL CELL

THEORY

The fuel cell was first devolved in Austria in the 1960's. Its first real applications appeared in the NASA space program from that same era. A fuel cell is defined as a type of device which, when exposed to certain chemicals, will produce electrical energy through a process called oxidation. This is accomplished due to the fact that when a chemical is exposed to the ACTIVE SURFACE of a fuel cell, the chemical will "give up" one of its electrons. This "free" electron will flow along a conductive surface and exit the fuel cell as voltage. The remaining chemical left on the fuel cell will then dissipate and the reaction is complete.

CONSTRUCTION OF A FUEL CELL

The fuel cell is remarkable in its simplicity of design and construction. It is comprised of five layers of material compressed into a wafer, soaked with an electrolytic, and covered in a plastic housing.

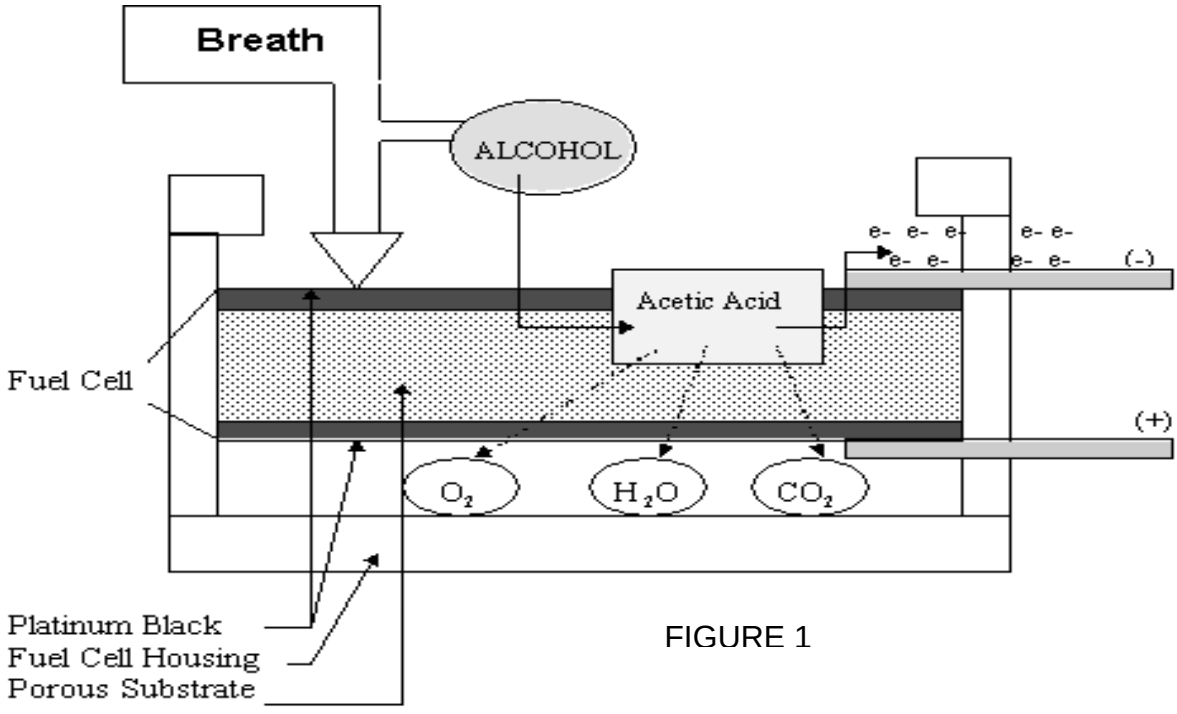


FIGURE 1

The central portion of the fuel cell is the CORE (FIGURE 1). This core can be made from many different materials, its main requirement being that it is porous, and that it can retain this porous quality throughout a number of reactions. On the outside of the core is the CONDUCTOR. The material most generally used as the CONDUCTOR is gold, since gold offers little resistance to electrical flow and dose not corrode easily. The conductor is layered on both sides of the core. The next layer is the ACTIVE SURFACE, which is affixed directly on the top of the conductor surfaces. The active surface is made from a material called PLATINUM BLACK. Platinum black is an extremely finely ground form of platinum. It is so finely ground that one gram of platinum black will provide a reactive surface area of 20 square meters. In fact, the fuel cell, which is approximately the size of a half-dollar, will have an active surface area of 2-3 square meters (or approximately 36 square feet). The final stage is to soak the cell in SULFURIC ACID, which acts as an ELECTROLYTIC for the reaction. Two PLATINUM CONDUCTOR LEADS are used for directing the electrons in the circuitry of the device. Platinum is used because of its low resistance quality and for the fact that platinum, when attached to gold, will not set up an appreciable radio frequency field

APPLICATION

The fuel cell is specific for alcohol, since its configuration will not allow for reactions with other substances which may occur in the breath. The reaction involved is as follows:

1 MOLECULE ETHANOL + FUEL CELL = 1 MOLECULE ACETIC ACID +
1 “FREE” ELECTRON (voltage)

Therefore:

“X” MOLECULES ETHYL ALCOHOL = “X” ELECTRONS = “X” AMOUNT OF CURRENT (voltage)

Therefore:

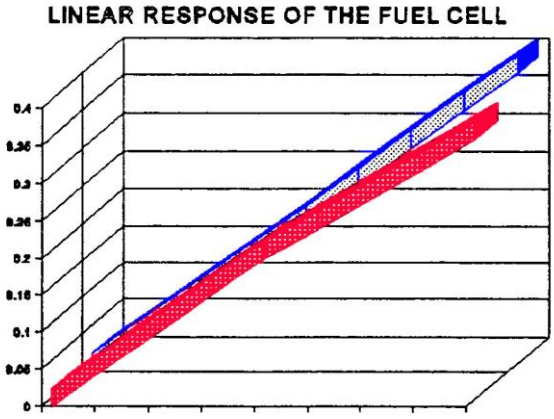
THE CURRENT PRODUCED BY THE FUEL CELL IS DIRECTLY PROPORTIONAL TO THE AMOUNTOFALCOHOL IN THE SAMPLE.

TEMPERATURE

The operational temperature range of the fuel cell is quite large (see the individual instrument operation manuals for specific temperatures). However, temperature extremes do have a significant effect on the speed of the reaction. For this reason testing should be done only when a temperature is visible on the temperature strip on the back of the unit, if the unit is so equipped.

LINEAR RESPONSE TO ALCOHOL CONCENTRATION

The linear response of the fuel cell is extremely good for values from 0.000 to about 0.1 50 g/210L(better than 2%). As concentration rises above this value, the fuel cell output diminishes slightly, and is in the neighborhood of 5% low at 0.300 g/210L. The following graph illustrates the deviation of the fuel cell response from perfect linear over the range of interest for breath alcohol devices.



SPECIFICITY OF THE FUEL CELL

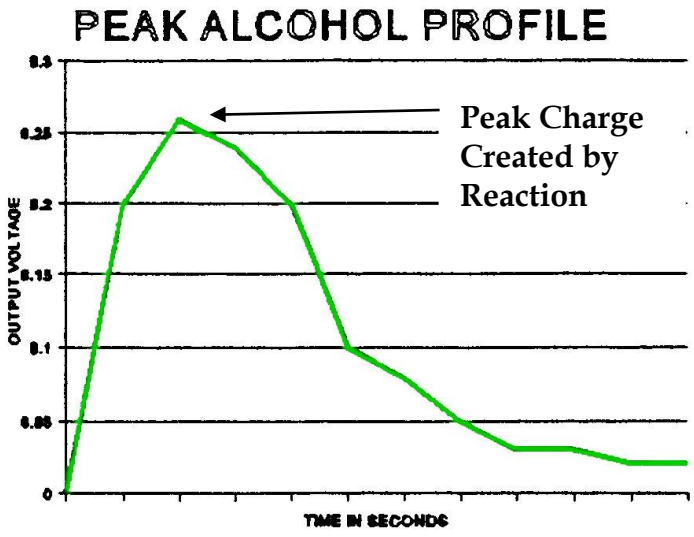
The fuel cell has a direct specificity for alcohol. Due to its unique composition, including the platinum black and the sulfuric acid, as it is electrolytic, the fuel cell will react only to the alcohol molecule.

CLEANUP OF THE FUEL CELL AFTER A POSITIVE ALCOHOL TEST

If several measurements are done in succession with a fuel cell, it is important that all residual charge from a previous test be eliminated before the next test is attempted. In order to speed this process; the fuel cell must be shorted out as soon as a test is completed. This quickly returns the output of the cell to zero before the next test is initiated.

MEASURING THE ALCOHOL CONCENTRATION - PEAK ALCHOL STYLE FUEL CELL

The measurement of the alcohol concentration is a function of the maximum, or peak, voltage produced by the fuel cell. The higher the alcohol concentration, the greater the voltage output.



The time for the rise to peak will vary from one fuel cell to another, according to the number of active sites available, the age of the cell, the operational temperature, and the

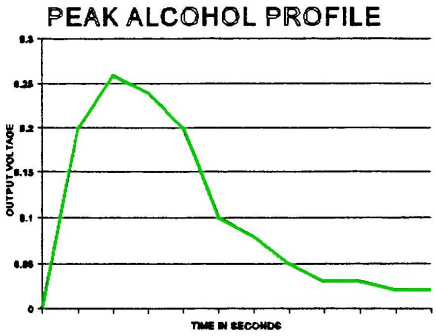
alcohol concentration of the sample. The peak height is indicative of the voltage level produced by the alcohol; the higher the peak, the greater the voltage output, the higher the alcohol concentration.

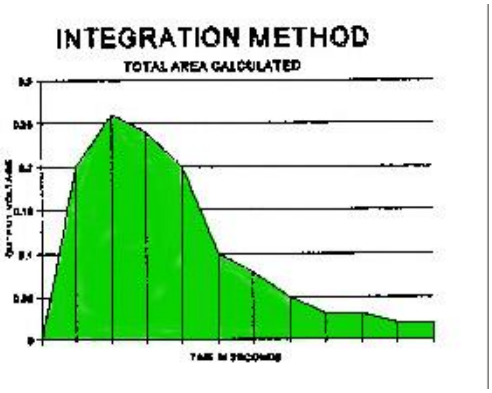
PEAK v. INTEGRATION METHODS

Some fuel cell instruments use the peak voltage method of establishing the alcohol concentration. This works very well, but with one major drawback. The number of positive samples analyzed in rapid succession had to be strictly limited, or the so-called "memory effect" would cause successive readings to be in error beyond the acceptable limits for measurement. In a typical PEAK reading unit, ten successive measurements of .100 g/210L at 3 minutes between readings might result in the tenth reading being .095 or .094 (5-6% low). To maintain accuracy, the instrument operating instructions call for no more than 5 positive tests per hour. This restriction did maintain the quality of results, but was satisfactory only in those situations where a relatively small number of tests were required.

In addition, once the fuel cell output had decreased due to repeated testing, an extended period of time, up to 16-24 hours, was required before the cell fully recovered its initial output capabilities.

To remedy the situation research was begun in 1986 which focused on the supposition that the entire charge from the fuel cell, rather than just the peak value of that charge, might contain enough information so that, when properly analyzed, the effects of memory and high alcohol concentration non-linearity might be minimized.





In other words, if the entire area under the curve is integrated (i.e., the sum of all of the electrons produced in the reaction is measured), the slump in reading from test to test is much diminished. Therefore, since the cell has already returned to zero output, it is ready for another test without a significant additional waiting period for cleanup. In addition, the linearity of the cell, which is so striking up to .150 gm/dl in the PEAK reading system, is preserved out to .400 gm/dl or more in the INTEGRATION method.

Durability of the Fuel Cell

Fuel cells, on average, have a fairly long life expectancy under normal operating conditions. "Catastrophic" failure of a fuel cell, such as mechanical damage (broken

leads, ruptured case) or chemical “poisoning” (raw cigarette smoke, submersion in water) is infrequent, but does occur. Except for these abusive failures, fuel cells normally slowly change in characteristics over an extended period of time. The response time becomes longer, the peaks are lower and slower, and cleanup requires a longer waiting period between tests. As long as the output is high enough for the unit to be calibrated, fuel cell life, in screening applications, becomes limited by the patience of the user to tolerate the longer test times. Since frequency of use does not seem to be a significant factor in the life of the cell, it is generally felt that long term changes in the platinum surface are primarily responsible for aging effects. An effect similar to aging, but to a certain extent reversible, is the “drying out “of the electrolyte by continuous exposure to extremely low humidity, coupled with relatively infrequent use.

HOW LONG DOES A FUEL CELL LAST

The simple answer is that there is no simple answer. Too many times answers have been given based on “best-case” scenarios (“I know someone who has a five-year-old cell who wouldn’t trade it for anything.”) and repair records (the majority of which are screeners, and some of which were either not used at all, or were used by people in very non-critical situations). Because of the cost of a fuel cell replacement, if a fuel cell does not fail within the warranty period, the tendency is to “use it ‘till it quits”; this also contributes to the long life spans indicated by repair records. With this experience, the manufacturers have, over the years, tended to increase their estimate of fuel cell life to the point where they now casually reply “three to five years” without any qualification.

We do, however, need to qualify this answer based on:

1) Whether the application is **screening** or **evidential**.
2) Whether the cell has been used or stored under environmental extremes of temperature or humidity.
3) The rate of change in characteristics with time being a statistical variable within any given group of cells.

APPROVED INSTRUMENTS

The Forensic Science Division has approved the following instruments for use as probable cause testing instruments.

From CMI Inc: The SD2, the SD5, the I300 and the I400

From Intoximeters: The Alcosensor III, III+, Alcosensor IV, and FST

From LifeLoc: The FC-10

Reference Materials and Data

SYMPOSIUM ON ALCOHOL AND ROAD TRAFFIC

INDIANA UNIVERSITY

December 12, 13, 14, 1958

RECOMMENDATIONS

As a result of the material presented at this Symposium, it is the opinion of this Committee that a blood alcohol concentration of 0.05% will definitely impair the driving ability of some individuals, and, as the blood alcohol concentration increases, a progressively higher proportion of such individuals are so affected, until at a blood alcohol concentration of 0.10%, all individuals are definitely impaired.

Signed:

R.N. Harger (Chairman) R. N. Harger

Henry Newman Henry Newman

Herman Heise Herman Heise

T.A. Loomis T. A. Loomis

Leonard Goldberg Leonard Goldberg

D. W. Penner D. W. Penner

H. W. Smith H. W. Smith

January 1972 Statement

Ad hoc Committee on the Blood-Breath Alcohol Relationship

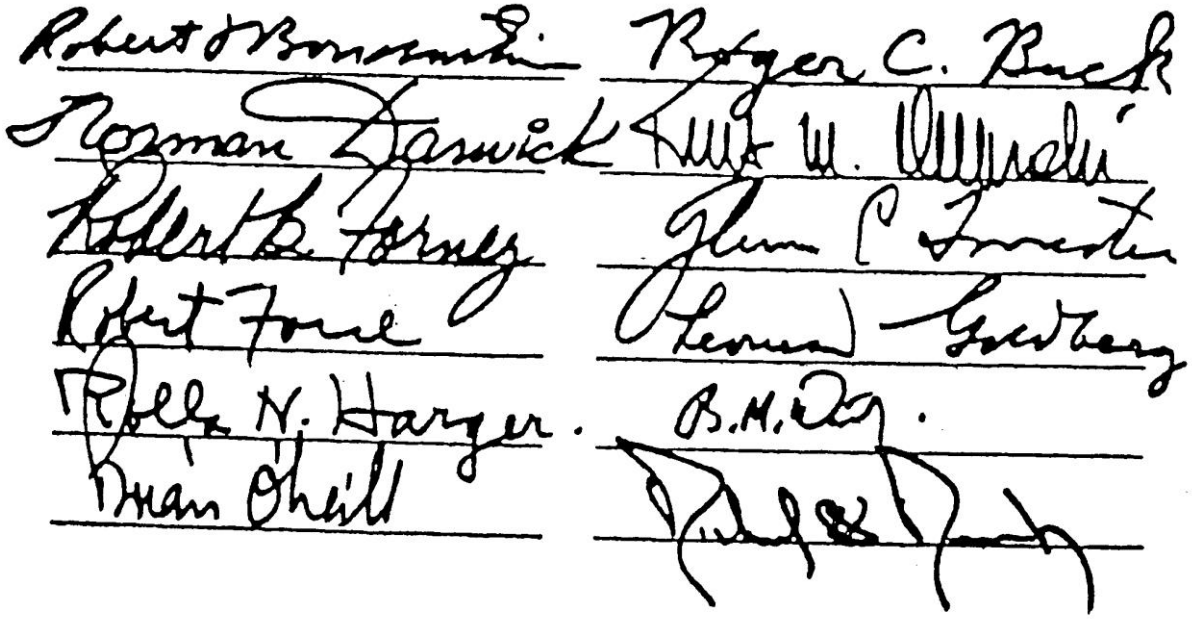
Indiana University

STATEMENT

The basic principle governing the design of breath alcohol instruments is that a physiological relationship exists between the concentration of alcohol in expired alveolar air and in the blood.

Available information indicates that 2.1 liters of expired alveolar air contain approximately the same quantity of alcohol as 1 milliliter of blood.

Continued use of this ratio in clinical and legal applications is warranted.



"The National Safety Council Committee on Alcohol and Drugs takes the position that a concentration of 80 milligrams of ethanol per 100 milliliters of whole blood (0 .08% W/V) in any driver of a motor vehicle is indicative of impairment in his driving performance."

This action was taken by the National Safety Council Committee on Alcohol and Drugs, 1971.

This is a position statement. Such positions are not immutable. Rather, there should be sufficient evidence to establish the position as a presumption of fact, which should stand until convincing evidence to the contrary is presented.

The phrase "in any driver of a motor vehicle", of course, refers to the word impairment but is modified by the word indicative.

It was and is my view that sufficient evidence does exist to establish a presumption that the mere presence of a blood concentration of ethyl alcohol of 0.08 percent in any driver of a motor vehicle indicates that his driving ability is impaired. That the degree of impairment will be varied and unpredictable is to be expected.

With the preface, then, that the motion which was passed represents a position that a concentration of 80 milligrams of ethanol per 100 milliliters of whole blood in any driver of a motor vehicle is indicative of impairment in his driving performance, I would like to present some references from the scientific literature in support of this position.

Exhibit # 1 is from Chapter 15 of Drill's Pharmacology in Medicine; Third Edition, 1965, which was authored by Dr. R. N. Harger and myself. This table presents data and the matching literature references of fifteen studies from 1954 to 1963 involving human subjects whose performance in tasks, including automobile driving, link trainer operation, simulated automobile driving, laboratory tests and neurophysical measurements with varying blood alcohol concentrations. Impairment in such performance in all subjects with alcohol ranged from 25 mg to 150 mg/100 ml of blood.

Exhibit # 2 is a revision of a report I made to this committee on October 28, 1971.

Exhibit # 3. This material consists of seven references and was kindly supplied by Dr. R. N. Harger.

The information reported here is to be considered preliminary.

Robert B. Forney

Robert B. Forney, Director
Indiana State Department of Toxicology

OTHER PUBLISHED STUDIES DOCUMENTING UNIVERSAL IMPAIRMENT FROM A BLOOD ALCOHOL CONCENTRATION OF 0.08%.

1. Bjeryer, K., and Goldberg, L. "Effect of Alcohol Ingestion on Driving Ability", Quart. J. Stud. Alc. 11:1-30, 1950. Those interested in the proposed 0.08% lower limit for the prima facie zone should reread this excellent study. The reader should particularly note Figs. 5 and 7. The blood alcohol concentrations in the drinking subjects ranged from 0.032% to 0.074% and averaged 0.048%; and the mean impairment from alcohol in the six practical road tests ranged from 3% to 70%. No subject had a blood alcohol concentration as high as 0.08%.

2. Kelly, M., Ylyrsten, A. L., Neri, A., and Rydbere. U. "Effects and After-Effects of Alcohol on Physiological and Psychological Functions in Man", Blutalkohol 7:422-1436, 1970. (English) The alcohol dosage was 1.43 g/kg in the form of beer or brandy taken with food during a fall meal lasting 90 minutes. The average blood alcohol concentration reached a peak of about 0.12% in around 2 hours and fell to zero in 12 hours. Measurements were made of: pulse rate, positional nystagmus, standing steadiness, hand steadiness, reaction time, and two psychological tests (Spokes A and B). All of these measurements showed impairment, the peak of which coincided with the blood alcohol peak. The impairment persisted, in decreasing degree, for a period of about 16 hours, which was 4 hours after the subjects became alcohol-free.

*Dept. of Alcohol Research, Karolinska Institute, Stockholm, Sweden, Director, Dr. Leonard Goldberg.

3. Schneble, H., "Das o,8-Promil.le-Ciesetz - ein Schlag ins Wasser?” (The 0.08% legal limit - a vain attempt?) A reply to an article in a Frankfurt, W. Germany newspaper criticizing the proposal to make it an offense to drive with a blood alcohol concentration of 0.08% or above. Schneble reviews some pertinent literature and concludes, " -- the legal establishing of a danger limit -value of 0.8 0/00 (0.08%) is urgently required, and can perform a modest contribution for a decrease of the accident-cause alcohol" (from author's English summary)

4. Moskowitz, H., and DePry, D.** Differential Effect of Alcohol on Auditory Vigilance and Divided-Attention Tasks". Quart. J. Stud. Alc. 29;54-63, 1968. Ten male subjects received a placebo of 300 ml of orange juice, or this volume of orange juice containing 80-Proof vodka to give an alcohol intake of 0.52 g/kg. The alcohol dosage resulted in peak blood alcohol concentrations of 0.07% to 0.08%. In the vigilance tests, this dose of alcohol produced no significant impairment, but in the divided-attention tests there was definite impairment in nine of the ten subjects.

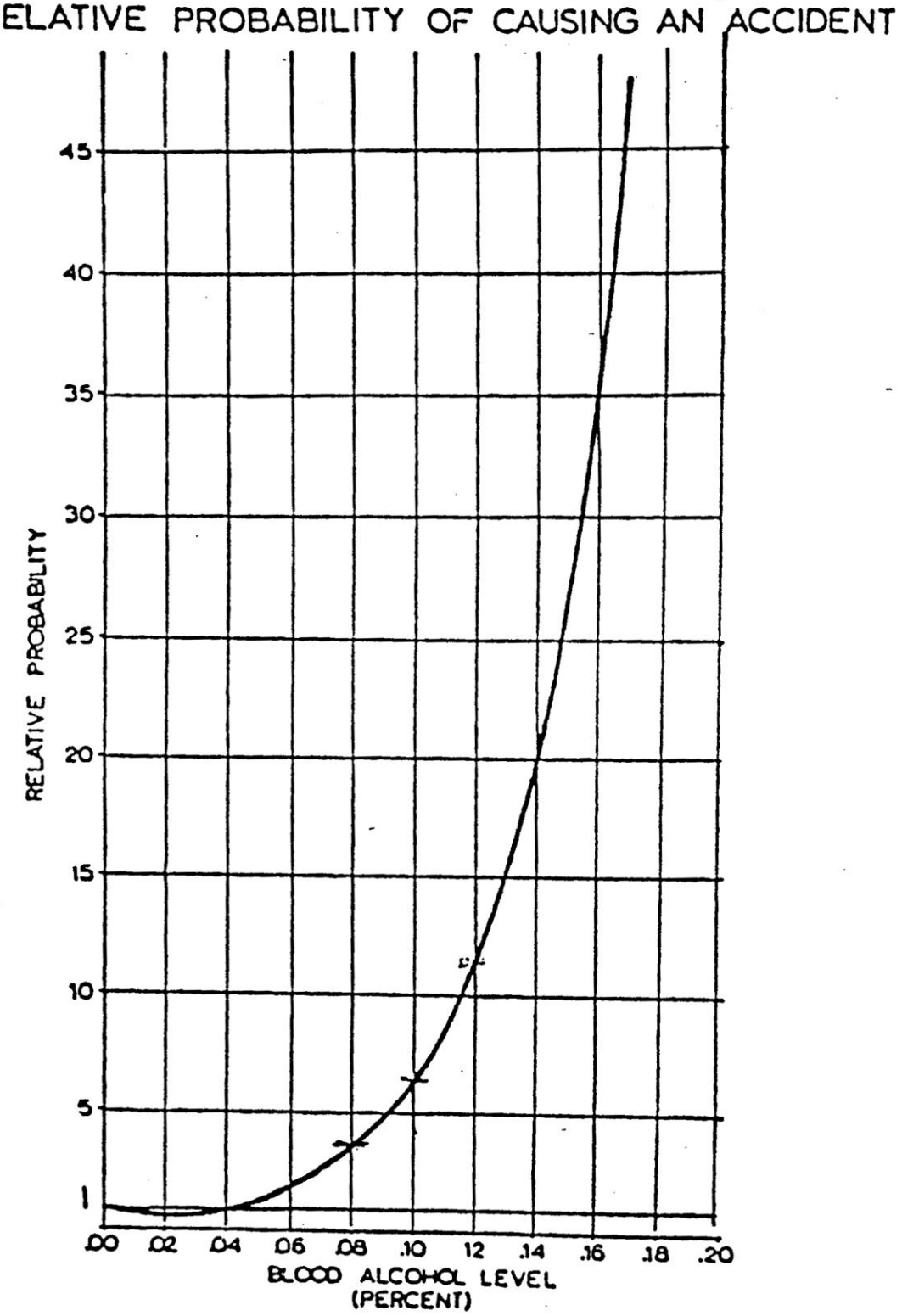
5. Moskowitz, H., and Burns, M.,** "Effect of Alcohol on the Psychological Refractory Period "; Quart - J. Stud – Alc., 32:782-7901 1971. A continuation of the 1968 study, employing reaction time to respond to two stimuli separated by varied inter-stimulus intervals - Ten male subjects were used, and the alcohol intake was 0.69 g/kg, diluted with orange juice) which gave blood alcohol peaks

of 0.08 to 0.10% The administration of alcohol caused a marked increase in the reaction time, which was almost doubled when the inter-stimu interval was 50 milliseconds, and, as this interval lengthened, the
difference in reaction time caused by alcohol diminished to about
20% with an inter-stimulus interval of 350 milliseconds.

6. Moskowitz, 11.1 and Rothy S.** "Effect of Alcohol on Response Latency in Object-Naming", Quart. J. Stud. Alc., 32-.969-9751 1971. This is a continuation of the two preceding studies, with the alcohol dosage reduced to 0-52 g/kg and measuring the alcohol influence and the latent time required- to name articles displayed to the 12 subjects. The blood alcohol peaks ranged from 0.06 to 0.08%. A mean increase in response latency of 11.5% was caused by the alcohol, and the authors conclude that, "This finding is offered in support of the view that alcohol impedes the rate at which the brain can process information."

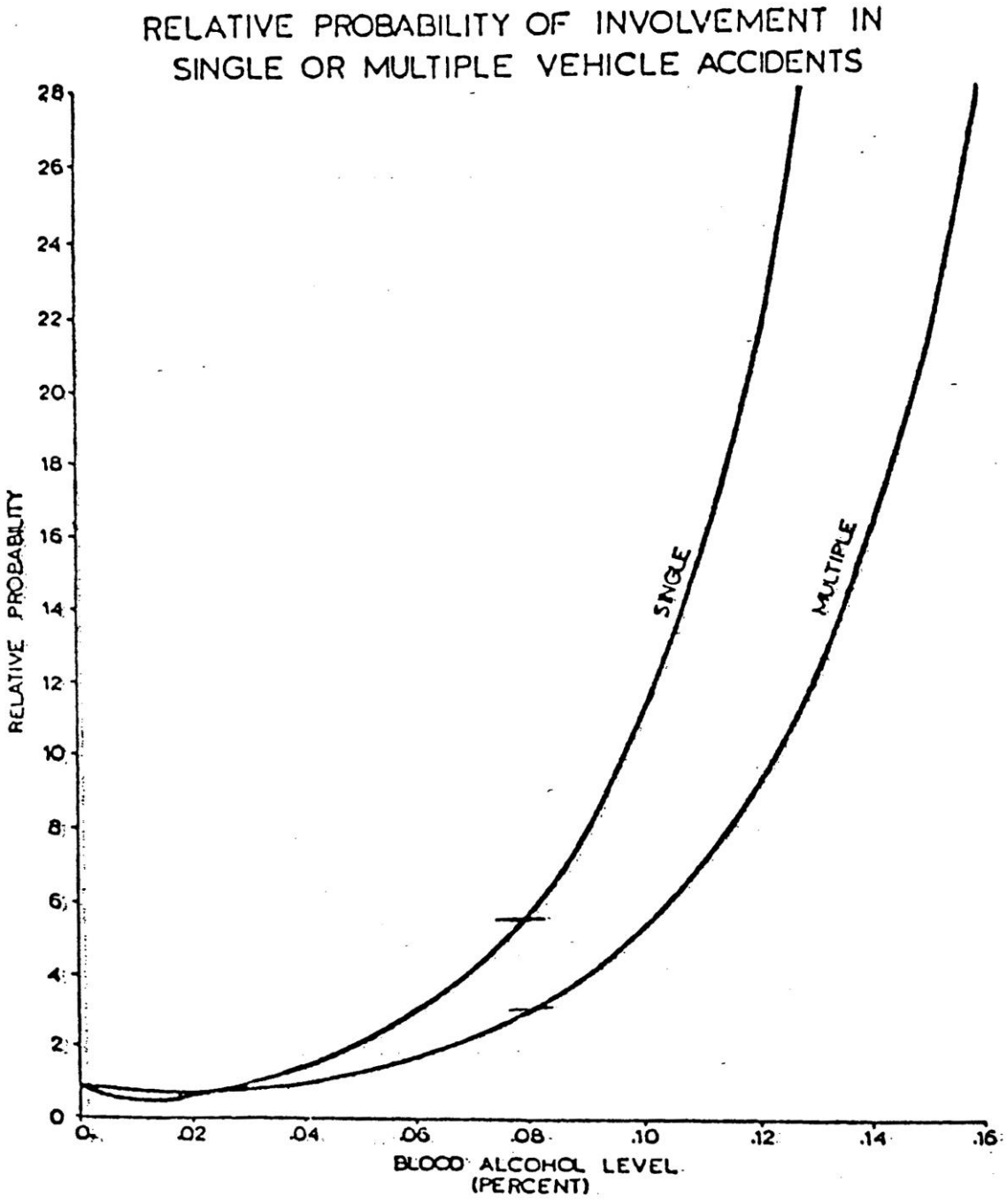
7. Laessig, R. H., and Waterwortho K. J., "Involvement of Alcohol in Fatalities of Wisconsin Drivers." U. S. Pub. Health Reports, 85:535-549, -L97o. (Abs. in Quart. J. Stud. Alc., 32:882-883, 1971). This is a statistical study of 507 drivers killed in traffic crashes during a 15-month period. The authors delineate four zones of blood alcohol 'as follows: up to 0.01% sober; between 0.02 and 0.07%, drinking; between 0.08 and 0.14%) under the influence; and 0-15% and higher) drunk. Of the 507 drivers killed, 37% were drunk, and 18% were under the influence.

CHART XV *



*Taken from "The Role of the Drinking Driver." A study conducted by Indiana University.

CHART XVII *



*Taken from "The Role of the Drinking Driver." A study conducted by Indiana University.

THE PHARMACOLOGY AND TOXICOLOGY OF ALCOHOL

Rolla N. Harger, Ph.D., Indianapolis

This report is Chapter 3 from a manual prepared by the Committee on Medicolegal Problems, dealing with medical and legal procedures involved in the use of chemical tests for intoxication.

Most of the drug effects of alcohol are due to its presence in the brain, since it is absorbed very rapidly and enters the brain within seconds after it appears in the blood.

The pharmacology of alcohol will be discussed in accordance with its effect on various organs and on certain bodily functions.

Effect on Body Organs

Skin: Moderate doses of alcohol cause a marked dilation of skin vessels, resulting in a flushed face and hyperemia of other body surfaces. However, in alcoholic coma, the resultant impaired circulation causes a pallor of the skin. These two effects are of central origin.

Gastrointestinal Tract: A temporary increase in the acidity of the gastric juice follows the ingestion of 4 to 10 cc. of alcohol, diluted to about 7 percent with water. This effect has been ascribed to the liberation of a histamine like substance, or perhaps gastrin, by the action of alcohol on the gastric mucosa (1). Experiments with isolated portions of the stomach and the duodenum showed that only the stomach, antrum and the duodenum exhibit this response to alcohol stimulated secretion in other parts of the stomach (2). Intravenously administered alcohol also causes an increase in the gastric secretion of acid, but whether this is due to alcohol in the brain is not known.

Concentrations of alcohol above 15 to 20 percent inhibit gastric secretion and may cause marked inflammation of the stomach mucosa. Vomiting frequently occurs after rather rapid drinking. Newman (3) has recently shown that the incidence of vomiting is practically the same after intravenous as after oral administration of alcohol, and it appears when the blood alcohol level reaches about 0.12 percent. This would seem to indicate that the emetic affect is also of central origin.

In the small intestine, absorption of alcohol is so rapid that the concentration here rarely exceeds 1 or 2 percent. Except for a moderate, temporary increase in intestinal secretion, alcoholic drinks have very little effect on the gastrointestinal tract beyond the stomach.

Heart and Circulation: Grollman (4) gave subjects 2.5 ounces of whiskey and observed an increase of 5 to 10 percent in pulse rate, blood pressure and total blood flow. These effects practically ceased in 30 minutes. He emphasized that these effects are mild

when compared to the action of many circulatory stimulants. Whether alcohol increases coronary blood flow is not entirely settled. Lasker and Sherrod (5) reported a marked augmentation of coronary blood flow of dogs after rapid intravenous injection of 50 percent alcohol. On the other hand, Russek and associates (6) could observe no significant electrocardiographic response in 12 heart patients who received 1 or 2 ounces of whiskey before exercise.

Liver: Josephson and Asplund (7) reported tests showing some impairment of liver function in one out of six healthy subjects four hours after each had drunk 300 cc. of 40 percent alcohol. Forbes and Duncan (8) observed a marked drop in the liver glycogen level in rats receiving 3 grams of alcohol per kilogram, a dose corresponding to 18 fluid ounces of 100 proof whiskey for a 150-pound (68 kilogram) person. They stated that administration of Alcohol failed to restore glycogen in the livers of fasted rats. Sutherland and Watson (9) measured the output of urinary coproporphyrin III in subjects after a period of severe alcoholic intoxication. They reported a marked rise in this porphyrin level lasting several days. However, this abnormality may not involve the liver. We will not attempt to discuss the question of the possible relationship between chronic alcoholism and liver cirrhosis.

Kidney: The increased volume of urine after the consumption of alcoholic beverages is due both to the augmented water intake and also the marked diuretic effect of alcohol (10). Alcohol inhibits the production of the antidiuretic hormone of the posterior pituitary. It appears unlikely that the moderate use of alcohol produces any kidney damage.

Effect on Central Nervous System

The most important drug effects of alcohol are those on the brain. The higher functions of the brain are inhibited first, with the more autonomic mechanisms affected later as the concentration of alcohol increases. Pharmacologists agree that the effect of alcohol in the brain is always a deterioration of function and never an improvement. This principle was first enunciated by the noted German pharmacologist, Schmiedeberg (11), who stated:

> The subjective and objective states and manifestations, from which alcoholic drinks are considered condiments, are usually attributed to a stimulating effect of the alcohol ... However, a closer consideration of these manifestations shows that they are the results of a beginning paralysis of certain parts of the brain. Since this view was first expressed in the first edition of this work (1883) the idea that alcohol acts as a stimulant to the nervous system is no longer held in pharmacological circles.
>
> In the psychic sphere there is first lost the finer grades of attention, judgment, reflection, and ability to comprehend. This serves to explain the typical behavior of persons under the influence of alcoholic drinks. The soldier becomes more courageous since he observes the danger less, and reflects upon it less. The speaker is not tormented and influenced by

> the proximity of the public; he, therefore, speaks freer and with more animation. One's self-appraisal rises greatly. Often one is astounded at the ease with which he expresses his thoughts and with the keenness of his judgment in matters that are beyond his mental sphere, when sober, and is later ashamed of this delusion. (Translation by author.)

There are three serious types of impairment resulting from the depressant effects of alcohol on the central nervous system.

Less Efficient Vision and Hearing: Tests of seven functions involved in Vision were made by Newman and Fletcher (12) on fifty subjects before and after drinking. The blood alcohol levels of the subjects ranged from 0.058 to 0.218 percent, all but four being below 0.150 percent. At 0.115 percent and above, all subjects showed impairment in one or more of the tests. The highest incidence of impairment was in visual acuity, with thirty-five of the fifty subjects showing definite deterioration of this function. The number of the fifty subjects showing impairment in the other six tests ranged from twenty-seven for eye coordination to eight for side vision.

Using a flicker fusion test, Goldberg (13) reported that, with abstainers, reduced visual acuity begins at blood alcohol levels of 0.01 to 0.20 percent, with the threshold for moderate drinkers 0.22 to 0.03 percent and for heavy drinkers 0.04 to 1.07 percent. In discussing these results he stated:

> Alcohol had the same effect on vision as the setting of a grey glass in front of the eyes, or driving with sun glasses in twilight or darkness; a stronger illumination is needed for distinguishing objects and dimly lit objects will not be distinguished at all; when a person is dazzled by a sharp light it takes a longer time before he can see clearly again. (14)

The effect of alcohol on binocular vision was studied by Brecher and others (15). They used a procedure, which caused momentary double vision without alcohol. After alcohol, the time required to attain single vision was greatly increased, being about doubled at 0.10 percent blood alcohol and quadrupled at 0.15 percent, when viewing at twenty feet. The authors stated, "somewhere between 0.05 and 0.10 percent, all subjects showed definite impairment". Charnwood (16) and Giardini (17) have also reported interference with ability to overcome double vision after the ingestion of 1.5 to 3 ounces of alcohol.

The effect of alcohol on hearing was tested by Hansen (18). He gave five subjects 0.33 to 1.0 gm. of alcohol per kilogram of body weight and reported an increase in the auditory discrimination threshold. This means that after ingestion of alcohol, a higher tone intensity was required for the subjects to perceive a given tone or to differentiate between tones.

Clumsiness of Voluntary Muscles: The efficient transmission of nerve impulse from brain to voluntary muscle is impaired by the presence of alcohol in the brain and causes

erratic muscular response. This impairment depends on the level of body alcohol and varies all the way from lessened efficiency in situations requiring intricate muscular coordination, through various stages of thick speech and staggering gait, to complete paralysis of voluntary muscles. Further rise in the concentration of alcohol in the brain also affects involuntary muscles, and may cause death by paralysis of respiration. The Harvard pharmacologist, Reid Hunt (19) once said, "A fact frequently overlooked is that a person deeply intoxicated is near death and that a dose of alcohol slightly greater' than the necessary to cause intoxication is a fatal dose." The fatal concentration of blood alcohol ranges from 0.5 to 0.9 percent, although lower concentrations have been reported in cases of fatal alcoholism (20).

The level of blood alcohol at which beginning incoordination of voluntary muscles appears and the relation of the blood alcohol level to the degree of incoordination have been investigated by a large number of workers. These studies have measured the subject's efficiency in such operations as typewriting, handwriting, target practice, arm-steadiness, sway while standing, equilibrium in walking and standing and speech. Other tests have involved the actual driving of a car or the use of a device simulating the operation of an automobile. The alcohol effect was always a lowering of efficiency, although the alcoholic subject frequently thought he was doing better than when alcohol-free. Goldberg (14) found that the threshold of impairment for the Romberg and finger-to-finger tests was a blood alcohol level of 0.05 to 0.10 percent which levels, for a 150 pound person, would mean a total quantity of body alcohol equal to the alcohol in 2 and 4 fluid ounces of 100 proof whiskey respectively. A review of a number of extensive studies of this sort was published by Harger and Hulpieu (21).

Lengthened reaction time is one criterion of efficiency of muscular response. Alcohol in the brain causes a longer time lag before the voluntary muscle can obey the brain. Forbes (22) found that a blood alcohol concentration of 0.10 to 0.20 percent causes an increase of 10 to 30 percent in reaction time. At a speed of 30 miles per hour a car travels 44 feet per second, so that an increase of a fraction of a second in applying the brake may be a serious safety hazard in an emergency.

Deterioration of Judgment and Self-Control: Judgment and self-control belong to the highest functions of the brain. Such functions are impaired by lower concentrations of body alcohol than the levels, which will inhibit the brain functions previously mentioned. Two results of impairment of these higher brain functions are euphoria and loss of inhibitions.

Euphoria: Euphoria means a hyper sanguine condition of the subject. Although this phenomenon can hardly be measured quantitatively, all drinkers know that the consumption of two or three cocktails will cause them to "see the world through rose-colored glasses." Basically, this is the chief reason for the popularity of alcoholic beverages. While alcoholic euphoria may make a social gathering more enjoyable, may improve the appetite of a hypochondriac and may tranquilize a victim of incurable disease, it is certainly contraindicated for an automobile driver. The driver should view his surroundings very clearly.

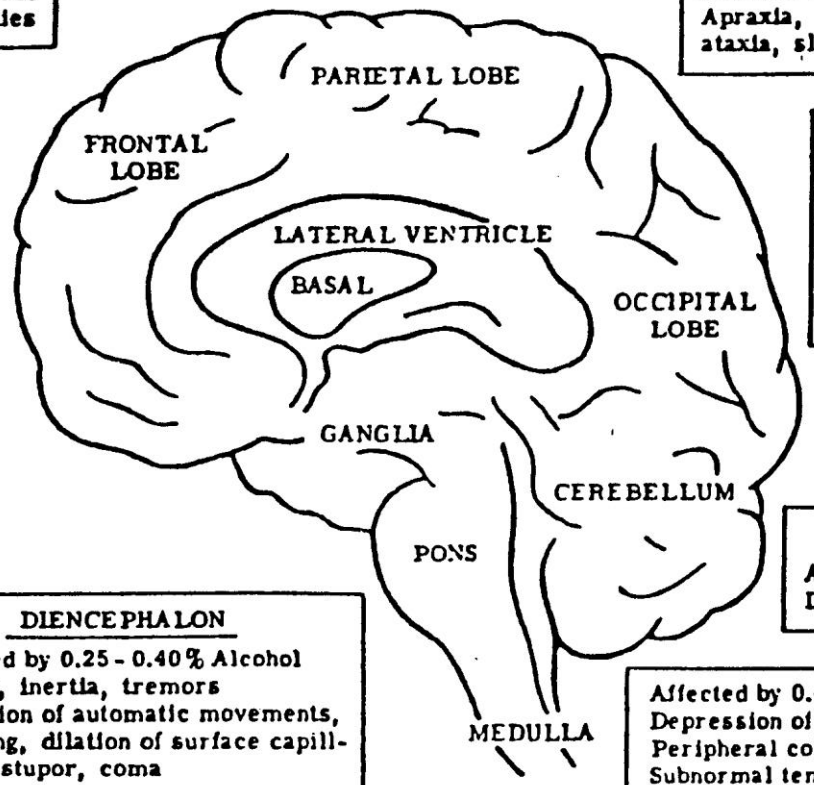
PHARMACOLOGICAL EFFECT OF ALCOHOL

"THE ACTION OF ALCOHOL ON THE BRAIN IS FROM FIRST TO LAST LIKE THAT OF A NARCOTIC DRUG"

SOMESTHETO-PSYCHIA AREA
Affected by 0.10 - 0.30% Alcohol
Dulled or distorted sensibilities

PSYCHOMOTOR AREA
Affected by 0.10 - 0.20% Alcohol
Apraxia, tremors, agraphia,
ataxia, slurred speech, loss of skills

FRONTAL LOBE
Effected by 0.01 - 0.10% Alcohol
Reaction is colored by the individual's personality
Removal of inhibitions
- Loss of self-control
- Weakening of will power
- Feeling of well-being
- Exaltation
- Increased confidence
- Expansiveness
- Generosity
- Altered judgment
- Increased good fellowship
- Loquaciousness
- Dulling of attention



VISUO-PSYCHIC AREAS
Affected by 020 - 0.30% Alcohol
Disturbances of:
- Color Perception
- Form
- Dimensions
- Motion
- Diplopia
- Distance

CEREBELLUM
Affected by 0.15 - 0.35% Alcohol
Disturbance of Equilibrium

DIENCEPHALON
Affected by 0.25 - 0.40% Alcohol
Apathy, inertia, tremors
Cessation of automatic movements, sweating, dilation of surface capillaries, stupor, coma

Affected by 0.40 - 0.50% Alcohol
Depression of respiration,
Peripheral collapse,
Subnormal temperature, Death

Loss of Inhibitions: The inhibitions are our moral brakes. The chief distinction between man and the lower animals is that the former exercises many more inhibitions. Without them, he could hardly live a civilized life. The role of alcohol in lowering inhibitions is aptly described in the quotations from Schmiedeberg, given above. Concentrations of alcohol in the brain and blood far below those necessary to produce detectable muscular incoordination will cause a blunting of the sense of caution and normal restraints.

The driver or industrial worker who is a little "high" becomes a poor safety risk. He will take chances which he would avoid when alcohol free. The recognition that alcohol in the brain causes the subject to become more reckless is the reason for the definition of "under the influence" adopted by most courts and is what has prompted our railroads, airlines and other industries to prohibit any drinking by an employee while on duty.

With some individuals, the loss of inhibitions caused by alcohol results in anti-social behavior. Seneca, the Roman philosopher and senator, wrote (23): "Drunkenness kindles and discloses every kind of vice, and removes the sense of shame that veils our evil undertaking. For more men abstain from forbidden actions because they are ashamed of sinning than because their inclinations are good." The role of alcohol as an important causative factor in acts of violence has been repeatedly emphasized in recent, careful studies (24).

The reasons why the central nervous system depression caused by even moderate concentrations of body alcohol is extremely detrimental to traffic safety have recently been very cogently stated by a special technical committee of the West German government (25): The motor vehicle operator requires a sensitive perception-and-judgment ability for every unusual and unexpected moving change of the traffic situation within his sphere; he must literally anticipate the future traffic situation. Especially this ability to feel one's way in the traffic events is adversely affected with certainty at a blood alcohol concentration of 1/5 pro mille even in alcohol-habituated motor vehicle operators. Because of all thin, no scientifically established facts are known which permit assuming that driving fitness still exists above a blood alcohol concentration of 1.5 pro mille. (1.5 pro mille equals 0.15 percent) Translation by Dr. Kurt Dubowski, Iowa Methodist Hospital, Des Moines, Iowa.

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Montana Administrative Rules

23.4.201 DEFINITIONS

Unless the context requires otherwise, the following definitions apply to this subchapter:

(1) "Accessory" means any device or item, which may or may not be expandable, but assists in the operation of the breath analysis instrument.

(2) "Alcohol" means an organic hydrocarbon molecule which contains a hydroxyl (oxygen, hydrogen) as its primary functional group, such compounds to include such common alcohols as: methanol, ethanol, isopropanol, and all other compounds chemically classified as an alcohol.

(3) "Alcohol analyses" includes any testing required to achieve a result demonstrating the presence and/or concentration of alcohol in breath, blood, or any other bodily substance.

(4) "Alveolar air" means that air which is located in the alveoli of the lungs and is responsible for the exchange of gases between the blood and the lung. This is the type of breath upon which the 2100:1 breath blood ratio is established.

(5) "Anticoagulant" means any substance which prevents the clotting of the blood sample.

(6) "Associated equipment" means:

(a) any device which can be directly attached to the breath analysis instrument and is not considered an expendable item, i.e., a wet bath simulator; or

(b) any approved device capable of capturing and analyzing deep lung air to detect and verify the presence of alcohol, i.e., a PAST device.

(7) "Blood" refers to whole blood, serum, or plasma.

(8) "Breath" refers to that portion of the exhaled deep lung air that is collected for alcohol analysis.

(9) "Breath analysis instrument" means any device which is capable of capturing and analyzing deep lung air to establish the concentration of alcohol contained in that sample. Such instruments must be approved by the Forensic Science Division.

(10) "Breath analysis instrument change" means any substitution or replacement of any electronic, optical, or mechanical part or device which adheres to the original specification(s) and does not affect or change the analytical or operational sections of the breath analysis instrument. Such change does not require reapproval of the breath analysis instrument.

(11) "Breath analysis instrument modification" means any alteration, variation, or redesign of any part, device, or electronic circuit which directly affects, alters, varies, or changes the analytical and/or the operational section of the breath analysis instrument. Such modification may at the discretion of the division, require reapproval of the breath analysis instrument.

(12) "Breath analysis instrument update" means any advancement, augmentation, addition, or replacement of any part or device with a different specification, which may

or may not affect the analytical or operational sections of the breath analysis instrument. Such update may, at the discretion of the division, require reapproval of the breath analysis instrument.

(13) "Breath-test specialist" means a person qualified under these rules to use a breath analysis instrument or a preliminary alcohol screening device, i.e., PAST device. Depending on the person's degree of training as set forth in ARM 23.4.216, he/she may be certified as:

(a) operator;

(b) senior operator; and/or

(c) technician.

(14) "College of American Pathologists" means the organization nationally recognized by that name with headquarters in Northfield, Illinois, which surveys clinical laboratories upon their request, and accredits clinical laboratories which it determines meet its standards and requirements.

(15) "Deep lung air" means that air which comes from the deeper section of the lung and contains only a portion of alveolar air. This is the type of breath captured by the breath analysis instrument.

(16) "Department" means the Department of Justice.

(17) "Division" means the Forensic Science Division of the Department of Justice.

(18) "The Joint Commission" (formerly known as The Joint Commission on Accreditation of Hospitals) means the organization nationally recognized by that name with headquarters in Chicago, Illinois, that surveys health care facilities upon their request and grants accreditation status to any health care facility that it determines meets its standards and requirements.

(19) "Laboratory" means the Forensic Science Division.

(20) "Manufacturer" means the actual producer of the breath analysis instrument, associated equipment, accessories, and/or supplies.

(21) "MLEA" means Montana Law Enforcement Academy.

(22) "NHTSA" means National Highway Traffic Safety Administration.

(23) "POST council" means Police Officer Standards and Training Advisory Council of the Montana Board of Crime Control.

(24) "Preliminary alcohol screening test" or "PAST" means any device meeting the definition of (8)(b).

(25) "Preservative" means any chemical which inhibits the development of bacterial growth in a collected blood sample or which inhibits or prevents enzymatic hydrolysis of drugs by cholinesterase, i.e., potassium oxylate and sodium fluoride.

(26) "Renewal materials" in ARM 23.3.217 means materials which relate to the field of breath alcohol testing, and may include an exam, a practical demonstration on the instrument, current legal decisions, or updates on instrument technology and operation.

(27) "Sample" means blood, breath, urine, or other biological fluid to be analyzed for the presence of drugs and/or alcohol pursuant to this subchapter. All samples must be of sufficient volume so that complete analysis may be performed.

(28) "SFST/HGN" means standardized field sobriety testing/horizontal gaze nystagmus.

(29) "Supply" means any item which is consumed during one or more test modes of the breath analysis instrument or associated equipment, i.e., simulator solution and mouthpieces.

(30) "Test," in reference to a breath analysis, means a full and complete analysis of properly delivered breath sample or samples. Such analysis is to be considered complete when the breath analysis instrument has executed its prescribed program, a final result known as the reported alcohol concentration is obtained, and a printed record is produced by the breath analysis instrument. All breath analyses must be performed in accordance with the procedures set forth by the Forensic Science Division. In reference to other biological sample analysis, a test of the sample may consist of more than one analysis of the submitted sample or samples in accordance with the procedures set forth by the Forensic Science Division.

(31) "Vendor" means any company or representative or a manufacturer responsible or involved in the sale and/or marketing of breath analysis instrumentation, associated equipment, accessories, and/or supplies.

23.4.203 EXEMPTIONS

(1) The following are exempt from the certification required by this subchapter:

(a) all clinical and hospital laboratories under the direct supervision of a pathologist or certified medical technologist which are either licensed by the Montana Department of Health and Environmental Sciences or accredited by the College of American Pathologists, the Joint Commission on Accreditation of Hospitals, or some other similar health accrediting authority;

(b) a laboratory operated by the department.

23.4.209 BREATH ANALYSIS INSTRUMENTS

(1) All models of breath analysis instruments used to administer testing according to 61-8-402 , MCA, must be approved by the division. The models operated by certified operators and/or senior operators prior to and on the effective date of this rule are deemed approved by the division.

23.4.210 SURVEYS AND PROFICIENCY TESTS

(1) Equipment and records used by nonexempt certified persons or persons applying for certification for blood testing are subject to on-site inspections by representatives of the division.

(2) The person shall accept from the division for analysis periodic evaluation samples and participate in a national blood alcohol proficiency testing program (i.e., program conducted by the College of American Pathologists).

(3) A copy of the results of evaluation sample analysis and proficiency tests shall be sent to the division.

23.4.211 BLOCD AND URINE TEST RECORDS

(1) All nonexempt persons performing blood and urine tests and/or analyses shall maintain the following records:

(a) proof of certification;

(b) records of tests performed and the results; and

(c) records of maintenance of instrumentation.

23.4.212 BREATH ANALYSIS INSTRUMENTATION AND ASSOCIATED EQUIPMENT

(1) All manufacturers/vendors of breath analysis instruments, associated equipment, and supplies are required to submit such breath analysis instrumentation, associated equipment, or supplies to the division for formal state approval prior to introduction into the state of Montana.

(2) A record of all breath analysis instruments which have met the approval criteria established by the division shall be kept on file at the division.

(3) A record of all associated equipment and supplies which have met approval criteria established by the division shall be kept on file at the division.

(4) The division reserves the right to withdraw approval status of any breath analysis instrument, associated equipment, or supply, or the manufacturer's/vendor's approval to market said product, if the manufacturer/vendor fails to comply with the provisions set forth in the approval criteria or regulations pertaining to the manufacturer's/vendor's responsibilities to the state of Montana.

(5) Manufacturers/vendors of breath analysis instrumentation, equipment, and/or supplies must comply with the following regulations:

(a) All manufacturers/vendors must have a completed and signed application on file with the division.

(b) All manufacturers/vendors must provide technical manuals, schematics, and other material necessary for operation, preventative maintenance, and repair of the breath analysis instruments and associated equipment.

(c) The manufacturer/vendor shall provide at least two breath analysis instruments for the approval process. The manufacturer/vendor shall provide at least two (or more at the request of the division) associated equipment devices for the approval process.

(d) The manufacturer/vendor shall, if requested to do so, send at least one representative knowledgeable in the technology and electronic configurations of the breath analysis instrument and capable of providing training for the personnel in the breath analysis section of the division. The manufacturer/vendor shall, if requested to do so, send at least one representative knowledgeable in the technology and electronic configurations of the associated equipment.

(e) The manufacturer/vendor must provide all information concerning any modification, change, or upgrade to an approved breath analysis instrument or approved associated equipment within six months of that modification, change or upgrade. The division will evaluate such modifications, changes, or updates and determine if such modification, change, or update necessitates reapproval of the breath analysis instrument.

(f) Failure to comply with these or any subsequent manufacturer/vendor related regulations may negate the manufacturer's approval to market additional breath

analysis instrumentation, associated equipment accessories, and/or supplies in the state of Montana.

(6) The division shall have the duty to select the primary breath analysis instrument for use in the state of Montana. Selection shall be based on, but not limited to, performance of the breath analysis instrumentation in each segment of the state approval process, breath analysis instrumentation field history, legal history, manufacturer's/vendor's support capability, and references of other users.

(7) Breath samples of deep lung air shall be analyzed using only the breath analysis instrumentation or PAST devices approved under this rule.

(8) All results of a breath analysis shall be reported as grams of alcohol by weight per 210 liters of deep lung breath (G/210L). All test results will be reported on a form approved by the division. Copies of all test results will be sent to the division on a monthly schedule. Failure to file a copy of the report with the division does not invalidate the test results, if the report is on file at the testing location.

23.4.213 FIELD CERTIFICATION OF BREATH ANALYSIS INSTRUMENTS AND ASSOCIATED EQUIPMENT

(1) Breath analysis instruments shall be field certified for accuracy at least once every 31 days by a senior operator using an ethyl alcohol water standard or an ethyl alcohol gas standard which has been approved by the division and using the field certification report form for the breath analysis instrument being certified.

(a) A field certification shall consist of a series of no less than two analyses obtained using an approved alcohol standard.

(b) A field certification is valid when the results of the approved standard are at plus or minus 10% of target value. The results of the field certification shall be reported to the third decimal (0.000) and recorded on the field certification report form. If a test record card or tape is used, it shall be affixed to the field certification report which is to be kept at the testing location, and a copy of the field certification report will be prepared for the division. All field certification reports will be sent to the division on a monthly basis.

(c) The approved ethyl alcohol water standard will not be used for longer than three months after its first date of use. The ethyl alcohol gas standard will not be used beyond the expiration date listed on the standard.

(d) Results of a field certification analysis outside the range specified in this rule shall be confirmed by the senior operator. If the test results are still out of the specified range, the breath analysis instrument will be removed from service and the division shall be notified.

(e) A field certification shall be performed whenever a new breath analysis instrument is placed in service or when a breath analysis instrument is returned to service. In addition, whenever a breath analysis instrument is placed in a mobile service capacity, a field certification shall be done prior to mobile use and again at the end of mobile use. The field certification results must be on file at the testing location before the breath analysis instrument can be used for subject testing.

(f) After each use, the ethyl alcohol water standard shall be stored in a closed container and placed in a cool dark area. This storage requirement does not apply to the ethyl alcohol gas standard.

(g) The field certification report form and results will be kept on file at the testing location. The division will receive copies of all field certification report forms along with copies of all breath analysis report forms. All reports will be sent to the division on a monthly basis.

(h) Failure to file a copy of the report with the division does not invalidate the field certification, or any subject analysis performed at that location, if the report is on file at the testing location.

(i) A field certification prior to any subject test, and either calibration checks with approved alcohol standards performed during the subject test or a field certification following a subject test, shall create the inference that the breath analysis instrument was in proper working order at the time of the subject test.

(j) A breath analysis instrument's field certification shall be considered valid for 31 days forward from the date of a proper field certification.

(2) All devices meeting the definition of "associated equipment" contained in ARM 23.4.201(6)(b) shall be field certified for accuracy at least once every 31 days by a breath-test specialist who has received training approved by the division in the proper methods for conducting such analyses.

(a) A PAST's field certification shall consist of a series of no less than two analyses using an ethyl alcohol water or ethyl alcohol gas standard approved by the division.

(b) A field certification is valid when the results of the approved standards are at plus or minus 10% of target value. The results of the field certification must be recorded and maintained in the administering agency's files.

(c) Results of a field certification analysis outside the range specified in (2)(b) shall be confirmed/adjusted by the senior operator. If the test results are still out of the specified range, the PAST will be removed from service.

(d) A field certification shall be performed whenever a new PAST is placed in service or when a PAST is returned to service. The field certification results must be on file with the agency before the PAST can be used for subject testing.

(e) The individual law enforcement agencies using PASTs shall maintain a record of the field certifications of each individual device. Such record shall include but not be limited to:

(i) the date of the field certification;

(ii) the serial number of the PAST;

(iii) the results obtained and if an adjustment was made;

(iv) the lot number of the ethyl alcohol water standard or ethyl alcohol gas standard; and

(v) the name of the individual conducting the analysis.

(f) A PAST's field certification shall be considered valid for 31 days forward from the date of a proper field certification.

23.4.214 LABORATORY CERTIFICATION

(1) All breath analysis instruments shall be returned to the division for a laboratory certification. A laboratory certification shall be considered valid for 365 days from the date of a laboratory certification. Such certification shall at a minimum consist of:

(a) a complete analysis of the breath analysis instrument's diagnostic functions and settings;

(b) a series of controlled ethyl alcohol water/gas standards shall be analyzed with an accuracy requirement of +/- 5% or .005, whichever is greater, on all target values;

(c) all updates, modifications, or changes which have been approved by the division may be installed; and

(d) a review of the breath analysis instrument's sensitivity for the detection of interfering substances.

(2) A record of the laboratory certification report shall be kept on file at the division.

(3) All new breath analysis instrumentation must receive a laboratory certification prior to placement in the field. Any breath analysis instrument sent to a location other than the division, or an approved repair facility within the state of Montana for maintenance or repair is required to receive a laboratory certification from the division prior to the instrument being placed back into service.

(4) All breath analysis instruments received from the division either after the laboratory certification, preventive maintenance, or after repair, must have a field certification performed by the senior operator, as set forth in ARM 23.4.213, prior to analysis of any subject's breath.

(5) The results of the laboratory certification report shall be placed on file with the division and a copy of the laboratory certification shall be filed with the testing location. Failure to file with the testing location does not invalidate the laboratory certification, or any subject analysis performed at that location, if such certification is on file with the division.

23.4.215 QUALIFICATION OF BREATH ANALYSIS LOCATION

(1) All locations performing breath analysis must have one or more senior operator(s) responsible for the care, maintenance, and field certification of the breath analysis instrument. The senior operator does not have to be a member of the department which has the physical placement of the breath analysis instrument.

(2) All locations must have a sufficient number of breath-test specialists to warrant placement. The number of breath-test specialists for any location will be based on the total number of operators and senior operators within the county.

(3) All locations will provide an adequate operational environment for the breath analysis instrument. If a location fails to do so, the division shall have the right to place that location on suspension, and if the location does not meet approval within 90 days of notification of suspension, the division will revoke the location's certification. If the breath analysis instrumentation is state-owned, the breath analysis instrumentation will be removed.

(4) All locations are required to submit copies of all field certification reports and all breath analysis reports on a monthly basis. Failure to maintain this reporting schedule may result in the revocation of a testing location's certification and revocation of the senior operator's certification. Failure to file the above reports does not invalidate any subject analysis or field certification performed at that location.

(5) In order to obtain approval as a certified test location, an application must be submitted to the division. The division will review the application and will respond with its decision. Applications will be available through the division. All locations established prior to April 1, 1990, are exempt from the application requirement and are granted certification status.

(6) Temporary testing locations may be designated upon the request of a law enforcement agency if the division feels that such location is warranted. Such location must conform to all certification specifications required for a permanent testing location.

(7) Mobile testing locations may be designated upon the request of a law enforcement agency if the division feels that such location is warranted. All mobile testing shall be done in a manner approved by the division. No formal application is required.

(8) All locations should have an equipment control form and a signed user agreement on file with the division to maintain their certification status.

23.4.216 INITIAL CERTIFICATION OF BREATH-TEST SPECIALISTS

(1) An individual meets the qualifications for an operator permit by:

(a) attending an approved training course conducted by personnel from the division;

(b) satisfactorily demonstrating knowledge of the principles of breath test analysis through discussion and examination; and

(c) satisfactorily demonstrating competent operation of the breath analysis instrumentation.

(2) The division shall issue an operator's permit to persons complying with (1)(a) through (c).

(3) If an operator candidate fails the certification examination, he/she may retake the examination within 30 days of notification of failure. An operator candidate failing the operator examination a second time, must retake the operator initial certification training course and examination.

(4) An individual meets the qualifications for a senior operator permit by:

(a) holding a valid operator permit;

(b) attending an approved senior operator training course conducted by personnel from the division;

(c) satisfactorily demonstrating knowledge of the principles of breath-test analysis through discussion and completion of the senior operator training course;

(d) satisfactorily demonstrating competent operation of the breath analysis instrumentation; and

(e) satisfactorily demonstrating competent preparation and analysis of controlled solutions utilized in field certifications.

(5) The division shall issue a senior operator's permit to an operator successfully complying with (4)(a) through (e).

(6) A person meets the qualifications for technician by:

(a) holding a valid senior operator permit for at least one year. A special exemption for this requirement may be obtained through the division;

(b) attending an approved technician training course conducted by personnel from the division, or an approved manufacturer's course in technical repair and maintenance;

(c) satisfactorily demonstrating knowledge of the technology utilized by the specific breath analysis instrument for which the individual wishes to hold a permit; and

(d) satisfactorily demonstrating competency in problem solving and repair of specific breath analysis instrument.

(7) The technician permit is held in addition to the senior operator permit. An individual holding a technician permit is required to continue the duties and responsibilities of a senior operator.

23.4.217 RENEWAL OF BREATH-TEST SPECIALIST PERMITS

(1) The division will develop and provide breath-test specialist permit renewal materials to a senior operator for each department.

(2) Senior operators shall provide the permit renewal materials to all breath-test specialists within the senior operators' department. A senior operator from another department may provide the permit renewal materials to departments with no senior operator.

(3) All breath-test specialists shall review the permit renewal materials and acknowledge review as required by the division.

(4) The senior operators shall send all acknowledgment forms to the division unless digital acknowledgment is requested by the division.

(5) The division shall renew permits for all breath-test specialists complying with (3).

(6) A breath-test specialist failing to comply with (3) prior to expiration of her/his current permit, shall not perform any analysis of a person's breath for alcohol until the breath-test specialist's permit is renewed. All breath-test specialists who fail to comply with (3) within 90 days of the expiration date of her/his current permit must either complete an initial certification course or file a written request with the division for an exemption. Exemption requests will be reviewed and approved for good cause by the division. Good cause may include, but is not limited to, lapse in law enforcement service due to military duty, illness, death in the family, or injury. If approved, the breath-test specialist must then comply with (3) within 30 days of the division's approval date.

(7) The division may directly provide the approved permit renewal materials to, and accept acknowledgment forms from, any breath-test specialist at the division's discretion.

23.4.218 PERMITS

(1) No individual may perform a breath analysis for alcohol pursuant to 61-8-402 , MCA, without a current permit. Individuals holding permits issued by the division shall perform only those functions designated by that permit.

(2) Permits shall expire on January 31 in the year following initial certification or permit renewal. The division has the right to deny or delay the issuance or renewal of any permit for good cause.

23.4.219 REVOCATION OF PERMITS

(1) The division may deny, deny renewal of, suspend, or revoke the permit of any permit holder who:

(a) obtained such permit falsely or deceitfully;

(b) fails to comply with any section of the rules; or

(c) fails to demonstrate that he/she can properly carry out the duties and responsibilities of the issued permit.

(2) The division has the right to revoke, suspend, or deny any permit for good cause.

23.4.220 COLLECTION OF BLOOD SAMPLES FOR DRUG AND/OR ALCOHOL ANALYSIS

(1) Blood samples will be collected from living individuals only by persons authorized by current law, upon written request of a peace officer, or officer of the court. Blood samples that are drawn or analyzed by medical staff for medical diagnostic or treatment purposes, and not at the request of a peace officer or an officer of the court, are exempt from these rules.

(2) The skin at the area of puncture must be thoroughly cleansed and disinfected with an aqueous solution of a nonvolatile antiseptic, i.e. betadine, etc. Alcohol phenolic solution may not be used.

(3) The blood sample will be deposited in a clean, dry container. The container should then be capped or stoppered, sealed, and the following information provided:

(a) name of the subject;

(b) date of the collection;

(c) time of the collection; and

(d) evidence seal to be signed and dated.

(4) All blood samples must be of sufficient volume to provide accurate and repeatable analyses. Required volumes will be dependent on the current technology employed by the division. Any submitted sample not meeting the required sample volume will not be analyzed.

(5) The division will provide collection kits consisting of approved collection tubes and the appropriate request forms for collection of blood samples. The division reserves the right to accept or reject any blood sample submitted in a commercially available collection kit.

(6) The approved collection tube will be one that contains a preservative, sodium fluoride or its equivalent, and an anticoagulant, potassium oxalate or its equivalent. The use of other types of collection tubes will be at the discretion of the division.

(7) When possible, the peace officer requesting the blood sample shall observe the collection of the sample so that he/she may attest to the sample's authenticity.

23.4.221 COLLECTION OF POSTMORTEM SAMPLES FOR DRUG AND/OR ALCOHOL ANALYSIS

(1) Sampling of body substances other than blood, breath, or urine is considered valid only in postmortem cases. All postmortem body material must be obtained prior to the embalming process. The sample or samples must be taken by a physician, board certified pathologist, the county coroner or a designated representative of the county coroner.

(2) Whenever a postmortem blood sample is collected, all practical precautions to ensure a representative, uncontaminated sample must be employed. Care must be taken to avoid contamination of the sample by gastrointestinal contents if it is necessary to sample heart blood. There must be adequate mixing of the blood sample before withdrawal. If a heart blood sample is taken without autopsy, precautions against dilution of the blood with pleural or pericardial fluids must be employed.

(3) In any postmortem collection of blood, the primary sample for analysis shall be femoral blood. If such sample is unattainable, the next sample of choice shall be heart

blood. If a heart blood sample is unattainable, the sample of choice will be urine. Any sample to be drawn will be an uncontaminated sample.

(4) In the event that no fluid samples can be preserved, tissue samples may be submitted. Preferred tissue samples to be brain, liver, lung, and kidney.

23.4.225 PRELIMINARY ALCOHOL SCREENING TESTS (PASTs)

(1) All models and/or types of PAST devices used for testing must be approved by the division. A list of approved PAST devices will be maintained at the division.

(2) Individuals conducting PASTs as authorized by statute must be certified as breath-test specialists.

(3) Individuals certified as breath-test specialists pursuant to ARM 23.4.216 on or before July 1, 1995, are deemed to be PAST-certified after attending a PAST operation course approved by the division. Individuals certified as breath-test specialists after July 1, 1995, are deemed to be PAST-certified.

(4) Individuals responsible for field certification of the PAST must receive training approved by the division outlining the procedures for conducting such certifications.

(5) All PAST results will be recorded in a manner approved by the division. As presently used, the results shall be reported only as positive or negative.

(6) PAST results of 0.020 G/210L or greater shall be considered positive for the presence of alcohol, and PAST results of less than 0.020 G/210L shall be considered negative for the presence of alcohol.