Horizontal Gaze Nystagmus: The Science and The Law

A RESOURCE GUIDE FOR JUDGES, PROSECUTORS AND LAW ENFORCEMENT

National Traffic Law Center

2nd Edition, February 2021

Horizontal Gaze Nystagmus: The Science and The Law

A RESOURCE GUIDE FOR JUDGES, PROSECUTORS AND LAW ENFORCEMENT

The first edition of this manual was prepared under Cooperative Agreement Number DTNH22-92-Y-05378 from the U.S. Department of Transportation National Highway Traffic Safety Administration. This second edition was updated under Cooperative Agreement Numbers DTNH22-13-H-00434 and 693JJ91950010. Points of view or opinions in this document are those of the authors and do not necessarily represent the official position or policies of the U.S. Department of Transportation, National District Attorneys Association, or the National Traffic Law Center.

National Traffic Law Center

Table of Contents

Table of Contents

National Traffic Law Center

The National District Attorneys Association's National Traffic Law Center (NTLC) is a resource designed to benefit prosecutors, law enforcement, judges, and criminal justice professionals. The mission of NTLC is to improve the quality of justice in traffic safety adjudications by increasing the awareness of highway safety issues through the compilation, creation, and dissemination of legal and technical information and by providing training and reference services.

When prosecutors deal with challenges to the use of breath test instruments, blood tests, the horizontal gaze nystagmus test, crash reconstruction, and other evidence, the NTLC can assist with technical and case law research. Likewise, when faced with inquiries from traffic safety professionals about getting impaired drivers off the road, the NTLC can provide research and statistics concerning the effectiveness of administrative license revocation, ignition interlock systems, sobriety checkpoints and much more.

The NTLC has a clearinghouse of resources including case law, legislation, research studies, training materials, trial documents and a directory of expert professionals who work in the fields of crash reconstruction, toxicology, drug recognition and many others. The information catalogued by the Center covers a wide range of topics with emphasis on impaired driving and vehicular homicide issues.

The professional staff at the NTLC includes experienced trial attorneys and research staff. Assistance is specifically provided in all areas of trial preparation, including methods to counter specific defenses. The NTLC facilitates the direct exchange of information among prosecutors, judges, and other criminal justice professionals in the field.

The NTLC was created in cooperation with the National Highway Traffic Safety Administration (NHTSA) and works closely with NHTSA and the National Association of Prosecutor Coordinators to develop and deliver prosecutor training programs, including: *Prosecution of Driving While Under the Influence*, *Prosecuting the Drugged Driver*, and *Lethal Weapon: DUI Homicide*. Each course incorporates substantive legal presentations by faculty with skill building sessions where students participate in a mock trial. The participants are critiqued and videotaped to assist in improving their trial skills.

NTLC is a program of the National District Attorneys Association. NDAA's mission is to be the voice of America's prosecutors and to support their efforts to protect the rights and safety of the people. NDAA was formed in 1950 by local prosecutors to give a focal point to advance their causes and issues at the national level. NDAA representatives regularly meet with the Department of Justice, members of Congress and other national associations to represent the views of prosecutors to influence federal and national policies and programs that affect law enforcement and prosecution.

For additional information contact NDAA or NTLC, 1400 Crystal Drive, Suite 330, Arlington, Virginia, 22202 (phone) 703-549-9222, (fax) 703-836-3195, www.ndaa.org.

Preface

Despite its history of use and the endorsement of the U.S. Department of Transportation's National Highway Traffic Safety Administration (NHTSA), the horizontal gaze nystagmus (HGN) field sobriety test is not fully utilized and understood by all traffic safety professionals. What is nystagmus? How does the presence of horizontal gaze nystagmus reflect alcohol impairment? How does the police officer test for HGN? What conclusions can reasonably be drawn from the presence of HGN?

To provide accurate information regarding the use of the HGN test in impaired driving enforcement and dispel the continuing controversy around HGN, the National District Attorneys Association's National Traffic Law Center (NTLC) is proud to provide criminal justice practitioners nationwide with the second edition of *Horizontal Gaze Nystagmus—The Science and the Law: A Resource Guide for Judges, Prosecutors and Law Enforcement*. Among other things, this guide provides an overview of the science supporting the HGN test as a valid indicator of impairment, distinguishes between HGN and other forms of nystagmus, and provides the necessary tools to establish admissibility of the HGN test in court.

The NTLC is grateful to the U.S. Department of Transportation National Highway Traffic Safety Administration for its financial support which made this guide possible.

The NTLC is committed to assisting criminal justice practitioners in their efforts to increase public safety in their communities. The NTLC hopes that this guide will promote increased training, use and acceptance of the HGN test as a valid and reliable tool in detecting, prosecuting, and adjudicating impaired drivers.

Nelson O. Bunn
Executive Director
National District Attorneys Association

Acknowledgments

This second edition of *Horizontal Gaze Nystagmus—The Science and The Law* would not have been possible without the support and funding of the National Highway Traffic Safety Administration and the dedicated efforts of the following professionals at the National Traffic Law Center:

M. Kimberly Brown, Senior Attorney

Erin T. Inman, Staff Attorney

Tom Kimball, former Director and Senior Advisor

Joanne E. Thomka, Director

Tiffany Watson, former Staff Attorney

The second edition would not have been achieved without the significant assistance of:

Karl Citek, O.D., Ph.D., FAAO(Dipl)
Professor of Optometry
Pacific University College of Optometry

The first edition of this guide was the result of a collaborative process which drew on the knowledge, expertise, and patience of many former employees of the NTLC, including:

Patricia Gould

Janice Frost

James J. Dietrich

Penney Azcarate

Alexia L. Williams

Ruth R. Sanderlin

Heike P. Gramckow

Many additional traffic safety professionals also reviewed and offered critique on the first edition. Those persons are:

The Honorable John Burkholder, Glendale (Arizona) City Court

Marcelline Burns, Ph.D., Research Psychologist, Southern California Research Institute (retired)

Linda Chezem, Purdue University Professor Emeritus (former Senior Judge, State of Indiana, Court of Appeals)

Karen Herland, Assistant City Attorney, Minneapolis City Attorney's Office

The Honorable Patrick McGann, Chicago Traffic Court (retired)

Sergeant Thomas Page, Drug Recognition Expert Unit, Los Angeles Police Department (retired)

Sergeant Craig Porter, Johnston (Iowa) Police Department (retired)

Jack Richman, O.D., Professor Emeritus, New England College of Optometry

Victor Vieth, Senior Director, Gundersen National Child Protection Training Center

E.A. "Penny" Westfall, Commissioner of the Iowa Department of Public Safety (retired)

Foreword to the Second Edition (2020)

by Karl Citek, O.D., Ph.D., FAAO(Dipl)

In the over two decades since the publication of the First Edition of this guide, I and many of my colleagues would have thought that we would be significantly beyond the issues and concerns raised about the HGN test at the end of the twentieth century. Sadly, that is not the case, and almost everything that Dr. Burns said in her Foreword back then (see below) is still true. We still hear many of the same old arguments against the HGN test. On the positive side, though, much of what Dr. Burns said is still true. Human physiology and responses to stimuli do not change in such a brief time.

What has changed is our further understanding and knowledge that medical and environmental conditions will not exactly mimic the responses on the HGN test caused by intoxication, when the Test is administered correctly and appropriately.

This new edition provides updated and expanded definitions and descriptions, both of the components of the HGN test itself as well as of those medical and environmental conditions that often are raised as alternative explanations for the officer's observations. As before, this guide will assist the officer, prosecutor, and judge in understanding the HGN test, the conditions under which it is used, how an officer is taught to administer the Test and interpret the results, and how certain medical and environmental conditions do or do not affect the administration or results of the Test. The HGN test is valid and reliable, and it can properly be used to establish a driver's impairment.

Foreword to the First Edition (1999)

by Marcelline Burns, Ph.D.

Although significant gains in traffic safety have been achieved over the last decades, it can be predicted with certainty that thousands of individuals will be the victims of alcohol-involved crashes in 1999 and, unfortunately, probably for many more years to come. Whenever we venture into the driving environment, as driver, passenger, cyclist, or pedestrian, we place ourselves at risk of becoming a victim. No matter how skilled and prudent we may be, there is no guarantee that we will be able to protect ourselves (or those we care about) from alcohol-impaired drivers. Since this amounts to an equal-opportunity potential for injury and death, one might expect all responsible adults to wholeheartedly support efforts to deter DUI drivers through sound programs. Unfortunately, such is not the case. Witness the persistent and vigorous efforts to prevent use of Horizontal Gaze Nystagmus (HGN) as a roadside sobriety test. To the extent those efforts succeed, traffic officers will have been denied a valid and reliable tool. That will not be a small loss since police officers are a vital link in the chain of events that removes impaired drivers from the roadway. If they are not allowed to use HGN and perform their duties with maximum effectiveness, we all will be more at risk than need be.

This HGN resource guide is a "good news" document, not only for the judges, prosecutors, and law enforcement officers to whom it is addressed, but for all safety minded citizens. The guide brings together a scientific and pragmatic approach to understanding HGN. Not only does it present sound information, it also provides a road map for the effective use of that information. Perhaps it will short-circuit the inaccurate and self-serving view of HGN that is propounded by defense counsel. Just possibly, the false arguments will subside, and traffic court time can be devoted to meritorious issues.

Lest the foregoing seem too harsh an indictment of the HGN challenges (and the challengers), consider the following. First, a very simple fact is often overlooked, perhaps because its simplicity belies its significance. The simple fact is that within a short time a traffic officer *must* warn, cite, arrest, or release every motorist who is stopped. Making no decision is not an option, nor is deferring the decision to a later time. The officer *must* make the often difficult decision, basing it on observations of driving, the driver's general behavior, appearance, and statements, and performance of roadside tests. The goal is (or ought to be) the release of non-impaired drivers and the arrest of DUI drivers. Given that goal, common sense dictates the use of roadside tests that have been shown in scientific studies to be the "best." Common sense *also* asks, "If not these best tests, then what?" It is telling in the extreme that the challengers to HGN offer no alternatives. Their argument is not, "Use Test X, which is a better test, instead of HGN." It is simply, "Do not use HGN."

Secondly and importantly, HGN was selected and recommended as one test within a battery, and officers are trained to use it in that context. It is a sensitive and accurate index of alcohol impairment, but for a skilled traffic officer, it is only one of multiple sources of information. Yet, arguments against it proceed as though it were the only evidence available to the arresting officer. It is true that circumstances occasionally prevent the administration of psychophysical tests, but even then HGN is not the only evidence. The consumption of alcohol may also be revealed from a suspect's demeanor and speech, as well as the odor of alcohol on the suspect's breath. Other factors include the time and place at which the suspect is stopped. (What are the odds of alcohol involvement when a violation is by an elderly parishioner leaving Sunday morning services vs. a young adult in the vicinity of a bar at 0200?). It approaches absurdity to suggest that officers will be able to check suspects' eyes but unable to make any other observations.

Finally, consider validity. If a test measures what it purports to measure, it is a valid test. The claim that HGN occurs in the presence of alcohol or other depressants, inhalants, and phencyclidine and is reliably associated with impairment by those substances has been validated repeatedly by breath, blood, and urine tests. In fact, except for individuals who refuse to provide a specimen, an officer's observation of HGN is routinely subjected to validation. The question which begs to be answered then is, "Why would officers confidently rely on HGN if their observations were not validated?" It is difficult to imagine that they would continue to use a test which repeatedly leads to decision errors.

HGN is not a magic bullet, but it is an excellent tool of investigation. It will be a boon for traffic safety and good fortune for all who use the roadways if police officers are trained and encouraged to use it at roadside. I am hopeful..... no, I am confident, that this resource guide, seriously studied and considered, will serve that objective.

Introduction

Consumption of alcohol or certain other drugs hinders the ability of the brain to correctly control eye muscles. The resulting abnormal eye movements are readily observable and identifiable by properly educated and trained observers, such as law enforcement officers. These observations form the basis of some of the key assessments of impaired drivers that officers conduct at roadside during traffic stops, including the Horizontal Gaze Nystagmus (HGN) and Vertical Gaze Nystagmus (VGN) tests. An important distinction between the HGN and VGN tests and all other field sobriety tests (FSTs) is that one cannot practice, rehearse, or train one's eye movements, either when sober or intoxicated, in order not to exhibit the abnormal eye movements caused by intoxication. In addition, one does not have the ability to control eye movements to the extent of minimizing or eliminating the effects of intoxication.

The HGN test is one of three tests that comprise the Standardized Field Sobriety Test (SFST) battery; the other two tests are the Walk-And-Turn (WAT) and One-Leg-Stand (OLS) tests.[1] The VGN test was originally part of the protocol conducted by specially-trained law enforcement officers investigating drivers who might be impaired by drugs other than or in addition to alcohol, known as the Drug Evaluation and Classification (DEC) or Drug Recognition Expert (DRE) Program. Since 2002, non-DRE officers have been taught the VGN test and are encouraged to conduct it after the HGN test.[2] While VGN is similar to certain components of the HGN test, in that it is a type of nystagmus that is readily and consistently caused by the same intoxicants that cause clues on the HGN test, the VGN test is a separate assessment apart from the HGN test protocol and scoring.

Consumption of alcohol or certain other drugs hinders the ability of the brain to correctly control eye muscles. The resulting abnormal eye movements are readily observable and identifiable by properly educated and trained observers, such as law enforcement officers.

The HGN test actually comprises three separate assessments of independent eye movements: smooth pursuit, presence of nystagmus when looking as far as possible to either side, and presence of nystagmus when looking only part of the way to either side. Thus, "HGN" is not a single entity or phenomenon, and the components of the HGN test are not simply three variations of the same phenomenon; it only makes sense to speak of the components individually or of the entire three-component test when discussing or describing "HGN." By comparison, the VGN test assesses only a single type of eye movement, so it may correctly be referred to simply as "VGN."

All the tests conducted at roadside are *screening tests* that guide an officer in making the decision, whether to arrest a driver for impaired driving. By its very nature, any screening test cannot and will not be 100% accurate, but it should be valid, reliable, and relatively easy to perform in a short amount of time.[3] In the context of an impaired driving investigation, it should provide good and sufficient

information regarding whether additional action, such as an arrest, and/or further testing, such as a breath test, is warranted. An analogy in the medical field is blood pressure testing, which is routinely conducted at any visit to a doctor: while a high blood pressure reading is abnormal and consistent with a medical condition that often requires medication, namely *hypertension*, a single high reading can be caused by other factors and cannot be used by itself to establish a diagnosis of that condition. Likewise, an officer considers all the evidence and observations available, including the subject's driving behavior; responses, actions, and appearance when being questioned; as well as performance on any roadside tests. Nonetheless, scientific evidence establishes that the HGN test, even when considered in isolation, is a reliable roadside measure of a person's impairment due to alcohol or other central nervous system (CNS) depressant drugs, inhalants, or dissociative anesthetics.[4]

Despite the strong correlation between alcohol consumption and HGN test results, some trial courts across the country still do not admit the results into evidence. Although the scientific evidence to prove this correlation exists, due to lack of knowledge, inadequate preparation, or limited proffers, the evidence prosecutors have presented to courts has at times been insufficient to satisfy the courts' evidentiary standards for admitting scientific or technical evidence. As a result, law enforcement officers in many jurisdictions use the HGN test only for purposes of establishing probable cause for arrest, if at all, without securing admission of the test results into evidence at trial. Ultimately, the factfinder never hears the results of the most reliable field sobriety test.

Legal and law enforcement communities need to better understand that the HGN test is the most reliable and effective indicator of impairment by alcohol and certain other drugs, and that ample evidence is available to prove that reliability. The challenge is in conveying to the factfinder the strong correlation between the HGN test and impairment and showing how to effectively use the available evidence to prove the HGN test's validity and reliability in court.

This guide is designed to assist judges, prosecutors, and law enforcement officers in gaining a basic understanding of the HGN test, its correlation to alcohol and certain other drugs, other types of nystagmus, the HGN test's scientific validity and reliability, its admissibility in jurisdictions in the US, and the purposes for which it may be introduced. Specifically:

- A law enforcement officer will be able to understand why a prosecutor asks specific questions regarding the officer's education, training, and experience in administering the HGN test and will be better prepared to respond to defense challenges regarding the extent of the officer's knowledge of the HGN test;
- Prosecutors will be better able to establish the scientific reliability of the HGN test under either the *Frye*[5] or *Daubert*[6] standard, to successfully articulate the HGN test's value to the factfinder, and to build a strong trial record, if necessary, to appeal adverse trial court rulings; and
- Judges will have a guide to evaluate and resolve issues regarding the reliability of the HGN test and the invalidity of arguments against its admissibility.

Legal and law enforcement communities need to better understand that the HGN test is the most reliable and effective indicator of impairment by alcohol and certain other drugs, and that ample evidence is available to prove that reliability.

Introduction

Many issues addressed throughout this publication, such as the scientific reliability of the HGN test, may not apply to routine testimony in impaired driving cases once a state's appellate court accepts the HGN test. Nevertheless, all sections are helpful to the judge, prosecutor, and law enforcement officer who may be unfamiliar with the subject matter or in need of review. For example, issues that may be applicable to every case may include the qualifications and experience of the officer administering the test, how the test is administered, how the HGN test clues occur, and the purposes for which the HGN test result may be used. The test should be used in the context for which it was developed: as one of the three roadside tests that make up the standardized field sobriety test (SFST) battery, along with any other evidence considered above. The National Traffic Law Center maintains legal compilations on states' HGN case law as well as *Daubert* and *Frye* law and are available upon request.

The goal of this guide is to assist prosecutors and law enforcement officers in every jurisdiction to lay the foundation for the admissibility of the HGN test, and to encourage judges to accept the results of a properly administered HGN test as relevant evidence of impairment.

The Science

SECTION I: WHAT ARE NORMAL EYE MOVEMENTS?

Normal eye movements that persons use during everyday activities, such as driving, include *fixation*, *smooth pursuit*, *saccade*, and *convergence*.[7] Other eye movements also are possible and common, such as those initiated or assisted by the vestibular system. However, these are not assessed by law enforcement officers and are beyond the scope of this guide.

Normal eye movements that persons use during everyday activities, such as driving, include *fixation*, *smooth pursuit*, *saccade*, and *convergence*.

Fixation is the steady maintenance of eye position when there is no relative motion between the observer and the object, such as when a driver stopped at an intersection looks at a traffic signal or a moving driver watches another vehicle that is traveling in the same direction and at the same speed. Smooth pursuit involves maintaining eye position on an object when there is relative motion between the observer and the object, such as when a moving driver reads a stationary road sign or a driver stopped at an intersection watches a pedestrian crossing the street. Saccades are rapid scanning eye movements, such as when reading text like this or when a driver looks quickly from one part of the road to another or to a mirror. Convergence involves maintaining single vision on an object that changes in distance from the observer or when an observer changes fixation between objects at different distances, such as when a driver looks from the road ahead to the dashboard or radio.[8]

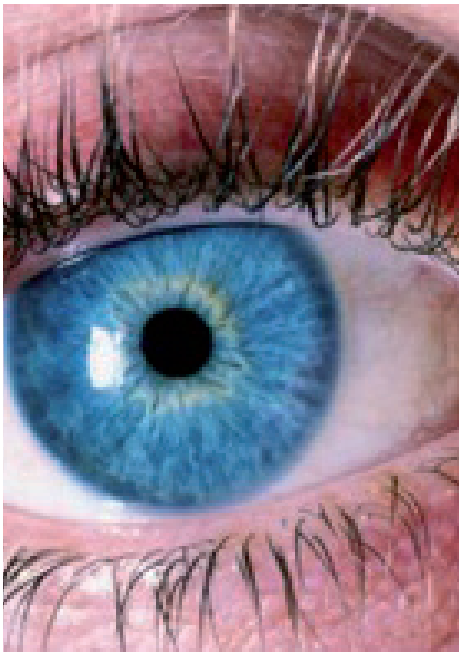
Fixation primarily is evaluated when one is undergoing a vision test at a doctor's office: the patient usually sits in a chair and reads the letters or numbers on a stationary eye chart at the other end of the room. As such, the doctor can measure the patient's threshold ability to see small objects or details, which is recorded as *visual acuity*. Note that neither fixation ability nor visual acuity are assessed by law enforcement officers at any time,[9] but these functions sometimes erroneously are raised or challenged when the HGN test and its results are presented in court.

When a person's head is stationary, the eyes can move from extreme left gaze to extreme right gaze, describing a dynamic visual field angle of about 120 degrees. For most normal individuals, smooth pursuit ability for a large object that can be easily seen, such as a finger or top of a penlight, and that moves in a predictable manner exceeds 60 degrees per second, to a maximum speed of just greater than 100 degrees per second. For example, an object moving at 100 degrees per second would pass across the entire visual field in just over 1 second. On the other hand, for a small object, such as the point of a pin, or an object that is dim, visible for only a brief amount of time, or moves in an unpredictable or erratic manner,

maximum smooth pursuit ability is only about 40 degrees per second.[10] This is equivalent to an object moving across the visual field in about 3 seconds (120 degrees divided by 40 degrees per second).

Saccades, also referred to as *saccadic* eye movements, normally can exceed speeds of 300 degrees per second, to perhaps as fast as 1,000 degrees per second, regardless of the size of the eye movement.[11] As such, if one were to move the eyes from extreme left gaze to extreme right gaze by making a saccade at the lowest speed, it would take only 0.4 second (120 degrees divided by 300 degrees per second); that is fast! However, during a saccade itself, regardless of the speed or amplitude, vision is suppressed.[12] This normal, natural phenomenon avoids forcing the brain to interpret images that otherwise would appear streaked or blurred.

SECTION II: WHAT IS "NYSTAGMUS"?



Nystagmus is the term used to describe an eye that is undergoing a repetitive, back-and-forth or "bouncing" movement. Nystagmus occurs when there is a disturbance of either the neurological control of the eye or the vestibular (inner ear) system. Nystagmus typically is an involuntary response, in that the person exhibiting the nystagmus cannot control it.[13] In fact, the person exhibiting the nystagmus often is unaware that it is occurring unless that person experiences *oscillopsia*, which is the false perception of motion of a stationary object, such as a clock on a wall that appears to be moving back and forth.[14]

There are well over forty named types of nystagmus, based either on the physiological, pathological/medical, or environmental cause, or merely the appearance of the motion.[15] Using only one's own eyes to make an observation, one can primarily identify only two types of nystagmus motion: (1) *pendular* nystagmus, in which the eye oscillates equally in both directions (like a bob on a pendulum); and (2) *jerk* or *beat* nystagmus, in which the eye drifts slowly in one direction (slow phase) and then is rapidly corrected through a fast, saccadic movement in the opposite direction (fast phase).[16] Jerk nystagmus traditionally is identified by the direction of its fast phase, for example, named such as "right-" or "rightward-beating" when the fast phase is to the right. Other types of motion are possible, but they cannot be easily distinguished from pendular or jerk nystagmus without the use of specialized instruments to record, measure, and analyze the eye movements, tools that often are not available or accessible to the law enforcement officer. In addition, many presentations of nystagmus have an amplitude of movement that only can be "seen" when recorded with specialized instruments, often less than 1 degree in amplitude; the smallest eye movement that can be seen with the eyes only is about 1.5 to 2 degrees in amplitude.[17]

Depending on the cause and nature of the nystagmus, the plane of movement can be horizontal, vertical, diagonal, or rotatory (in which the eye appears to rotate about its visual axis). Also, depending on the cause and nature of the nystagmus, and independent of the plane of movement, the most common types of nystagmus can occur

- when the person is looking straight ahead, termed nystagmus in primary gaze, or *resting nystagmus*;
- only when looking away from straight ahead, termed *gaze evoked nystagmus* (GEN);
- only when one eye is covered or closed, termed *latent nystagmus*; or
- only when trying to converge the eyes by a certain amount, termed *convergence nystagmus*.

Resting nystagmus typically remains present when the person looks away from straight ahead or converges the eyes. Although, when the person is not looking straight ahead, and depending on the exact cause, the nystagmus can increase in amplitude and/or frequency (thus appearing more "pronounced" or rapid); decrease in amplitude and/or frequency (thus appearing less pronounced or slower); or remain the same. Likewise, depending on the exact cause, jerk nystagmus can vary in direction predictably or at random, or it can always have the same direction. By definition, GEN, latent nystagmus, and convergence nystagmus are identified when resting nystagmus is not present.

GEN appears as jerk nystagmus when trying to fixate an object away from straight ahead. The motion is such that the eye drifts away from the object and corrects itself with a saccadic movement back to the object.[18] If GEN occurs naturally in someone, without intoxication, it typically is too small or too brief for that person to be aware of or for an observer, such as a law enforcement officer, to be able to detect without specialized instruments.[19]

Many normal persons exhibit another type of jerk nystagmus when moving the eyes to the extreme left or right, known as *endpoint nystagmus*.[20] Endpoint nystagmus usually is small in amplitude (thus not always easy to observe) and dissipates within 1 to 2 seconds as the eyes establish fixation (thus not sustained with continued gaze in that direction). Conversely, sustained fixation to the extreme left or right for at least 30 seconds, and usually longer, can induce yet another type of jerk nystagmus, *fatigue nystagmus*, in some individuals. This involves an actual fatiguing of the eye muscles and has nothing to do with other physical fatigue or sleep deprivation.[21] Neither of these types of nystagmus will be confused with those that are expected with intoxication.

SECTION III: INTOXICATION AND EYE MOVEMENTS

Intoxication can cause very specific and consistent changes to eye movements, making them appear abnormal, and it can induce additional abnormal eye movements. Alcohol and certain other drugs (see below) do so by disrupting the proper function of the eye movement control centers in the CNS, specifically in the cerebellum and brainstem.

Intoxication impairs one's ability to track a moving object using smooth pursuit eye movements, which is assessed as the first component of the HGN test. The impaired person makes a continuous series of small saccades in order to try to keep up with the object ("catch-up saccades") or to try to anticipate the location that the object is moving to ("anticipatory saccades"). If we think of normal smooth pursuits as represented by a windshield wiper moving easily and smoothly across a wet windshield, then using saccades in place of smooth pursuits can be represented by a windshield wiper dragging across a dry windshield, catching on the glass and not moving smoothly across it. Because saccades incorporate suppression of vision, the ability to see small objects or details is reduced for a person who has an induced problem with smooth pursuits. For some persons, or at a high level of intoxication for a person, the ability to make saccades also can be lost, such that the only way that the person then can move the eyes is to move the head or the head and body together, such as turning at the waist.

Intoxication also induces two basic types of jerk nystagmus: *alcohol gaze nystagmus* (AGN), which describes the second and third components of the HGN test as well as VGN, and *positional alcohol nystagmus* (PAN). Although alcohol causes both types, AGN and PAN are very different and easily distinguishable. Other CNS depressant drugs, inhalants, and dissociative anesthetics can cause jerk nystagmus that is similar or identical to AGN, since the mechanisms of action of the impairment of the neurological control of eye movements often are the same, but they will not typically cause nystagmus that is similar to PAN.

Intoxication can cause very specific and consistent changes to eye movements, making them appear abnormal, and it can induce additional abnormal eye movements.

The characteristics of AGN and PAN are described below.

Alcohol Gaze Nystagmus (AGN)

AGN encompasses three types of jerk nystagmus specifically caused by alcohol intoxication when the head is upright when standing or seated, or in line with the spine when lying down. AGN occurs when the eye moves away from straight ahead, either (1) horizontally as far as possible (known as Distinct and Sustained Nystagmus at Maximum Deviation), or (2) partially (known as Onset of Nystagmus Prior to 45 Degrees), or (3) vertically (known as VGN). In all cases, the fast phase is in the direction in which the eye is looking: to the right when looking right; to the left when looking left; and up when looking up. AGN rarely manifests as resting

nystagmus or when looking down. In fact, the only drug known to consistently cause resting nystagmus is the dissociative anesthetic, phencyclidine.[22]

The presence of any nystagmus that is induced, that is, it is not normally present and is directly caused by some external factor such as intoxication, can reduce one's ability to see small details or objects.[23] This occurs because the fast phase of jerk nystagmus effectively is a saccade, during which vision is suppressed, and, unlike for a person who may have had nystagmus for a long time, the brain is not capable of properly processing vision during the slow phase or possibly between phases. The effect of alcohol on eye movement has been described as follows:

> Alcohol is a central nervous system depressant affecting many of the higher as well as lower motor control systems of the body. This results in poor motor coordination, sluggish reflexes, and emotional instability. The part of the nervous system that fine-tunes and controls hand movements and body posture also controls eye movements. When intoxicated, a person's nervous system will display a breakdown in the smooth and accurate control of eye movements. This breakdown in the smooth control of eye movement may result in the inability to hold the eyes steady, resulting in several observable changes of impaired oculomotor functioning.[24]

Positional Alcohol Nystagmus (PAN)

PAN occurs when a foreign substance or poison, such as alcohol, is present within the fluid contained in the vestibular (inner ear) system. The vestibular system controls a person's balance, coordination, and orientation. The eyes depend on the vestibular system to stabilize them during head movements.[25] Disruptions in the vestibular system will have an adverse effect on the messages sent to the eyes when the head moves.[26] Testing for PAN involves tipping the head to the side when standing or seated, or turning the head to the side when lying down, neither of which are part of the test procedures of the SFST battery or any other roadside assessment.

PAN manifests as jerk nystagmus in primary gaze, that is, it appears as resting nystagmus. The direction of the fast phase depends both on head position and the relative alcohol concentrations in the blood and inner ear fluid.[27] There exist three phases of PAN, referred to as PAN I, PAN II, and Intermediate. In PAN I, the alcohol concentration is higher in the blood than in the inner ear fluid and occurs when a person's blood alcohol content (BAC) is increasing. The fast phase of the nystagmus is in the direction of the head tilt, such as tilting the head toward the right shoulder or turning the head to the right when lying down induces right-beating resting nystagmus. In PAN II, the alcohol concentration is lower in the blood than in the inner ear fluid and occurs when a person's BAC is decreasing. The fast phase of the nystagmus is now opposite the direction of the head tilt, such as tilting the head toward the right shoulder or turning the head to the right when lying down induces left-beating resting nystagmus. It can take about 8 to 10 hours for alcohol to clear from the inner ear fluid after alcohol is cleared from the blood, so PAN II could be present for that long after BAC has returned zero.[28]

Note that neither PAN I nor PAN II is expected when the head is upright or simply tipped forward (bringing the chin down to the chest) or back. Also, in the Intermediate Phase, the alcohol concentrations in the blood and inner ear fluid are approximately equal. Here, nystagmus, if present, could be in either direction or have some other appearance; another random eye movement that does not appear like nystagmus could occur; or there could be no nystagmus or other eye movement at all, the eye appearing to have steady fixation. Either of the last two possibilities could lead to the very incorrect conclusion that the person is not intoxicated!

Nausea, dizziness, vertigo and vomiting can accompany any phase of PAN, which indicates a high level of alcohol intoxication.[29] High intensity PAN is evident when a subject's eyes are open, but open eyes block lower intensity PAN.[30] As a result, PAN is most easily recorded when the subject is lying down, with the head turned to the side with the eyes closed.[31]

AGN and PAN Compared

In comparing AGN and PAN, it is evident that both are caused by alcohol, yet their origins and manifestations are very different.[32] AGN is neurological in origin, caused by impairment of the eye control centers in the cerebellum and brainstem, while PAN is vestibular in nature, independent of the simultaneous disruption in the cerebellum and brainstem.[33] Unlike AGN, PAN manifests itself only when the head is not upright, such as when the head is tilted toward either shoulder for a standing or seated subject, or when the subject is lying down, with the head turned to the side.[34] At low intensities, PAN stops when the eyes are open.[35] Furthermore, PAN presents as resting nystagmus and changes direction depending on relative alcohol concentrations in the blood and inner ear fluid and the position of the head, while AGN is not resting nystagmus and its direction of motion depends only on the direction of the gaze.[36] Because of these differences, officers correctly conducting the HGN and VGN tests will not confuse AGN and PAN. But because PAN can still be present once a person's BAC has gone to zero, defendants sometimes claim or attempt to confuse matters by arguing that the officer observed PAN and not AGN.

In comparing AGN and PAN, it is evident that both are caused by alcohol.

SECTION IV: THE HGN AND VGN TESTS

Development of the Standardized Field Sobriety Test Battery

Law enforcement officers have used field sobriety tests (FSTs) to detect impairment and to develop probable cause to arrest.[37] Most FSTs test a person's coordination, balance, and dexterity, all of which diminish as a person reaches higher and higher BACs. Many FSTs also test a person's ability to perform simple tasks simultaneously because impairment limits the ability to divide attention among several activities at once. All FSTs assess to some degree the extent of a person's impairment. In 1977, law enforcement officers throughout the country were using different tests in a variety of ways with no scientific evidence of their effectiveness in detecting impairment. One of these tests was the HGN test.

Estimates of impaired driving rates and alcohol-related traffic injuries and fatalities prompted the National Highway Traffic Safety Administration (NHTSA) in 1977 to commission the Southern California Research Institute (SCRI) to determine the best methods of detecting impaired drivers using field sobriety tests. An underlying premise was that better detection methods would lead to more impaired driving arrests, higher conviction rates and ultimately lower incidents of impaired driving.

The 1977 SCRI study validated earlier observations regarding the relationship between the HGN test and alcohol consumption and found that the HGN test, along with the WAT and OLS tests, were easy FSTs to administer at roadside and the most accurate in detecting impairment.[38] Once the researchers identified the most accurate tests, they turned their attention to standardizing the administration of the tests in 1981.[39] Through standardization, the SCRI researchers ensured that law enforcement officers everywhere could administer the tests quickly, easily, effectively, and uniformly.[40] At that time, the researchers also found that when all three test results (HGN, WAT and OLS) were combined, it was possible to accurately determine whether an individual's BAC was 0.10% or higher 83% of the time.[41]

Defendants often challenge the validity and the reliability of the HGN test. *Validity* is whether the test measures what it claims to measure. The validity of the HGN test can be established through the multitude of scientific articles, including the 1977 NHTSA study, that establish a correlation between HGN and the presence of alcohol. *Reliability* is whether the test repeatedly and consistently measures what it claims to measure. The 1981 NHTSA study tested the reliability of HGN and found that HGN occurs repeatedly and in multiple subjects as examined by multiple officers when alcohol is present.[42]

After standardization, NHTSA funded a third study in 1983 to further corroborate these findings. Using data from the 1981 SCRI laboratory study, the NHTSA researchers determined that the HGN test was 77% accurate in detecting whether an individual's BAC was 0.10% or higher.[43] The WAT test was found to be accurate 68% of the time.[44] The NHTSA researchers found, however, that when the results of the HGN and WAT test data were combined, the two tests were 80% accurate in detecting whether an individual's BAC was 0.10% or higher.[45] (See Appendix A for a copy of the matrix law enforcement officers use to combine HGN and WAT test scores.) Finally, the researchers predicted that the OLS Test alone accurately indicated impairment 65% of the time.[46] NHTSA researchers then conducted a field study and confirmed the tests' ability to "effectively discriminate between drivers with BACs less than 0.10% and drivers with BACs equal to or over 0.10%."[47] The field study also concluded that the HGN test was the most "powerful" of the three tests.[48]

While these initial studies showed the accuracy of the HGN test, more recent studies demonstrate that the HGN test is even more accurate when administered by law enforcement officers trained and experienced in the administration of the HGN test. A 1986 study found the HGN test 92% accurate in detecting

impairment.[49] A 1987 study found that experienced law enforcement officers were correct 96% of the time in determining a 0.10% BAC or more using the HGN test.[50]

The result of these studies was the SFST battery now used by law enforcement officers almost everywhere.[51] The purpose of the SFST battery, and especially the HGN test, is to increase the ability of law enforcement to: (1) identify drivers with BACs in the 0.08 to 0.12% range that make up the bulk of the impaired drivers who do not necessarily exhibit exaggerated characteristics of impairment;[52] and (2) detect impairment in alcohol-tolerant drivers who may not display any gross coordination and balance problems.[53]

Administering the HGN Test[54]

The HGN test is very easy to administer.[55] The officer must administer the test in a way that ensures that the subject's eyes can be seen clearly, that is, in a well-lit area or by use of a flashlight to illuminate part of the subject's face. The subject should not face toward the flashing lights of a police cruiser or passing cars, which can disrupt vision, attention or cause optokinetic nystagmus.[56] The subject does not have to be standing but can be sitting[57] or lying down,[58] as long as the head is in line with the spine and not tipped or tilted.

The HGN test is very easy to administer.

The law enforcement officer informs the subject, "I am now going to check your eyes." The officer is not "testing" the subject's vision, as an ophthalmologist or optometrist would, but instead, the officer is "checking" the eyes for the physical manifestation of HGN test indicators or clues.

Before checking the subject's eyes, the officer asks the subject to remove eyeglasses or inquires whether the subject is wearing contact lenses. While removal of the eyeglasses makes it easier for the officer to observe the subject's eyes and eye movements, wearing or not wearing glasses does not affect the HGN test results. Early concerns that contact lenses, especially hard or rigid contact lenses, may affect the HGN test result led some to provide for the subject to remove the lenses. Contact lenses can potentially slightly dampen the appearance of nystagmus,[59] but they will not eliminate nystagmus entirely nor affect the test in any other way. While, in theory, a contact lens can displace or even fall out of the eye when the eye moves as far to the side as it will go, that should not happen with a properly fitted contact lens of any type; officers now are not taught to automatically have subjects remove contact lenses.[60] However, if the subject is wearing tinted or colored contact lenses that obscure the view of the subject's natural pupils, the officer can choose to ask the subject to remove the contact lenses. Officers are taught to note whether the subject is wearing contact lenses and which type on the HGN Guide (shown on page 13).

The officer also asks the subject whether he or she has any medical condition or impairment that would either prohibit the subject from taking the test or that would affect the test results. The officer should note on the HGN Guide any condition that prohibits the taking of the test and then, if possible, move on to the remaining SFSTs. If the subject claims to have a natural nystagmus or any other condition that may affect the test result but does not prohibit the taking of the HGN test, the officer should note the condition but still perform the test. If the subject indicates that he or she has poor vision or is blind in one eye, the officer continues with the test as long as there are no other conditions that could interfere with the test or confound the test results.

The subject does not have to see the object clearly to perform the HGN test. The subject just has to see the object well enough to be able to follow it with his eyes. Blurry vision is not a medical condition that prohibits the subject from taking the test or performing satisfactorily.

The HGN test requires only a relatively large object for the subject to follow with his or her eyes, such as a pen, fingertip or top of a penlight.[61] The officer places the object approximately 12 to 15 inches from the subject's face and slightly higher than eye level.[62] The testing distance represents a comfortable viewing distance for the subject, as well as a good physical distance for officer safety and subject control, in that the officer maintains about an arm's-length separation from the subject. Testing distances outside this range are valid from a scientific perspective but can compromise officer safety: closer than 12 inches can bring the officer too close to the subject, and it can be uncomfortable for the subject to maintain convergence on an object that close; at farther than 15 inches, the officer would be more than arm's-length from the subject throughout much of the testing. Placing the object slightly above eye level helps open the subject's eyes and makes their movement easier to observe. For all this testing, the officer moves the object in a straight line across an imagined flat plane between the officer and the subject. (See Appendix B, Picture 1.)

The officer instructs the subject to follow the object with the eyes only—the head should remain still. The officer asks if the subject understands the instructions. If a subject has difficulty keeping the head still during testing, the officer is taught to have the subject hold the head still by pressing the palms of the hands to the cheeks or to hold the chin. The officer should avoid holding the subject's chin or using a flashlight or other tool as a chinrest because it brings the officer into contact with the subject and compromises officer safety.

After positioning the object, but before conducting the test, the officer performs two pre-test checks for signs of medical impairment. First, the officer checks for "equal tracking" by moving the object across the subject's entire horizontal field of vision in a time of about 4 seconds in each direction. The officer observes whether both of the subject's eyes together can follow the object and that each eye has full range of motion, that is, is able to move all the way to either side. The officer then checks for "equal pupil size," noting that it is typical for as many

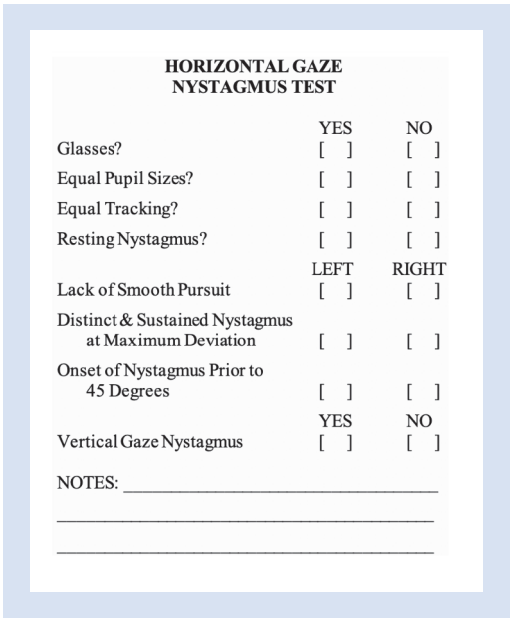
as 38% of normal healthy persons to have a small difference, up to 0.6 mm, in pupil sizes at any given time.[63] Lack of equal tracking, for any reason, or a large difference in pupil sizes, for example, greater than 1.0 mm, may indicate presence of a prosthetic (glass) eye, medical condition, or injury. If the subject exhibits any of these characteristics, the officer can ask the subject again about medical or eye conditions and may choose to discontinue the HGN test and seek medical assistance, as appropriate and necessary.

In conducting the HGN test, the officer looks for six "clues," three in each eye, that indicate impairment. The officer should record the clues on the HGN Guide or similar report or data sheet. The left eye is checked first for each clue. Each eye is checked twice for each clue, first to note the presence or absence of the clue, then to confirm the observation. If needed, the officer may individually check any clue for either eye additional times, the officer does not need to conduct the entire test again.

Clues typically will occur equally in the two eyes and in the order of testing as intoxication level increases. While it is not impossible for a particular clue to be present only in one eye or to occur in one eye before the other (often as intoxication level is increasing), or for an earlier clue to be absent when later clues are present, most circumstances in which this occurs involve the officer missing the observation of the supposedly absent clue. Again, the officer may re-check any individual clue to confirm its absence or presence, as needed.

The clues are, in order:

- **Lack of smooth pursuit.** The officer moves the object steadily from the center of the subject's face toward the left ear, in a time of about 2 seconds within a tolerance of plus or minus 0.5 second. The officer then moves the object all the way across the subject's field of vision toward the right ear, in a time of about 4 seconds within a tolerance of plus or minus 1 second. The officer continues by moving the object at the same speed back toward the left ear, once more back toward the right ear, and finally back to the center. The speed of movement is about 30 degrees per second: about 60 degrees between the center and either side in about 2 seconds; and about 120 degrees between extreme left and right in about 4 seconds. The officer observes each eye when the object is in front of it. If there was no smooth pursuit movement of the eye being observed, the officer records that as a positive clue for that eye. (See Appendix B, Picture 2.)
- **Distinct and sustained nystagmus at maximum deviation.** Starting again from the center of the subject's face, the officer moves the object toward the left ear, bringing the eye as far over as possible, and holds the object there for at least 4 seconds. The speed of movement is irrelevant, as long as the subject can follow the object. The officer notes the clue if there is distinct and sustained nystagmus at this point. The officer holds the object at maximum deviation for at least 4 seconds to ensure that movement of the object did not possibly cause endpoint nystagmus. The officer then checks the right eye in the same manner and rechecks both eyes. (See Appendix B, Picture 3.)



HORIZONTAL GAZE NYSTAGMUS TEST

	YES	NO
Glasses?	[ ]	[ ]
Equal Pupil Sizes?	[ ]	[ ]
Equal Tracking?	[ ]	[ ]
Resting Nystagmus?	[ ]	[ ]
	LEFT	RIGHT
Lack of Smooth Pursuit	[ ]	[ ]
Distinct & Sustained Nystagmus at Maximum Deviation	[ ]	[ ]
Onset of Nystagmus Prior to 45 Degrees	[ ]	[ ]
	YES	NO
Vertical Gaze Nystagmus	[ ]	[ ]

NOTES: _____

_____

_____

- **Onset of nystagmus prior to 45 degrees.** The officer moves the object at a speed that would take about 4 seconds to reach the edge of the subject's left shoulder, or about 10 degrees per second. The officer notes this clue if the point or angle at which the eye begins to display nystagmus is before the object reaches 45 degrees from the center of the subject's face. The officer then moves the object at a similar speed toward the subject's right shoulder and rechecks both eyes. For safety reasons, officers usually use no apparatus to estimate the 45-degree angle. Forty-five degrees from center is at the same distance to the side of straight ahead as the object is from the subject's face, for example, 12 inches to the side (*i.e.*, slightly beyond the edge of the shoulder for most adults) when the object is 12 inches from the subject's face. (See Appendix B, Picture 4.)

Administering the VGN Test

After the HGN test, the officer checks for VGN by starting from the center of the subject's face, again at a distance of 12 to 15 inches. The subject is instructed to keep the head still or to tip the head forward slightly, bringing the chin to the chest, and to follow the object with the eyes only. The officer raises the object straight up several inches above the subject's eyes and holds the object there for at least 4 seconds. VGN is positive if the subject exhibits a vertical jerk nystagmus; if nystagmus is horizontal or rotatory, while abnormal, or if there is no nystagmus, then the VGN test is negative.

When caused by intoxication, the presence of VGN is a good indicator of a high dose of alcohol, other CNS depressant drugs, inhalants, or dissociative anesthetics for that subject. While it is possible for persons to have VGN naturally, in the absence of any other indicators or problems, there is no evidence that any intoxicant is capable of causing VGN without simultaneously causing clues on the HGN test. In fact, research indicates that the presence of VGN caused by intoxication is always accompanied by the presence of at least 4 of the 6 possible clues on the HGN test.[64]

After the HGN and VGN tests are complete, the officer will conduct the WAT and OLS tests. At the conclusion of these tests, the officer will make the decision to arrest, release, or take other action, such as seeking medical assistance for the subject. The officer may use a preliminary breath test to estimate the individual's blood alcohol level. Ultimately, if the officer follows all these clear procedures, the HGN and VGN tests will be instrumental in giving the officer the information needed to make an accurate decision.

Defense attorneys who specialize in impaired driving cases know the SFST training manual as well as if not better than some law enforcement officers and many prosecutors, so any deviation from the manual, however slight, will be highlighted on cross examination, damaging the officer's, the prosecutor's, and the HGN test's credibility.

SECTION V: OTHER TYPES OF NYSTAGMUS AND ABNORMAL EYE MOVEMENTS

There exist several non-alcohol related types of nystagmus caused by neural, vestibular, or muscle activity. These other types are due to a variety of causes, such as certain chronic or acquired medical conditions and environmental conditions. Many times, defendants will suggest that the nystagmus the law enforcement officer saw was actually caused by something other than alcohol or other drugs. A properly trained law enforcement officer, however, will not mistake other types of nystagmus, natural or otherwise, with HGN test clues when considering all the facts that contribute to the arrest decision.

Nystagmus Caused by Non-Alcohol Related Disturbance of the Vestibular System

Rotational nystagmus is caused by a disturbance in the inner ear fluid when a person spins around. The nystagmus lasts only as long as the person is being spun, and actually goes away if spinning is maintained for longer than about 15 seconds. If an observer could see a person's eyes while that person is spinning, a distinct jerking of the eye would be evident as resting nystagmus. *Post-rotational nystagmus* occurs after the person stops spinning. The nystagmus lasts only for about 15 seconds and can easily be seen as resting nystagmus; if the person intentionally looks at an object, post-rotational nystagmus can dissipate even faster.[65]

Caloric nystagmus is caused by the movement of the inner ear fluid due to a difference in temperature of the fluid between the left and right ear. One way this can occur is if warm water is poured in one ear and cold water is poured in the other.[66] Obviously this is an implausible scenario at roadside.

Nystagmus Caused by Non-Impairing Drugs

Several common non-impairing drugs can cause certain types of nystagmus. But none of these would be mistaken for or confused with those caused by intoxication. For example, nicotine can cause resting nystagmus, but only in total darkness, disappearing as soon as any light is present.[67] Aspirin, when taken long term at high doses, can be toxic to the vestibular system, thus possibly causing nystagmus consistent with a vestibular problem.[68] Finally, caffeine can induce nystagmus in someone with an existing vestibular problem; the nystagmus will have an appearance, and occur under test conditions, consistent with the vestibular problem.[69]

Nystagmus Caused by Neural Activity

Some types of nystagmus are caused by neural or muscle activity. *Optokinetic nystagmus* occurs when the eyes fixate a continuous or large object that moves or passes quickly through the field of vision, such as when a subject watches utility poles pass by while in a moving car or a moving train while waiting at a railroad crossing. Optokinetic nystagmus also occurs when the eyes watch an

object displaying contrasting moving images, such as black and white stripes on a spinning drum.[70] In either case, because the nystagmus is caused by the eye trying to catch up with the moving object, it lasts only as long as it takes for the object to stop moving, for the object to pass out of the field of vision, or for the eye to catch up to the object. Optokinetic nystagmus requires that the subject fixate the moving object; if fixation is on another object that is either stationary or moving differently, there will be no nystagmus.

Epileptic nystagmus is a jerk nystagmus caused by abnormal neural activity that occurs primarily during epileptic or other types of seizures.[71]

Nystagmus Due to Other Pathological Disorders

Nystagmus can occur in people with brain damage, brain tumors, or vestibular diseases. These disorders and others like them occur in a small number of the general population and even less often in drivers. Many of these alternative causes are so severe that it is unlikely that a person afflicted with such a disorder would be driving, would not know he or she has the disorder, or would be unaware of the effect the disorder has on his or her body. In addition, these types of nystagmus typically will not appear like those expected with intoxication (*e.g.*, pendular rather than jerk) or under test conditions inconsistent with the HGN test (*e.g.*, lying down with the head turned to the side).

One claim of impaired drivers exhibiting HGN is that fatigue and not alcohol is the cause of their impairment. NHTSA and independent studies show that fatigue has no significant effect on the manifestation of HGN.[72]

Natural Nystagmus

The defense may argue that the nystagmus the law enforcement officer detected was a naturally occurring nystagmus rather than the result of intoxication or any of the conditions listed above. As outlined below, the differences between any type of naturally occurring nystagmus and those caused by intoxication are many and a properly trained officer will have no trouble distinguishing between them at roadside.

Research indicates that a very small number of people, about 24 per 10,000 or 0.24% of the population, have natural nystagmus.[73] It can be caused by a known pathological condition, such as albinism, or it can simply be "congenital."[74] Congenital nystagmus merely indicates that the person has had the condition since birth or early childhood; often, the actual physiological cause is not known. Those who have natural nystagmus generally know they have it and will most likely tell the officer before the test is administered. Visible natural nystagmus can present as resting nystagmus or nystagmus that is different in appearance than expected with intoxication, such as rotatory, pendular, or left-beating jerk nystagmus when looking to the right or up.[75]

Microsaccades, a.k.a. Physiological Nystagmus

Microsaccades, sometimes inappropriately referred to as *physiological nystagmus*, exist in every person's eye in order to keep the retinal image from fading when fixating on one point.[76] The eye movements occur so that light entering the eye will continually fall on non-fatigued cells of the retina. The actual movement of the eye can be any one or combination of very small horizontal, vertical, and rotational motions. Microsaccades cannot be seen with the naked eye and are controlled by a part of the CNS other than that affected by alcohol impairment. Microsaccades cannot be confused for any indicator on the HGN or VGN tests.

Summary

The HGN and VGN tests are designed to check the eyes under specific test conditions and for specific types of abnormal eye movements that are known to occur with intoxication. Their results are not invalidated by the existence of other types or causes of nystagmus. As shown above, various types of nystagmus not associated with intoxication manifest themselves in different ways. Law enforcement officers will not confuse HGN and VGN test clues with any other type of nystagmus if the testing is conducted correctly. Research shows that the HGN test is a valid and reliable indicator of intoxication and is the most effective roadside test of impaired drivers.

Although HGN is the most effective and reliable field sobriety test, do not allow the trial to turn into a referendum on HGN. The HGN test is only one of many pieces of evidence that the prosecution has available to prove that the defendant was impaired.

The Law

SECTION VI: HGN IN THE COURTROOM

HGN finds its way into the courtroom as one of the SFSTs. Besides chemical blood and breath tests, the HGN test is the best evidence that the defendant ingested alcohol.[77] The HGN test provides the best evidence, however, only if the factfinder (either the judge or jury) understands that the test result correlates with a degree of impairment.

There are several issues that may affect the admissibility of HGN test results:

1. Whether the HGN test is characterized as scientific or as simply an observation of a physical trait;
2. If HGN is deemed scientific, whether it is reliable;
3. Whether the law enforcement officer is properly trained to administer the HGN test;
4. Whether the officer properly administered the test in the particular case; and
5. The purpose for which the HGN test result will be used.

Besides chemical blood and breath tests, the HGN test is the best evidence that the defendant ingested alcohol.

Observation of a Physical Characteristic or Scientific Test

Jurisdictions treat the HGN test in one of two ways: (1) as an observation of a physical characteristic like other SFSTs or (2) as scientific evidence. Where there is no precedent, the prosecutor may advocate that the results of the HGN test are not scientific evidence, "extracted from empirical testing conclusions,"[78] but rather observations by the law enforcement officer of a physical characteristic of a subject.

Determination of HGN as Observation of a Physical Characteristic

When at all possible, the prosecution should convey to the trial court that the HGN test is a method for the law enforcement officer to observe a physical characteristic of the subject, *i.e.*, an involuntary jerking of the eyeballs. This position is preferable for the prosecution because it focuses on the law enforcement officer's ability to observe a suspect's physical characteristics, and to interpret those characteristics based on the officer's training and experience. Some state courts have taken this position and held that the HGN test is similar to the other two SFSTs in that HGN is a physical manifestation of alcohol impairment, like a staggering gait, that can be readily observed by a law enforcement officer.[79] These state courts found that the HGN test is "objective in nature and does not require expert interpretation," just like the WAT and OLS tests.[80] These courts also distinguish the HGN test from scientific tests, like polygraph tests, in that the HGN test does not require a measuring or recording instrument.[81]

To qualify HGN evidence as a physical observation, the prosecution should show that the HGN test operates on the same physiological principles as the other SFSTs, *i.e.*, alcohol impairs muscle control. The only foundation required is a showing of the officer's training and experience in administering the test, and a showing that the test was in fact properly administered.[82] The law enforcement officer must establish his or her proficiency in conducting the test in order to make the correct observations. To do this, the law enforcement officer testifies about his or her training and experience with the HGN test (*e.g.*, When and where trained? How many classroom hours? Did the officer perform the test on sober and impaired subjects in the classroom and how many times? How many times has the officer given the HGN test in the field?). The officer must also testify that the HGN test was properly administered in accordance with his or her training. In other words, the prosecutor lays the same foundation as if the law enforcement officer was testifying about the WAT or OLS. With that foundation, the HGN test results are admissible as evidence of impairment. The prosecutor may also argue that it is common knowledge that alcohol affects muscle control based on the physical observations of the suspect.

While no expert testimony is needed to get the HGN test admitted into evidence at trial, as a practical matter, some demonstration to the fact finder of the HGN test's reliability as an indicator of impairment may be needed. When the HGN test is admitted as a physical observation, the law enforcement officer can establish this reliability. The officer would explain that, based on the officer's training and experience in the interpretation and administration of the HGN test to impaired subjects, the officer can accurately identify that a subject is impaired when he or she performs unsatisfactorily on the HGN test.[83] For example, the officer may testify that he or she has observed people impaired by alcohol on many occasions and in various settings, and has noted a strong correlation between alcohol consumption and HGN.[84] To be persuasive to the fact finder, at trial the officer should take the opportunity to communicate evidence of the HGN test's reliability. The significance of the HGN test as the most reliable of SFST of alcohol impairment will otherwise be lost.

While no expert testimony is needed to get the HGN test admitted into evidence at trial, as a practical matter, some demonstration to the fact finder of the HGN test's reliability as an indicator of impairment may be needed.

Determination of HGN as a Scientific Test

Many state courts hold that the HGN test is a scientific test, resting upon the scientific principle that there is a relationship between alcohol consumption and HGN rather than it being simply an observation or common knowledge.[85] In jurisdictions with no appellate decisions on HGN test evidence, trial courts must make the determination of whether the HGN test meets certain evidentiary standards and the trier of fact must accept the test. Initially, the trial court has the role of "gatekeeper."[86]

> In performing its role as "gatekeeper," the trial court ensures that the trier of fact does not attach an undue aura of reliability to "scientific" evidence that is

> not scientifically valid. Evidence that purports to be based on science beyond the common knowledge of the average person that does not meet the judicial standard for scientific validity can mislead, confuse, and mystify the jury.[87]

Procedurally, the trial court may perform this "gatekeeper" role by holding an evidentiary hearing.[88] At that hearing, it is within the discretion of the trial court to determine what scientific evidence the jury will hear.

The two most common evidentiary standards for scientific evidence are (1) the *Frye* standard and (2) the Federal Rules of Evidence (FRE) or *Daubert* standard. Which standard a court applies depends on the law of the individual jurisdiction. The primary purpose of each of these standards is to ensure that the evidence is reliable and not junk science. The principal difference between them is how each measures that reliability.

Frye Standard

In 1923, the Court of Appeals for the District of Columbia held in *Frye v. United States*[89] that for new or novel scientific evidence to be admissible, it must "have gained general acceptance in the particular field in which it belongs." This standard came to be known as the *Frye* standard.[90] Technically, there are two prongs to the *Frye* standard:

1. identifying the "particular field" or relevant scientific community; and
2. demonstrating that novel scientific evidence (such as the HGN test) is generally accepted in that community.

Combined, both prongs provided a measure of the reliability of the scientific evidence.[91]

In the seminal case of *State v. Superior Court (Blake)*, the Arizona Supreme Court examined which fields of science constituted the relevant scientific community required by *Frye* before determining that the HGN test was generally accepted in that community. The court first found that "the work of highway safety professionals and behavioral psychologists who study effects of alcohol on behavior is directly affected by the claims and application of the HGN test, so that both these groups must be included in the relevant scientific community."[92] The court also found that the relevant scientific community should include the fields of neurology and criminalistics, but to a lesser extent because neither of those fields focus specifically on HGN and alcohol.[93] Other courts have agreed with the conclusions of *State v. Superior Court (Blake)*.[94]

One or more witnesses must be called regarding general acceptance in the relevant community. Before any witness can testify about general acceptance, however, the court must qualify the witness as an expert. There is no bright line test under *Frye* governing when a court must qualify a witness as an expert. The expert must impart to the jury knowledge within the scope of the expert's special skill and experience that is otherwise unavailable to the jury from other sources.[95]

Courts measure the quality of the witness's special skill and experience in terms of years of study and work experience, degrees and other accolades received, research performed, and publications written, among other things. How to use witnesses to prove general acceptance of the HGN test in these communities is addressed below.

It is important to point out that although evidence may rest on scientific principles, *Frye* only applies to scientific evidence that is "new or novel." At least one state court that applied a relevancy standard for determining the admissibility of scientific evidence found that the HGN test was not novel for the purpose of showing some indication of alcohol.[96] The court admitted the HGN test in conjunction with the results of the other SFSTs. This is a minority position, however.

In recent years, courts and commentators have criticized the *Frye* standard as being too likely to exclude relevant evidence, too difficult to apply, too vague and undefinable.[97] Some courts have rejected *Frye* altogether to allow in more relevant evidence.[98] In those states that still adhere to it, however, the *Frye* standard remains essentially unchanged.

Federal Rules of Evidence or *Daubert* Standard

In 1993, the United States Supreme Court held in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*[99] that the Federal Rules of Evidence (FRE), specifically Rule 702, replaced the common law *Frye* standard as the evidentiary basis for admitting scientific evidence[100] in federal courts.[101] The Supreme Court found that Rule 702 does not incorporate the general acceptance requirement of the *Frye* standard, as a prerequisite for the admission of expert scientific testimony.[102] The result is a more liberal standard, which allows the factfinder to hear scientific evidence conditioned upon testimony indicating that the evidence to be admitted is both relevant to the issues involved at trial and reliable.

As with the *Frye* standard, a trial court using the FRE standard must qualify a witness to testify about the evidence at issue. Similar to the *Frye* standard, under the FRE standard a witness may testify about scientific or technical evidence based on "knowledge, skill, experience, training, or education" if this "will assist the trier of fact to understand the evidence or to determine a fact in issue...."[103] If the witness satisfies these requirements, the prosecution can refer to the witness as an expert on the evidence. Unlike the *Frye* standard, however, the court does not make a specific determination of the relevant scientific community under the FRE standard. Instead, the court incorporates that determination into its decision of whether the testimony to be offered is scientific knowledge that will assist the trier of fact in understanding the evidence or issue.

FRE and *Frye* jurisdictions look at the same measures of expertise to qualify experts, *i.e.*, years of study and work experience, degrees and other accolades received, research performed, and publications written. Keep in mind that even though a court may qualify a witness as an expert, the defense is still free to attack the witness's qualifications and damage the witness's credibility as an "expert."

As part of its assessment of whether the evidence should be admitted, the trial court must assess whether the reasoning or methodology underlying the testimony is scientifically valid and whether the reasoning or methodology can be applied to the facts in issue. The *Daubert* Court did not endorse any one method of determining the reliability of scientific evidence under the FRE.[104] The Court did suggest, however, several factors which may be relevant in this determination. The first is whether the theory or technique applied "can be (and has been) tested."[105] The second is whether the theory or technique has been published and subjected to peer review.[106] The third is whether there is a "known or potential rate of error" and whether there are standards to control the operation of the technique.[107] Finally, the Court stated that *Frye's* "general acceptance in the scientific community" standard is still a consideration, but relegated it to one factor among many to consider in determining the reliability of a scientific theory or technique.[108]

Keep in mind that a court's "new or novel" determination is a threshold question only in states using the *Frye* standard;[109] it is not a requirement in the FRE standard.[110] In *Daubert*, the Supreme Court explained that:

> Although the *Frye* decision itself focused exclusively on "novel" scientific techniques, we do not read the requirements of Rule 702 to apply specially or exclusively to unconventional evidence. Of course, well-established propositions are less likely to be challenged than those that are novel, and they are more handily defended. Indeed, theories that are so firmly established as to have attained the status of scientific law, such as the laws of thermodynamics, properly are subject to judicial notice under Fed. Rule Evid. 201.[111]

Considering this language, courts may find scientific evidence that is not "new or novel" already comes with a large degree of reliability, so that no further inquiry is needed. Some FRE states, however, have taken the *Frye* standard's "new or novel" requirement to determine whether to apply *Daubert*.[112]

The Supreme Court in *Daubert* clearly indicated that the FRE standard applies only to federal trials involving scientific evidence and did not preempt the states from following the standard they choose.[113] In *Kumho Tire Co. v. Carmichael*, the Court extended *Daubert's* "gatekeeping" obligation to all expert testimony.[114] Most states that did not adopt the FRE standard continue to follow the *Frye* standard.[115] Many of the states that adopted the FRE standard follow the *Daubert* rationale.[116] Other FRE states disagree with the *Daubert* rationale and continue to follow the *Frye* standard.[117] Still other states, regardless of whether they adopted the FRE standard or not, have established their own scientific standards.[118]

Meeting the Scientific Standard of the Jurisdiction

To date, the courts have determined that HGN evidence does meet *Frye* and is, therefore, admissible at trial; with one exception.[119] Some courts have held that the prosecution failed to present sufficient evidence for the trial court to make findings as to the scientific reliability of the HGN test.[120] In these cases, the prosecution generally relied solely on the testimony of the arresting officer to establish the reliability of the HGN test.

To demonstrate that the HGN test meets the scientific standard of the jurisdiction, a prosecutor can ask that the trial court take judicial notice of the validity and reliability of the HGN test as found in case law from other jurisdictions.[121] This allows the prosecution and the defendant to avoid the cost of expert testimony. If required, the prosecutor will present evidence at an evidentiary hearing. There are two types of evidence the prosecution should use: expert testimony and scientific studies. The prosecution should use both types of evidence to show that the HGN test is valid, reliable, and meets the appropriate scientific standard. Moreover, more than half of the states have admitted HGN test results either to establish probable cause in a criminal case or as substantive evidence of intoxication. The prosecution should also make these cases available to the trial court.

Although a minority of courts have been willing to take judicial notice of the HGN test's reliability, the better and safer practice may be to move for an evidentiary hearing. Do not wait for the defense to file a motion challenging the admissibility of the test results.

HGN at the Evidentiary Hearing

Scientific Studies and Case Law

Initially, a prosecutor should comply with the requirements of the local jurisdiction such as filing a motion requesting an evidentiary hearing and asking the court to set a briefing schedule. In addition, the prosecution should file a memorandum of points and authorities prior to the hearing with sufficient opportunity for the court to become familiar with the scientific literature on HGN and its use as a field sobriety test.

Appellate courts will not consider new issues or evidence on appeal that the prosecution did not present to the trial court. Make sure that all evidence is admitted and preserved for the record.

Provide the original studies conducted for NHTSA by the SCRI and subsequent validation studies to the court. In addition, append articles from the scientific literature. It is helpful to include scientific literature from disciplines other than law enforcement, particularly when arguing for admissibility under *Frye* to establish general acceptance. (See Appendix C for a bibliography of studies and articles on HGN and related topics.)

The most important studies regarding the validity and reliability of HGN are the three original NHTSA studies establishing the SFST battery. At a minimum, these studies should be provided to the court. Subsequent validation studies, such as the Colorado validation study conducted in 1995 by SCRI, should also be included. Also, scientific articles on HGN and other types of nystagmus are helpful in explaining and defining scientific terms. Contact the National Traffic Law Center for copies of many of the studies and articles listed in Appendix C.

Although courts have found law enforcement to be part of the relevant scientific community under existing case law, the court is more likely to accept HGN if the prosecution can show a wider acceptance.

Frye requires the proponent of the evidence to prove general acceptance in the relevant scientific community. In *Daubert*, the Court stated in dicta that evidence that satisfied *Frye* would also satisfy the requirements of FRE 702.[122] Cases that hold that the HGN test is scientifically reliable under *Frye* are, therefore, relevant to an inquiry under the FRE or other state standard. Cases decided under a different standard, however, may be irrelevant to prove reliability under *Frye*.

Defendants often file motions to suppress the HGN test results with cites to secondary authorities criticizing the HGN test. Usually these cites are to defense-oriented journals or manuals written by attorneys, not to scientific articles. The prosecution should cite primary authority, such as the NHTSA studies or medical journals. Do not cite to articles written by attorneys, either defense or prosecution.

Expert Witnesses

The purpose for calling expert witnesses is to establish that:

1. there is a correlation between alcohol impairment and HGN;
2. the HGN test is a valid test for alcohol impairment;
3. the test is reliable;
4. a police officer can be trained to accurately administer and interpret the test results; and
5. officers are unlikely to mistake alcohol-induced nystagmus for other forms of nystagmus.

Regardless of the scientific standard at issue, if an expert is required, the officer who administered the test will rarely be qualified to testify about the relation of alcohol to nystagmus (except for his or her observations), comment on the NHTSA studies or the scientific literature, or establish general acceptance or the relevant scientific community.[123] At the evidentiary hearing, the court will confine the officer's testimony to training and experience in administering the test, administration of the test to the defendant, and the defendant's test results. The court should allow the officer to testify that he or she has administered the test to impaired and unimpaired persons and identify the differences in the test results. In the context of this discussion, since the court has not yet deemed HGN admissible, the decision to arrest the defendant is largely irrelevant at this point. (See Appendix E for predicate questions for the arresting/SFST officer.)

The scientific standard at issue will largely determine the type(s) of expert(s) the prosecution will call. There is no magic number of experts nor is there a particular type or combination of experts the prosecution must use. The following examples are based on cases in which the HGN test was subjected to an evidentiary hearing.

A witness that can establish the scientific validity of the HGN test, its selection as one of the SFSTs, and its reliability is needed. It is helpful for the witness to testify as to the ability of police officers to effectively use and interpret HGN test results. The testimony of a professional within the scientific research field is also important in establishing the relevant scientific community. (See Appendix F for predicate questions at an evidentiary hearing and at trial.)

Although not essential, often the prosecution's case is advanced by testimony of a medical expert. This is particularly important in a *Frye* jurisdiction to establish general acceptance. The prosecution can call an expert from any number of professions to testify regarding the reliability of HGN as a test for alcohol impairment. For example, an optometrist, ophthalmologist, neurologist, emergency room or urgent care physician may all be qualified to discuss the effect of alcohol on eye movements. The expert should be able to distinguish alcohol-induced nystagmus from other types of nystagmus, including natural nystagmus. The expert should also have an opinion about whether an officer can be trained to administer and interpret HGN results. Other experts the prosecution may call are toxicologists or pharmacologists. These individuals often have expertise in the effects of alcohol on the human body.

The American Optometric Association has passed a resolution endorsing the HGN test as an effective test for alcohol impairment. If using an optometrist as a witness, have a copy of the resolution available. It will enhance the credibility of your witness. The resolution will also tend to diminish the credibility of a defense optometrist who opposes HGN. (See Appendix D for a copy of the American Optometric Association's resolution.)

It may be important to have a witness from the law enforcement community. This expert should have special expertise in the use of the HGN test. Typically, this witness would be an instructor in the SFSTs or a Drug Recognition Expert who has received specialized training in detecting impaired drivers. The officer should be able to testify about the training officers receive in administering the test and about the reliability of the test. Many officers maintain an HGN log where they record the results of the test and the actual chemical test results. This information is helpful to the court on the issue of reliability and an officer's ability to correctly administer and interpret the test results.

Not all medical professionals have studied the effects of alcohol on humans nor routinely encounter patients who are under the influence. An expert who (1) has studied the effects of alcohol, (2) actually uses nystagmus testing, and (3) is familiar with the protocol specified for HGN in the standardized field sobriety testing manual is the best expert. It is beneficial if the expert has seen a law enforcement officer administer the test to impaired subjects. At a minimum, the expert should (1) review the protocol and (2) be able to give an opinion as to its validity as a test for alcohol impairment and whether a properly trained officer is capable of administering the test and interpreting the results. The expert should also be able to discuss acceptance of the HGN test in his or her particular field. The prosecutor and the expert witness must thoroughly prepare to ensure that the expert's testimony is clear, concise, and conveys to the factfinder the high degree of validity and reliability of the HGN test. (See the appendices for examples of predicate questions for various experts, including a SFST/DRE instructor (Appendix G), an optometrist (Appendix H), and an emergency room physician (Appendix I).)

In many jurisdictions, a prosecutor's time is short, and funding is limited. Gathering experts together to testify about HGN may not be feasible. In jurisdictions with no precedent, however, courts that deem the HGN test scientific will require expert testimony unless they are willing to take judicial notice of the HGN test's validity and reliability. Prosecutors should make every effort to select a test case, secure the necessary funding, and provide expert testimony required by the court to get the HGN test admitted in their state.

Experts from fields such as ophthalmology or toxicology can be called to testify about the NHTSA studies and the validity and reliability of the HGN test. All experts:

1. must read and be familiar with the NHTSA studies; and

2. should be trained in the use of the HGN test.

Contact the National Traffic Law Center for more information about possible experts and funding options for expert witnesses.

HGN at Trial

In addition to meeting standards for admissibility, most jurisdictions require the prosecution to lay some foundation before the factfinder can hear the evidence. The foundation often consists of two parts: establishing a correlation between alcohol impairment and HGN, and the qualifications of the police officer who administered the test.

The prosecution may call at trial the same types of experts who testified at the evidentiary hearing to establish this correlation, although it is unnecessary for the prosecution to present the same extensive testimony at trial as may be presented at the evidentiary hearing. The evidence needs to be sufficient, however, to persuade the trier of fact that a correlation exists between alcohol impairment and HGN and to withstand appellate review.

> Once a state's highest court has found the HGN test reliable, it will generally be unnecessary to call expert witnesses at trial to establish the nexus between alcohol impairment and HGN. Prosecutors, however, may still want to consider using expert testimony. Often an expert can more readily convince the factfinder of the test's validity.

In those jurisdictions that require expert testimony concerning the correlation between alcohol impairment and HGN, unless the court qualified the law enforcement officer as an expert on the administration and interpretation of HGN, the officer may not be permitted to testify at trial about the defendant's impairment.[124] When an officer testifies about the other tests in the SFST battery, the officer can usually offer a lay opinion regarding the defendant's sobriety based on the common characteristics of impairment that require no specialized knowledge to understand.[125] Where HGN is viewed as scientific evidence, however, the officer can usually only state the results of the test and not that they correlate with any degree of impairment.

Qualifying the officer to testify about the HGN test results is like qualifying the officer to testify about any other FST. The prosecutor should place emphasis on the officer's training and experience in administering the test. The officer should describe administering the test under controlled conditions to subjects who were not impaired and those who were and the differences the officer saw. The officer must also testify that the test was administered correctly in the case at trial.[126] For instance, the Alabama Court of Criminal Appeals suggested that a proper foundation for the HGN test would include evidence of the officer's training and experience in conducting the test.[127] The Montana Supreme Court found an officer may testify about HGN test results. The Montana Law Enforcement Academy had certified the officer after completing the requisite number of training hours.[128] This training and experience, coupled with testimony that the officer administered the test properly, is part of the foundational requirement to enable the officer to testify about the results of the test.[129]

Purpose and Limits of HGN Test Results

Courts have allowed the prosecution to use HGN test results for several purposes. Although not specifically addressed in many jurisdictions, courts generally accept the HGN test as a basis for probable cause to arrest without showing that the test meets the applicable scientific standard.[130] Some states have addressed this issue in the context of administrative license revocation proceedings, where the standard of proof for revocation is also probable cause to arrest.[131]

Once the court accepts HGN as a reliable indicator of impairment, it is evidence of impairment.[132] Although the HGN test is an excellent indicator of impairment, the test results alone are not used to convince a jury that a defendant was impaired.[133] Combined with other evidence of impairment, such as erratic driving, odor of an alcoholic beverage, glassy or bloodshot eyes or unsatisfactory performance on other SFSTs, HGN is strong evidence of impairment.

The HGN test and other field sobriety tests do not directly test a subject's ability to drive a car. Instead, they measure the mental and physical skills necessary to drive a car safely, such as muscle control and divided attention.

Many law enforcement officers are so experienced in giving the HGN test that they can estimate very closely a person's BAC based on the results, especially by examining the angle of onset. Despite this ability, to date no court has allowed an officer to testify as to a specific BAC based on HGN because the HGN test is not a statutorily approved method of determining a subject's BAC and the angle of onset is estimated without a precise measuring device.[134] An expert can testify, however, to the fact that research has verified the reliability of the HGN test in distinguishing between persons with a .10 BAC or higher and persons with a BAC lower than .10. Unless a law enforcement officer is qualified as such an expert, which is rare, the officer cannot testify to this fact.

Conclusion

Impaired driving detection and prosecution has improved since the initial 1977 NHTSA study, due in large part to the use of the SFST battery by law enforcement on the street and prosecutors in the courtroom. Efforts to reduce impaired driving in many parts of the United States could not fully benefit from administering the SFST battery, however, because of the exclusion of the HGN test from some impaired driving trials. The potential effectiveness of the SFST battery to curb impaired driving cannot be fully achieved unless all three tests are utilized throughout the country.

To further improve impaired driving enforcement, the HGN test should be administered by law enforcement in the field, introduced into evidence by prosecutors in the courtroom, and accepted by judges as reliable. For this to happen, a basic understanding of both the science and the law behind the HGN test is needed. HGN is based on simple scientific principles and is readily understood. A considerable body of scientific evidence supports its validity and reliability. Once law enforcement personnel, prosecutors, and judges understand HGN, they will realize how vital HGN evidence is in detecting, prosecuting, and convicting impaired drivers.

Endnotes

[1] *DWI Detection and Standardized Field Sobriety Testing (SFST): Instructor Guide*, Session 8, U. S. Department of Transportation, National Highway Traffic Safety Administration (02/2018).

[2] Karl Citek, Bret Ball, & Dale Rutledge, *Nystagmus Testing in Intoxicated Individuals*, 74 Optometry: J. of Am. Optometric Assoc. 695 (2003).

[3] Donald Chalmas Reynolds, *The Validity of a Screening Test*, 59 Am. J. of Optometry & Physiological Optics 67 (1982).

[4] *Saving Lives and Preventing Crashes—The Drug Evaluation and Classification (DEC) Program*, National District Attorneys Association, National Traffic Law Center, 2018.

[5] *Frye v. United States*, 293 F. 1013 (D.C. Cir. 1923).

[6] *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579 (1993).

[7] June M. Stapleton, et al., *Effects of Alcohol and Other Psychotropic Drugs on Eye Movements: Relevance to Traffic Safety*, 47 Q.J. Stud. on Alcohol 426, 430 (1986).

[8] *Lack of Convergence* is assessed primarily as part of a DRE evaluation and will not be considered further here.

[9] Citek, *supra* note 2, at 701.

[10] Citek, *supra* note 2, at 696.

[11] I. Lehtinen et al., *Acute Effects of Alcohol on Saccadic Eye Movements*, 63 Psychopharmacology 17 (1979).

[12] Svenja Gremmler & Markus Lappe, *Saccadic Suppression During Voluntary Versus Reactive Saccades*, 17 J. of Vision 1 (2017).

[13] CJ. Forkiotis, *Optometric Exercise: The Scientific Basis for Alcohol Gaze Nystagmus*, 59 Curriculum II, No. 7 at 9 (April 1987); Gregory W. Good & Arol R. Augsburger, *Use of Horizontal Gaze Nystagmus as a Part of Roadside Sobriety Testing*, 63 Am. J. of Optometry & Physiological Optics 467, 469 (1986).

[14] Louis F. Dell'Osso & Robert B. Daroff, *Duane's Clinical Ophthalmology*, vol. 2, ch. 11, "Nystagmus and Saccadic Intrusions and Oscillations," 3 (2005).

[15] Raymond D. Adams & Maurice Victor, *Principles of Neurology*, ch. 13, "Disorders of Ocular Movement and Pupillary Function," 117 (4th ed. 1991).

[16] See Forkiotis, *supra* note 13, at 9.

[17] C. Denise Pensyl & William J. Benjamin, *Borish's Clinical Refraction*, ch. 10, "Ocular Motility," 335 (1998).

Endnotes

[18] Chad A. Whyte, Anne Marie Petrock, & Michael Rosenberg, *Occurrence of Physiologic Gaze-Evoked Nystagmus at Small Angles of Gaze*, 51 Investigative Ophthalmology & Visual Science 2476 (2010).

[19] *Id.* at 2477.

[20] L.A. Abel, R.B. Daroff, & L.F. Dell'Osso, *End-Point Nystagmus*, 17 Investigative Ophthalmology & Visual Science 539 (1987).

[21] Karl Citek et al., *Sleep Deprivation Does Not Mimic Alcohol Intoxication on Field Sobriety Testing*, 56 J. of Forensic Sciences 1170 (2011).

[22] R. Stanley Burns, et al., *Phencyclidine—States of Acute Intoxication and Fatalities*, 123 West J Med 345 (Nov 1975); Paul Dominici, et al., *Phencyclidine Intoxication Case Series Study*, 11 J. Med. Toxicol. 321 (2015).

[23] R. John Leigh & David S. Zee, *The Neurology of Eye Movements*, ch. 10, "Diagnosis of Nystagmus and Saccadic Intrusion," 476 (4th ed. 2006).

[24] Jack E. Richman & John Jakobowski, *The Competency and Accuracy of Police Academy Recruits in the Use of the Horizontal Gaze Nystagmus Test for Detecting Alcohol Impairment*, 47 New Eng. J. Optometry 5, 6 (Winter 1994).

[25] David A. Robinson, *Eye Movement Control in Primates*, 161 Science 1219 (Sept. 1968).

[26] L. Goldberg, *Effects and After-Effects of Alcohol, Tranquilizers and Fatigue on Ocular Phenomena*, Alcohol and Road Traffic 123, 125–28 (1963).

[27] *Id.* at 128.

[28] Ronald J. Hill, William E. Collins, & David J. Schroeder, *Influence of Alcohol on Positional Nystagmus Over 32-Hour Periods*, 82 Ann. Otology, Rhinology, & Laryngology 103 (1973).

[29] Goldberg, *supra* note 26, at 126.

[30] *Id.*

[31] Eye movements with the eyes closed were recorded with electro-oculography, which utilizes electrodes placed at the outer corners, under and over the eye. *Id.* at 124.

[32] Gunnar Aschan, Different Types of Alcohol Nystagmus, 140 Acta Oto-laryngol 69, 76 (1958); Goldberg, *supra* note 26, at 128.

[33] National Highway Traffic Safety Administration, U.S. Department of Transportation, *Development and Field Test of Psychophysical Tests for DWI Arrest*, No. DOT-HS-805-864 at 79–83 (March 1981) [hereinafter *1981 NHTSA Study*].

[34] Goldberg, *supra* note 26, at 124–28.

[35] *Id.*

[36] Aschan, *supra* note 32, at 76–77.

[37] Field sobriety tests encompass any exercise a law enforcement officer asks an impaired driving suspect to perform along the roadside to test for impairment. The standardized field sobriety test battery consists only of the horizontal gaze nystagmus test, the walk-and-turn test and the one-leg-stand test.

[38] National Highway Traffic Safety Administration, U.S. Department of Transportation, *Psychophysical Tests for DWI Arrests*, No. DOT-HS-802-424 at 39 (June 1977) [hereinafter *1977 NHTSA Study*].

[39] *1981 NHTSA Study*, *supra* note 33, at 3.

[40] *Id.*

[41] *Id.* at 2. A later field study, using standardized procedures for administering the three FSTs, showed that ninety three percent of the decisions to arrest and eighty-six percent of the decisions to arrest or release were correct. Colorado Department of Transportation, *A Colorado Validation Study of the Standardized Field Sobriety Test (SFST) Test Battery*, 14 (Nov. 1995) [hereinafter *A Colorado Validation Study*].

[42] A measure of HGN reliability requires multiple measurement. For test–retest reliability, the same officers must examine the same subjects at the same BAC on a second occasion. For inter-officer reliability, two or more officers must examine the same subjects independently.

Reports of officer accuracy in percentages are not measures of reliability. They are important measures in that they serve to validate the test battery. That is, if officers make a high percentage of correct decisions based on the test battery, then it is valid.

Validity and reliability are linked. An unreliable test (one that gives varying results from one time to another) cannot be a valid test. Note that reliability is measured with coefficients in the range of -1 (no reliability) to +1 (perfect reliability).

[43] National Highway Traffic Safety Administration, U.S. Department of Transportation, *Field Evaluation of a Behavioral Test Battery for DWI*, No. DOT-HS-806-475 at 4 (Sept. 1983) [hereinafter *1983 NHTSA Study*]. NHTSA research found that HGN may be evident when a person's BAC reaches approximately .06 BAC. *1977 NHTSA Study*, *supra* note 38, at 7. Some studies have found that horizontal gaze begins to break down at even lower BAC levels. *See* I.M.S. Wilkinson et al., *Alcohol and Human Eye Movement*, 97 Brain 785, 791 (1974) (finding that smooth pursuit begins to break down at .04 BAC); Good & Augsburger, *supra* note 13, at 468 (stating that some changes in horizontal gaze begin at .03 BAC).

[44] *Id.*

[45] *Id.*.

[46] *Id.*

[47] *1983 NHTSA Study*, *supra* note 43, at 11.

[48] *Id.*

[49] Good & Augsburger, *supra* note 13, at 471.

[50] Forkiotis, *supra* note 13, at 4. *See also A Colorado Validation Study*, *supra* note 41, at 14 (finding that experienced law enforcement officers were accurate ninety-three percent of the time in deciding to arrest when using the SFST battery).

[51] Marcelline Burns, *The Use of Horizontal Gaze Nystagmus as a Field Sobriety Test*, Proceedings, 35th International Congress on Alcoholism and Drug Dependence, Oslo, Norway at 1 (1988) [hereinafter Burns, *The Use of HGN*]. The HGN test is also part of the twelve-step drug recognition evaluation protocol, which law enforcement uses to detect drivers under the influence of drugs other than alcohol.

[52] See *id.* at 1.

[53] *See A Colorado Validation Study*, *supra* note 41, at 19.

[54] Description of the administration of the HGN test is taken from *DWI Detection and Standardized Field Sobriety Testing (SFST) Participant Manual*, Session 8, p. 30–36, U. S. Department of Transportation, National Highway Traffic Safety Administration (02/2018) [hereinafter *Participant Manual*].

[55] Humphrey Belton, *Lateral Nystagmus: A Specific Diagnostic Sign of Ethyl Alcohol Intoxication*, 100 N.Z. Med. J. 534, 535 (Aug. 1987) (advocating the teaching of HGN to the public through repeated demonstrations on television).

[56] R. John Leigh & David S. Zee, *The Neurology of Eye Movements*, ch. 2, "The Vestibular-Optokinetic System," 21 (4th ed. 2006).

[57] A. James McKnight et al., *Sobriety Tests for Low Blood Alcohol Concentrations*, 34 Accident Analysis and Prevention 305 (2002).

[58] Citek, *supra* note 2.

[59] John S. Stahl, Gordon T. Plant, & R. John Leigh, *Medical Treatment of Nystagmus and Its Visual Consequences*, 95 J. of the Royal Society of Medicine 235 (2002).

[60] *Participant Manual*, *supra* note 54, at Session 8, p. 33.

[61] Research has shown that the characteristics of the stimulus used, including size, shape and brightness, have no effect on the HGN test results. Forkiotis, *supra* note 13, at 11.

[62] There are several state appellate court cases that incorrectly include "covering one eye" as part of the administration of the HGN test. *See*, *e.g.*, *State v. Superior Court (Blake)*, 718 P.2d 171, 173 (Ariz. 1986); *State v. Clark*, 762 P.2d 853, 856 (Mont. 1988). Subjects were asked to cover one eye in the initial NHTSA study. *1977 NHTSA Study*, *supra* note 38, at 13. However, when the test was standardized this requirement was dropped. *1981 NHTSA Study*, *supra* note 33,

at 85. NHTSA's research showed that "monocular versus binocular fixation" was an "unimportant variable." *Id*. at 7. Other research demonstrates that the angle of onset occurs much sooner when one eye is covered. *See* Aschan, *supra* note 32, at 73.

[63] Byron L. Lam, H. Stanley Thompson, & James J. Corbett, *The Prevalence of Simple Anisocoria*, 104 Am. J. Ophthalmology 69 (1987).

[64] Citek, *supra* note 2, at 707.

[65] Leigh & Zee, *supra* note 56, at 25.

[66] Adams & Victor, *supra* note 15, at 111. Note that caloric nystagmus does not occur when a person is seated in a heated car with the window open, allowing cold air into the vehicle.

[67] Vera C. Zingler et al., *The Effect of Nicotine on Perceptual, Ocular Motor, Postural, and Vegetative Functions at Rest and in Motion*, 254 J. of Neurology 1689 (2007).

[68] K.J. Goulden et al., *Clinical Valproate Toxicity Induced by Acetylsalicylic Acid*, 37 Neurology 1392 (1987).

[69] Steven D. Rauch, *Clinical Hints and Precipitating Factors in Patients Suffering from Meniere's Disease*, 43 Otolaryngol Clin N Am 1011 (2010).

[70] There is research that has found that barbiturates and alcohol suppress or eliminate optokinetic nystagmus while causing other types of nystagmus. M.B. Bender & F.H. O'Brien, *The Influence of Barbiturate on Various Forms of Nystagmus*, 29 Am. J. Ophthalmology 1541, 1552 (1946); V. Zikmund & F. Jagla, *Changes in the optokinetic nystagmus cessation limit under the influence of ethanol and caffeine*, 31 Activ. Nerv. Super 223 (1989).

[71] Peter W. Kaplan & Ronald Tusa, *Neurophysiologic and Clinical Correlations of Epileptic Nystagmus*, 43 Neurology 2508, 2513 (Dec. 1993).

[72] *1981 NHTSA Study*, *supra* note 33, at 10–11; Citek, *supra* note 21, at 1177.

[73] Nagint Sarvananthan et al., *The Prevalence of Nystagmus: The Leicestershire Nystagmus Survey*, 50 Investigative Ophthalmology & Visual Science 5201 (2009).

[74] Forkiotis, *supra* note 13, at 11.

[75] Richard V. Abadi, *Mechanisms Underlying Nystagmus*, 95 J. R. Soc. Med. 231 (2002).

[76] Martina Poletti & Michele Rucci, *Eye Movements Under Various Conditions of Image Fading*, 10 J. Vis. 1 (2010).

[77] See *supra* notes 47–53 and accompanying text (detailing the accuracy of the HGN test).

[78] *United States v. Everett*, 972 F. Supp. 1313, 1319 (D.Nev. 1997).

[79] *City of Fargo v. McLaughlin*, 512 N.W.2d 700, 706 (N.D. 1994); *State v. Nagel*, 506 N.E.2d 285, 286 (Ohio Ct. App. 1986); *State v. Sullivan*, 426 S.E.2d 766, 769 (S.C. 1993); *Salt Lake City v. Garcia*, 912 P.2d 997, 1000 (Utah Ct App. 1996).

[80] *State v. Murphy*, 451 N.W.2d 154, 157 (Iowa 1990) (citing *Nagel*, 506 N.E. 2d at 286); *See also Anderson v. State*, 252 P.3d 211, 212–13 (Okla. Crim. App. 2010); *State v. Engelhorn*, 2016 ND 167, P1, 883 N.W.2d 852, 853 (N.D. 2016).

[81] *See*, *e.g.*, *McLaughlin*, 512 N.W.2d at 707; *Nagel*, 506 N.E.2d at 286.

[82] *McLaughlin*, 512 N.W.2d at 708.

[83] *See Garcia*, 912 P.2d at 1001.

[84] *See id.*

[85] *State v. Witte*, 836 P.2d 1110, 1121 (Kan. 1992). *See also Ex parte Malone v. City of Silverhill*, 575 So.2d 106, 107 (Ala. 1990); *State v. Superior Court (Blake)*, 718 P.2d 171, 178 (Ariz. 1986); *People v. Joehnk*, 35 Cal. App. 4th 1488, 1507–08, 42 Cal. Rptr. 2d 6, 38 (Cal. Ct. App. 1995); *State v. Ruthardt*, 680 A.2d 349, 356 (Del. Super. Ct. 1996); *State v. Meador*, 674 So. 2d 826, 834 (Fla. Dist. Ct. App. 1996); *Manley v. State*, 424 S.E.2d 818, 819 (Ga. Ct. App. 1992); *State v. Garrett*, 811 P.2d 488, 490 (Idaho 1991); *People v. Buening*, 592 N.E.2d 1222, 1227 (Ill. App. Ct. 1992); *State v. Armstrong*, 561 So. 2d. 883, 887 (La. Ct. App. 1990); *Schultz v. State*, 664 A.2d 60, 62 (Md. Ct. Spec. App. 1995); *State v. Berger*, 551 N.W.2d 421, 424 (Mich. Ct. App. 1996); *State v. Klawitter*, 518 N.W.2d 577, 584 (Minn. 1994); *Young v. City of Brookhaven*, 693 So.2d 1355, 1360–61 (Miss. 1997); *State v. Hill*, 865 S.W.2d 702, 703–4 (Mo. Ct. App. 1993) (reversed on other grounds); *Clark*, 762 P.2d at 856; *State v. Torres*, 976 P.2d 20, 30 (N.M. 1999); *State v. O'Key*, 899 P.2d 663, 675 (Or. 1995); *Commonwealth v. Miller*, 532 A.2d 1186, 1188 (Pa. Super. 1987); *State v. Murphy*, 953 S.W.2d 200, 201 (Tenn. 1997); *Emerson v. State*, 880 S.W.2d 759, 763 (Tex. Crim. App. 1994); *State v. Cissne*, 865 P.2d 564, 568 (Wash. Ct. App. 1994); *State v. Barker*, 366 S.E.2d 642, 644–45 (W. Va. 1988).

[86] *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 588 (1993). *See also Kumho Tire Co. v. Carmichael*, 526 U.S. 137, 119 S. Ct. 1167 (1999).

[87] *State v. O'Key*, 899 P.2d 663, 678 n.20 (Or. 1995).

[88] *See infra* notes 121–122 and accompanying text (discussing the evidence presented in an evidentiary hearing for HGN).

[89] 293 F. 1013 (D.C. Cir. 1923). In *Frye*, the Court of Appeals affirmed a lower court ruling excluding the results of a polygraph test offered by a defendant charged with second-degree murder. *Id*. at 1013–14.

[90] *Id.* at 1014.

[91] *See State v. Merritt*, 647 A.2d 1021, 1024 n.3 (Conn. App. Ct. 1994); *Witte*, 836 P.2d at 1117.

[92] *Superior Court (Blake)*, 718 P.2d at 179–80.

[93] See *id.*

[94] *See also Joehnk*, 35 Cal. App. 4th at 1504–7, 42 Cal. Rptr. 2d at 15–17; *O'Key*, 899 P.2d at 675 and 685–86.

[95] *United States v. Jackson*, 425 F.2d 574, 576 (D.C. Cir. 1970); *State v. Tran*, 847 P.2d 680, 686 (Kan. 1993).

[96] *Whitson v. State*, 863 S.W.2d 794, 798 (Ark. 1993).

[97] *E.g.*, Paul C. Gianelli, *The Admissibility of Novel Scientific Evidence: Frye v. United States, a Half-Century Later*, 80 Colum. L. Rev. 1197, 1223–28 (1980).

[98] *See infra* notes 100–106 and accompanying text (discussing the *Daubert* alternative to the *Frye* test).

[99] 509 U.S. 579 (1993). In *Daubert*, the Supreme Court ruled that the plaintiffs, children born with birth defects, could introduce expert testimony on the issue that the defendant's product, Bendectin, caused the birth defects even though the expert's theory of causation was not generally accepted in the relevant scientific community. *Id*. at 598.

[100] Fed. R. Evid. 702. Rule 702 states: "Testimony by Experts—If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise."

[101] *Daubert*, 509 U.S. at 591–95.

[102] *Id.*

[103] *Id.*

[104] *Id.* at 593; See also *O'Key*, 899 P.2d at 678.

[105] *Daubert*, 509 U.S. at 593.

[106] *Id.* at 593–94.

[107] *Id.* at 594.

[108] *Id. See also State v. Pennell*, 584 A.2d 513, 515 (Del. Super. Ct. 1989); *O'Key*, 899 P.2d at 680; *Commonwealth v. Sands*, 675 N.E.2d 370, 371 (Mass. 1997).

[109] See *supra* notes 89–98 and accompanying text (describing the *Frye* standard).

[110] See *supra* note 100 and accompanying text (describing the Federal Rules of Evidence Standard).

[111] *Daubert*, 509 U.S. at 592 n.11.

[112] *Prater*, 820 S.W.2d 429, 433 (Ark. 1991); *Pennell*, 584 A.2d at 515.

[113] *Daubert*, 509 U.S. at 586–88.

[114] *Kumho Tire Co.*, 119 S. Ct. at 1167.

[115] *People v. Leahy*, 882 P.2d 321 (Cal. 1994); *Jones v. United States*, 548 A.2d 35 (D.C. App. 1988); *Smith v. Deppish*, 807 P.2d 144 (Kan. 1991); *People v. Hughes*, 453 N.E.2d 484 (N.Y. Ct. App. 1983); *Commonwealth v. Zook*, 615 A.2d 1 (Pa. 1992).

[116] *State v. Coon*, 974 P.2d 386 (Alaska 1999). *See also State v. Sharpe*, 435 P.3d 887 (Alaska 2019) (refining *Daubert* / *Coon* application in Alaska); *Whitson*, 863 S.W.2d 794; *Prater*, 820 S.W.2d 429; *State v. Gleason*, 844 P.2d 691 (Idaho 1992); *State v. Foret*, 628 So.2d 1116 (La. 1993); *Commonwealth v. Lanigan*, 641 N.E.2d 1342 (Mass. 1994); *Hulse v. DOJ, Motor Vehicle Div.*, 961 P.2d 75 (Mont. 1998); *Torres*, 976 P.2d 20; *State v. McGrady*, 232 N.C.App. 95, 753 S.E.2d 361 (N.C. Ct. App. Jan. 21, 2014); *Taylor v. State*, 889 P.2d 319 (Okla. Crim. App. 1995); *O'Key*, 899 P.2d 663; *State v. Hullinger*, 649 N.W.2d 253 (S.D. 2002); *Murphy*, 953 S.W.2d 200; *Emerson*, 880 S.W.2d 759; *Wilt v. Buracker*, 443 S.E.2d 196 (W. Va. 1993).

[117] *Schultz*, 664 A.2d 60; *Klawitter*, 518 N.W.2d 577; *Hill*, 865 S.W.2d 702; *State v. Baue*, 607 N.W.2d 191 (Neb. 2000); *State v. Harvey*, 699 A.2d 596 (N.J. 1997); *State v. Baity*, 991 P.2d 1151 (Wash. 2000).

[118] *State v. Balbi*, 874 A.2d 288 (Conn. App. Ct. 2005); *Harper v. State*, 292 S.E.2d 389 (Ga. 1982) (creating a standard even more liberal than the FRE).

[119] *Young*, 693 So.2d at 1358. The court did allow law enforcement to use HGN test evidence for probable cause determinations. *Id*. at 1360.

[120] The admissibility of the HGN test in the courts of California, a *Frye* state, is a good example of the effectiveness of expert testimony and existing literature about the HGN test. In *People v. Loomis*, 156 Cal. App. 3d Supp. 1, 7, 203 Cal. Rptr. 767, 771 (1984), the appellate court reversed a defendant's conviction on two grounds. First, the state failed to lay the proper foundation to establish the scientific reliability of the HGN test. The police officer and no experts testified. Second, the police officer attempted to quantify the defendant's BAC. *Id*. at 8, 203 Cal. Rptr. at 773. In *Leahy*, 882 P.2d 321, 34 Cal. Rptr. 2d 663, the state relied solely on the police officer and again the court reversed the conviction for failure to establish the scientific reliability of the HGN test. *Id*. at 323, 34 Cal. Rptr. 2d at 665. The court finally admitted HGN test results in *Joehnk*, 35 Cal. App. 4th 1488, 42 Cal. Rptr. 2d 6. In that case, the state presented three experts who testified about the acceptance of the HGN test in relevant scientific communities, as well as studies to show its reliability. *Compare State v. Reed*, 732 P.2d 66, 69 (Or. Ct. App. I 987) (rejecting HGN when state presented arresting police officer's testimony only) with *O'Key*, 899 P.2d at 682 n.34 (admitting HGN when state presented testimony of four experts and arresting police officer).

[121] *See Hawkins v. State*, 476 S.E.2d 803, 808–09 (Ga. Ct. App. 1996) (court judicially noticed that HGN test is a reliable scientific test); *Buening*, 592 N.E.2d at 1227 (judicially noticing decisions of other courts to hold that HGN test meets the *Frye* standard); *State v. Taylor*, 694 A.2d 907, 912 (Me. 1997) (taking judicial notice of the reliability of the HGN test to detect impaired drivers); *Schultz*, 664 A.2d

at 74 (holding the HGN test is a reliable indicator of alcohol impairment and of its acceptance in the relevant scientific community). *But see People v. Kirk*, 681 N.E.2d 1073, 1077 (Ill. App. Ct. 1997) (criticizing the court in *Buening*, *supra*, for judicially noticing decisions of other courts); *State v. Helms*, 490 S.E.2d 565, 568 (N.C. Ct. App. 1997) (*declining* to take judicial notice of the HGN test's reliability based on the record before it); *Cissne*, 865 P.2d at 569 (Wash. Ct. App. 1994) (same).

[122] *See Daubert*, 509 U S. at 587 (1993).

[123] *See Leahy*, 882 P.2d at 323, 34 Cal. Rptr. 2d at 665 (1994). *But see Ruthardt*, 680 A.2d at 361–62 (holding that a police officer may be qualified to testify about the underlying scientific principles that correlate HGN with alcohol).

[124] While a court rarely qualifies a law enforcement officer to give this type of testimony, there is nothing prohibiting an officer who is qualified to testify. *Ruthardt*, 680 A.2d at 361–62.

[125] *People v. Williams*, 3 Cal. App. 4th 1326, 1332, 5 Cal. Rptr. 2d 130, 134 (1992). *But see People v. Randolph*, 28 Cal. App. 5th 602, 239 Cal. Rptr. 3d 395 (2018) (finding law enforcement officers may also qualify as experts for HGN foundational purposes).

[126] *Schultz*, 664 A.2d at 62 and cases cited therein.

[127] *Sides v. State*, 574 So. 2d 856, 858 (Ala. Crim. App. 1990).

[128] *Hulse*, 961 P.2d at 94–5 (finding an expert must also testify about the correlation between alcohol and HGN).

[129] *Id. See also Armstrong*, 561 So.2d at 887; *State v. Bresson*, 554 N.E.2d 1330, 1335–36 (Ohio 1990).

[130] *State v. Grier*, 791 P.2d 627, 631 (Alaska Ct. App. 1990); *Superior Court (Blake)*, 718 P.2d at 178; *Merritt*, 647 A.2d at 1026 n.4. *Cf. Ruthardt*, 680 A.2d at 354; *O'Key*, 899 P.2d at 681 n.30.

[131] *See*, *e.g.*, *Muscatell v. Cline*, 474 S.E.2d 518, 525 (W. Va. 1996).

[132] *Whitson*, 863 S.W.2d at 798; *Sieveking v. State*, 469 S.E.2d 235, 236 (Ga. Ct. App. 1996); *Armstrong*, 561 So.2d at 887; *Hill*, 865 S.W.2d at 704 (reversed on other grounds); *Bresson*, 554 N.E.2d at 1336.

[133] *See*, *e.g.*, *Garrett*, 811 P.2d at 491 (stating "standing alone [an HGN test result] does not provide proof positive of DUI, because many other factors may cause nystagmus").

[134] *E.g.*, *Middleton v. State*, 780 S.W.2d 581, 583–84 (Ark. Ct. App. 1989); *Howard v. State*, 744 S.W.2d 640, 641 (Tex. App. 1987).

Glossary of Terms

Terms in *italics* are defined elsewhere in this glossary.

alcohol gaze nystagmus (AGN) • *Gaze-evoked nystagmus* caused by the effects of alcohol upon the nervous system. Examples include the second and third components of the *HGN test* and *VGN*.

caloric nystagmus • A *vestibular nystagmus* caused by differences in temperature between the ears, *e.g.*, one ear is irrigated with warm water or air and the other irrigated with cold water or air.

congenital nystagmus • Nystagmus that occurs without any apparent physiological, vestibular, or neurological disturbance.

endpoint nystagmus • Nystagmus that occurs when moving the eye to a maximum lateral position in order to fixate an object. It occurs naturally in over 50% of normal persons. It is distinguished from the second part of the *HGN test*, Distinct and Sustained Nystagmus at Maximum Deviation, in that endpoint nystagmus often is too small to see without specialized instruments and usually dissipates within 1–2 seconds.

epileptic nystagmus • Nystagmus evident during an epileptic seizure.

field sobriety test (FST) • Any number of tests used by law enforcement officers, usually on the roadside, to determine whether a driver is impaired. Many FSTs test balance coordination and all, including the *HGN test*, assess the ability of the driver to divide attention between several tasks at once.

fixation • Ability of the eye to focus on one point.

gaze-evoked nystagmus (GEN) • *Jerk nystagmus* that occurs when the eyes gaze or fixate upon an object or image that is not straight ahead of the person, but prior to maximum deviation (see *endpoint nystagmus*). Usually caused by a disruption of the nervous system. If caused by intoxication, GEN is the third part of the *HGN test*, Onset of Nystagmus Prior to 45 Degrees, and the first two parts of the *HGN test* normally would also have been observed.

horizontal gaze nystagmus (HGN) test • A test battery of three separate, independent assessments of eye movements in the horizontal plane. The sub-tests are Lack of Smooth Pursuit, Distinct and Sustained Nystagmus at Maximum Deviation, and Onset of Nystagmus Prior to 45 Degrees.

Glossary of Terms

jerk nystagmus; beat nystagmus • Nystagmus where the eye drifts slowly away from a point of focus (slow phase) and then quickly corrects itself with a *saccade* back to the point of focus (fast phase). Jerk nystagmus usually is named by the direction of the fast phase, such as right(ward)- or up(ward)-beating.

National Highway Traffic Safety Administration (NHTSA) • The agency within the United States Department of Transportation that administers traffic safety programs. NHTSA's duties include funding studies on field sobriety tests and training law enforcement officers in the administration of the standardized field sobriety test battery.

neurological nystagmus • Nystagmus caused by some disturbance in the nervous system.

nystagmus • An involuntary bouncing or jerking of the eye caused by any number of vestibular, neurological or physiological disturbances. The plane of the eye movement can be horizontal, vertical, oblique, or rotatory, depending on the nature and cause of the nystagmus.

oculomotor • Referring to the muscles that move the eye or movement of the eyeball.

one-leg-stand (OLS) test • One of the three tests that make up the *standardized field sobriety test battery*. This test requires a subject to stand on one leg, look at his foot and count out loud to thirty. The subject is assessed on the ability to understand and follow instructions as well as the ability to maintain balance for thirty seconds.

optokinetic nystagmus (OKN) • Nystagmus evident when trying to fixate on a continuously moving object or group of objects, such as when watching a train while stopped at a crossing, utility poles pass by while in a moving car, or alternating moving images, such as black and white stripes on a spinning drum. OKN is not a simple reflex response, requiring attention to the moving object. The OKN response can be impaired with intoxication.

oscillate • To move back and forth at a constant rate between two points.

pathological disorder • Disruption of the normal functions of organs of the body due to disease, illness, or injury.

pendular nystagmus • Nystagmus in which the eye oscillates or swings equally in two directions.

physiological nystagmus • Nystagmus that occurs so that light entering the eye will continually fall on non-fatigued cells on the retina. Physiological nystagmus occurs in everyone and can occur in any direction, but is so slight that it cannot be detected without the aid of specialized instruments.

positional alcohol nystagmus (PAN) • *Positional nystagmus* when alcohol is present at different concentrations in the blood compared to the fluid of the *vestibular system*. PAN has three phases:

—PAN I • The alcohol concentration is higher in the blood than in the vestibular system fluid. Direction of nystagmus is in the direction of the head tilt.

—Intermediate • The alcohol concentrations in the blood and the vestibular system fluid are approximately equal; nystagmus may or may not be present.

—PAN II • The alcohol concentration is lower in the blood than in the vestibular system fluid. Direction of nystagmus is opposite the direction of the head tilt.

positional nystagmus • Nystagmus that occurs when the head is not upright when standing or seated, or when the head is not in line with the spine when supine (lying on the back). Positional nystagmus can appear as *resting nystagmus* when it occurs under the conditions that cause it.

post-rotational nystagmus • *Resting nystagmus* caused by movement of the vestibular system fluid after a person stops spinning. Nystagmus ceases after a few seconds, especially if the person is allowed to fixate on a stationary object.

resting nystagmus • Nystagmus that occurs when the person is looking straight ahead.

rotational nystagmus • Nystagmus caused by movement of the vestibular system fluid when a person is spinning. After a few seconds of spinning in a single direction and at a constant speed, nystagmus ceases as the vestibular system adapts to the movement.

saccade; saccadic eye movement • Rapid movement of the eye from one fixation point to another. Normal speed can exceed 300 degrees/second. During the eye movement itself, however small or brief, vision is suppressed. Inability to make saccades can result in the need to make head or head-and-body movements in order to move the eyes.

smooth pursuit • Continuous fixation of an object when there is relative movement between the observer and the object, such as when a moving driver reads a stationary sign or a stopped driver watches another vehicle that is moving. Normal speed can exceed 100 degrees/second when the object is easy to see, moves over a large part of the visual field, and/or moves in a predictable manner. Inability to make smooth pursuits can result in *saccades*, *i.e.*, "lack of smooth pursuit."

Southern California Research Institute (SCRI) • A research organization that conducted the first two research studies that eventually produced the standardized field sobriety test battery. SCRI has conducted subsequent field sobriety test validation studies as well as drug recognition evaluation studies.

standardized field sobriety test (SFST) battery • A group of tests selected as the best field sobriety tests to increase the ability of law enforcement officers to detect driver impairment. The results of this battery, usually administered along the roadside, contribute extensively to a law enforcement officer's decision to arrest a person for impaired driving.

walk-and-turn (WAT) test • One of the three tests that make up the *standardized field sobriety battery*. This test requires a person to take nine heel to toe steps down a straight line, turn and take nine heel to toe steps back up the line. The subject is assessed on the ability to understand and follow instructions as well as the ability to maintain balance during the instruction stage and walking stage.

vertical gaze nystagmus (VGN) • Upward-beating *jerk nystagmus* that occurs when the eyes fixate or move upward along a vertical plane.

vestibular nystagmus • Nystagmus caused by a response by or disturbance in the *vestibular system*. Many types of vestibular nystagmus will be elicited as *positional nystagmus*.

vestibular system • The system of fluid-filled canals located in the inner ear that assists in balance, coordination and orientation.

APPENDIX A
Combined Test Scoring Procedure

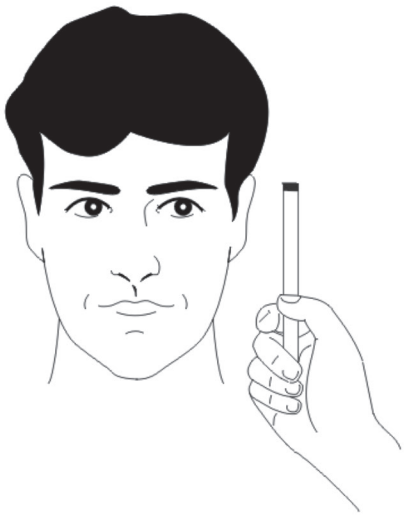
HORIZONTAL GAZE NYSTAGMUS TEST SCORE

Walk & Turn Test Score	0	1	2	3	4	5	6
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							

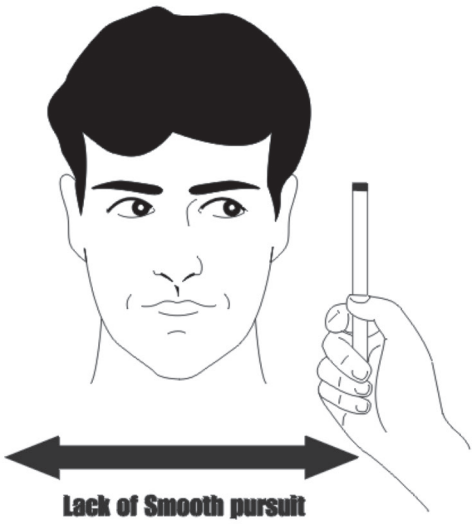
The above matrix utilizes the combined test scores for the horizontal gaze nystagmus test and the walk and turn test. If the box at the intersection of a subject's horizontal gaze nystagmus and walk and turn test scores is shaded, a subject's blood alcohol content is predicted to be .10%. Data showed that the accuracy of law enforcement officers correctly classifying subjects as above or below .10% blood alcohol content is 80% using this matrix.

APPENDIX B
Illustrations of the HGN Test

1



2

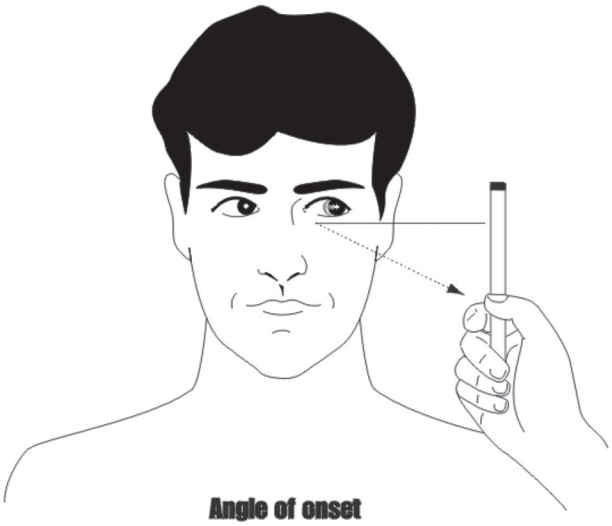


Lack of Smooth pursuit

3

Nystagmus at
maximum deviation

4



Angle of onset
prior to 45°

APPENDIX C
Bibliography of Horizontal Gaze Nystagmus Studies and Articles

PUBLICATIONS FAVORABLE TO HGN

National Highway Traffic Safety Administration (NHTSA) Research Studies

T.E. Anderson, *Development of Effective Behavioral Test Procedures for Alcohol-Impaired Driver Identification*, Research Notes, NHTSA, U.S. Department of Transportation (Nov. 1983). Briefly summarizes the NHTSA research on field sobriety testing.

National Highway Traffic Safety Administration, U.S. Department of Transportation, T*he Robustness of the Horizontal Gaze Nystagmus Test*, DOT HS 810-831 (Sept. 2007).

National Highway Traffic Safety Administration, U.S. Department of Transportation, *Validation of the Standardized Field Sobriety Test Battery at BACs Below 0.10 Percent*, DOT HS 808-839 (Aug. 1998).

National Highway Traffic Safety Administration, U.S. Department of Transportation, *The Detection of DWI at BACs Below 0.10*, DOT HS 808-654 (Sept. 1997).

National Highway Traffic Safety Administration, U.S. Department of Transportation, *DWI Detection and Field Sobriety Testing Student Manual* (1995). Manual is used to instruct law enforcement in the three phases of impaired driving detection: vehicle in motion, personal contact and pre-arrest screening. Pre-arrest screening includes instruction on the standardized field sobriety test battery.

National Highway Traffic Safety Administration, U.S. Department of Transportation, *The Detection of DWI Motorcyclists*, DOT HS 807-856 (March 2013).

National Highway Traffic Safety Administration, U.S. Department of Transportation, *Pilot Test of Selected DWI Detection Procedures for Use at Sobriety Checkpoints*, DOT HS 806-724 (1985).

National Highway Traffic Safety Administration, U.S. Department of Transportation, *Field Evaluation of a Behavioral Test Battery for DWI*, No. DOT HS 806-475 (Sept. 1983). Study to confirm the effectiveness of the standardized filed sobriety test battery using a larger sample size. Concluded that the HGN test was the most effective of the three tests and that greater accuracy in determining whether a subject's BAC is over .10 can be gained by combining the scores of the HGN and Walk-and-Turn test.

National Highway Traffic Safety Administration, U.S. Department of Transportation, *Development and Field Test of Psychophysical Tests for DWI Arrest*, No. DOT HS 805-864 (March 1981). Study to determine the effectiveness of the sobriety test battery and standardized the administration and scoring of each test. Test battery was subjected to laboratory and field evaluation. Concluded that more field testing needed to be performed, but the study showed that the test battery would be effective in increasing the ability of police officers to detect impaired drivers.

National Highway Traffic Safety Administration, U.S. Department of Transportation, *The Visual Detection of Driving While Intoxicated Field Test of the Visual Cues and Detection Methods*, DOT HS 805-620 (April 1980).

National Highway Traffic Safety Administration, U.S. Department of Transportation, *Psychophysical Tests for DWI Arrest*, No. DOT-HS-802-424 (June 1977). Study to determine the easiest and most effective methods of roadside testing in order to increase the ability of police to detect impaired drivers. Concluded that alcohol gaze nystagmus testing was most effective, along with walk-and-turn and one-leg stand tests.

Other Research Studies and Articles

Richard V. Abadi, *Mechanisms Underlying Nystagmus*, 95 J. R. Soc. Med. 231 (2002).

L.A. Abel, R.B. Daroff, & L.F. Dell'Osso, *End-Point Nystagmus*, 17 Investigative Ophthalmology & Visual Science 539 (1987).

Raymond D. Adams & Maurice Victor, *Principles of Neurology*, ch.13, "Disorders of Ocular Movement and Pupillary Function," (4th ed. 1991). Lists the several varieties of pendular and jerk nystagmus, their manifestations and causative diseases.

Gunnar Aschan, *Different Types of Alcohol Nystagmus*, 140 Acta Oto-laryngol 69 (Sweden 1958). Explores the causes and manifestations of positional alcohol nystagmus (PAN) and how it compares with alcohol gaze nystagmus.

Gunnar Aschan & M. Bergstedt, *Positional Alcoholic Nystagmus in Man Following Repeated Alcohol Doses*, 80 Acta Oto-laryngol 330 (Sweden 1975).

Gunnar Aschan et al., *Positional Alcoholic Nystagmus in Man During and After Alcohol Intoxication*, 17 Q.J. Stud. on Alcohol 381 (1956).

Lea Averbuch-Heller et al., *Convergent-Divergent Pendular Nystagmus: Possible Role of the Vergence System*, 45 Neurology 509 (Mar. 1995) (abstract only). Seeks to examine the possible sources of convergent-divergent oscillation in subjects exhibiting acquired pendular nystagmus.

R.W. Baloh et al., *Effect of Alcohol and Marijuana on Eye Movements*, 50 Aviat. Space Environ. Med. 18 (Jan 1979).

G.R. Barnes, *The Effects of Ethyl Alcohol on Visual Pursuit and Suppression of the Vestibulo-Ocular Reflex*, 406 Acta Oto-laryngol 161 (1984).

Appendix C

Jason Barton, *Blink- and Saccade-Induced Seesaw Nystagmus*, 45 Neurology 831 (April 1995). Examining the possible causes of seesaw nystagmus manifesting itself after subject blinks.

Humphrey Belton, *Lateral Nystagmus: A Specific Diagnostic Sign of Ethyl Alcohol Intoxication*, 100 N.Z. Med. J. 534 (Aug. 1987). Advocating the use of lateral nystagmus test to detect alcohol impairment in drivers because "lateral nystagmus...is the most reliable diagnostic sign in the assessment of alcohol impairment." Article also advocates demonstrations on television "so that lay people may detect intoxication in potential drivers and discourage and prevent impaired motorists from driving."

M.B. Bender & F.H. O'Brien, *The Influence of Barbiturate on Various Forms of Nystagmus*, 29 Am. J. Ophthalmology 1541 (1946). Investigates the various effects barbiturates have on eye movement and the creation or suppression of various types of nystagmus by barbiturates.

L.H. Blomberg & A. Wassen, *The Effect of Small Doses of Alcohol on the "Optokinetic Fusion Limit,"* 54 Acta Physiol. Scand. 193 (1962). Blood Alcohol Concentration and Driving, Position Statement by the American College of Emergency Room Physicians, 17 Annals of Emergency Med. 11 (1988).

Marcelline Burns, *An Overview of Field Sobriety Test Research*, Perceptual and Motor Skills, Vol. 97, 1187–1199 (Dec. 2003).

Marcelline Burns, *Field Sobriety Tests for the Marine Environment Final Report*, The Indian Creek Public Safety Department, FL (1996).

Marcelline Burns, *The Controversy and the Issues: Horizontal Gaze Nystagmus*, 3 The DRE 7 (May/June 1991). A response to defense articles challenging the validity of the HGN test.

Marcelline Burns, *DUI Enforcement Problems at Roadside*, 7 Alcohol, Drugs and Driving 215 (1991). Identifying the various obstacles police officers face in detecting impaired drivers. Advocates the use of HGN to detect drivers that have high alcohol tolerance levels and do not display the typical balance and coordination problems usually association with impairment.

Marcelline Burns, *Why Police Check a Driver's Eyes*, 15 U.S. J. Drug and Alcohol Dependence 7 (1991).

Marcelline Burns, *Recognition of the Drug-impaired Driver by Examination of Behavioral and Physiological Signs*, Proceedings, 34th Annual Meeting Human Factors Society, Orlando, FL 1015 (1990). Describes the drug recognition evaluation procedure (of which HGN is a part), concluding that the procedure is highly effective in identifying drug impairment.

Appendix C

Marcelline Burns, *The Use of Horizontal Gaze Nystagmus as a Field Sobriety Test*, Proceedings, 35th International Congress on Alcoholism and Drug Dependence, Oslo, Norway (1988). Describes HGN and its use by law enforcement in impaired driving investigations. Also briefly examines the legal challenges to HGN and why some courts refuse to admit testimony about HGN test results.

Marcelline Burns, *Field Sobriety Tests: An Important Component of DUI Enforcement*, 1 Alcohol, Drugs and Driving: Abstracts and Reviews 21 (1985).

Marcelline Burns & Eugene Adler, *Study of a Drug Recognition Expert (DRE) Program*, 1 Alcohol, Drugs and Traffic Safety 437 (C.N. Kloeden and A.J. McLean eds. 1995). Study to evaluate the effectiveness of the drug recognition evaluation process, of which HGN is a part. Study concludes that the drug recognition evaluation program is a valid means of drug recognition and detecting drug impairment.

Marcelline Burns & Eugene Adler, *Drug Recognition Expert (DRE) Validation Study*, Final Report, E0072023, Governor's Office of Highway Safety, State of Arizona (1994).

Marcelline Burns & H. Moskowitz, *Alcohol Impairment Tests for DWI Arrests*, Transportation Research Record, National Research Council (1979).

R. Stanley Burns, et al., *Phencyclidine—States of Acute Intoxication and Fatalities*, 123 West J Med 345 (Nov 1975); Paul Dominici, et al., Phencyclidine Intoxication Case Series Study, 11 J. Med. Toxicol. 321 (2015).

Karl Citek et al, *Sleep Deprivation Does Not Mimic Alcohol Intoxication on Field Sobriety Testing*, Journal of Forensic Sciences, Vol. 56, No. 5 (Sept. 2011).

Karl Citek and D.A. Rutledge, *Nystagmus Testing in Intoxicated Individuals*, Optometry, Vol. 74, No. 11, 695–710 (Nov. 2003).

Harvey Cohen, *Prosecution of the Impaired Driver* 8A-1 (1989). Addresses the legal aspects of field sobriety tests, and HGN in particular, and their admissibility in court. Summarizes common criticisms of the HGN test's ability to accurately detect impairment.

W.E. Collins, *Effects of Mental Set Upon Vestibular Nystagmus*, 63 J. Exp. Psychology 191 (1962).

Colorado Department of Transportation, *A Colorado Validation Study of the Standardized Field Sobriety Test (SFST) Test Battery* (Nov. 1995). Study conducted by Marcelline M. Burns and Ellen W. Anderson to evaluate the effectiveness of the standardized field sobriety test battery, taking into account variables such as age, sex and weather conditions during testing. The study concluded that the standardized field sobriety test battery, despite these variables, is highly effective.

Louis F. Dell'Osso & Robert B. Daroff, *Duane's Clinical Ophthalmology*, vol. 2, ch. 11, "Nystagmus and Saccadic Intrusions and Oscillations," 3 (2005).

Appendix C

Federal Aviation Administration, Department of Transportation, *Alcohol and Disorientation Related Responses I. Nystagmus and "Vertigo" During Caloric and Optokinetic Stimulation*, FAA-AM-71-6 (Feb. 1971).

Fiorentino, Dary D., *Validation of Sobriety Tests for the Marine Environment*, Accident and Injury Prevention (2010).

Florida Department of Transportation, State Safety Office, *A Florida Validation Study of the Standardized Field Sobriety Test (S.F.S.T.) Battery*, AL-97-05-14-01 (1997). Study conducted by Marcelline M. Burns and Teresa Dioquino to evaluate the effectiveness of the standardized field sobriety test battery, taking into account variables such as age, sex and weather conditions during testing. The study found officers using the SFSTs were 95% accurate in arrest decisions.

C.J. Forkiotis, *Optometric Exercise: The Scientific Basis for Alcohol Gaze Nystagmus*, 59 Curriculum II, No. 7 (April 1987). Discussion of nystagmus and its use in the standardized filed sobriety test battery and court. Gives a scientific basis for the relationship between alcohol and nystagmus. Written for ophthalmologists preparing to testify about the HGN test.

A.R. Fregly et al., *Relationships Between Blood Alcohol, Positional Alcohol Nystagmus and Postural Equilibrium*, 28 Q.J. Stud. on Alcohol 11 (March 1967).

George Goding & Robert Dobie, *Gaze Nystagmus and Blood Alcohol*, 96 Laryngoscope 713 (July 1986). Testing the accuracy of the angle of nystagmus onset in predicting the BAC of the subject. The study found that the correlation between the two is very high.

L. Goldberg, *Effects and After-Effects of Alcohol, Tranquilizers and Fatigue on Ocular Phenomena*, Alcohol and Road Traffic 123 (1963). Explores the different manifestations of positional alcohol nystagmus and compares them with gaze nystagmus. Also examines the effects of different variables, such as different alcoholic beverages and fatigue, on positional alcohol nystagmus.

Gregory W. Good & Arol R. Augsburger, *Use of Horizontal Gaze Nystagmus as a Part of Roadside Sobriety Testing*, 63 Amer. J. Optometry & Physiological Optics 467 (1986). Studying the training procedures of the Ohio Highway Patrol regarding the standardized field sobriety test battery and examining the accuracy of the HGN test in indicating whether a subject BAC is over .10.

K.J. Goulden et al., *Clinical Valproate Toxicity Induced by Acetylsalicylic Acid*, 37 Neurology 1392 (1987).

Svenja Gremmler & Markus Lappe, *Saccadic Suppression During Voluntary Versus Reactive Saccades*, 17 J. of Vision 1 (2017).

Eric Halperin & Robert L. Yolton, *Is the Driver Drunk? Oculomotor Sobriety Testing*, 57 J. Am. Optometric Ass'n 654 (Sept 1986). Informational article about the DUI laws, the SFST battery and HGN in particular. Cautions that HGN may be evident in a small number of subjects without the influence of alcohol and suggests that this fact should be noted in the subject's optometric records.

Appendix C

Douglas H. Harris, *Visual Detection of Driving While Intoxicated*, Human Factors, Vol. 22, No. 6, 725–732 (1980).

P. Helzer, *Detecting DUIs Through the Use of Nystagmus*, Law and Order 93 (Oct. 1984).

Ronald J. Hill, William E. Collins, & David J. Schroeder, *Influence of Alcohol on Positional Nystagmus Over 32-Hour Periods*, 82 Ann. Otology, Rhinology, & Laryngology 103 (1973).

V. Honrubia et al., *Experimental Studies on Optokinetic Nystagmus*, 65 Acta Oto-laryngologica 441 (1968).

Te-Long Hwang et al., *Reversible Downbeat Nystagmus and Ataxia in Felbamate Intoxication*, 45 Neurology 846 (April 1995). Reporting a case of a man exhibiting downbeat nystagmus (nystagmus only seen in the primary eye position; usually suggests a dysfunction in the brain) and concluding that the nystagmus was due to felbamate toxicity (a poisonous amount of an anti-epileptic drug).

A.W. Jones & A. Neri, *Age-Related Differences in the Effects of Ethanol on Performance and Behaviour in Healthy Men*, 29 Alcohol & Alcoholism 171 (1994). This study measured the possible differences of alcohol impairment between men of different ages by using a series of coordination and clinical tests, of which positional alcohol nystagmus was one. The study found that there is no significant difference of alcohol impairment between men aged 20–59.

Peter W. Kaplan & Ronald Tusa, *Neurophysiologic and Clinical Correlations of Epileptic Nystagmus*, 43 Neurology 2508 (Dec. 1993). Explores the causes and manifestations of epileptic nystagmus.

Byron L. Lam, H. Stanley Thompson, & James J. Corbett, *The Prevalence of Simple Anisocoria*, 104 Am. J. Ophthalmology 69 (1987).

H. Lehti, *The Effect of Blood Alcohol Concentration on the Onset of Gaze Nystagmus*, 13 Blutalkohol 411 (1976). Examining methods of measuring gaze nystagmus in order to determine the simplest effective method.

R. John Leigh & David Zee, *The Neurology of Eye Movements*, 191–201 (1983). Discussion of different types of oculomotor disorders that effect eye movement. Contains a chart listing different types of nystagmus, their manifestations and possible causes.

Lehtinen et al., *Acute Effects of Alcohol on Saccadic Eye Movements*, 63 Psychopharmacology 17 (1979).

J. Levett & L. Karras, *Effects of Alcohol on Human Accommodation*, Aviat. Space, Environment Med., 434–437 (1977).

D. Levy et al., *Smooth Pursuit Eye Movements: Effects of Alcohol and Chloral Hydrate*, 16 Psychiatric Res. 1 (1981).

Appendix C

Craig Liden et al., *Phencyclidine: Nine Cases of Poisoning*, 234 J. Amer. Med. Ass'n 513 (Nov. 1975) (selected sections). Examining the effects of phencyclidine on the body. States that horizontal, vertical and rotational nystagmus are all indicators of phencyclidine in the body.

V. Manak, *Voluntary Saccadic Eye Movements in a Forced Visual Task*, 19 Activ. Nerv. Sup. 193 (1977). Replicating the effects of passing headlights on the eyes of a driver, finding that there is a lengthening of saccadic eye movement.

Donald Mattus, *Boating Under the Influence*, 7 The DRE 2 (Summer 1995). Advocating the use of the HGN test to determine the BACs of boaters.

James McKnight et al., *Sobriety Tests for Low Blood Alcohol Concentrations*, 34 Accident Analysis and Prevention 305 (2002).

J.W. Metz & R.F. Balliet, *Visual Threshold: Human Scotopic Luminosity Functions Determined with Optokinetic Nystagmus*, 13 Vision Res. 1001 (1973).

Y. Mizoi et al., *Diagnosis of Alcohol Intoxication by the Optokinetic Test*, 30 Q.J. Stud. on Alcohol 1 (Mar.June 1969).

K.E. Money & W.S. Myles, *Heavy Water Nystagmus and Effects of Alcohol*, 247 Nature 404 (Feb. 1974). Researching various elements and causes of positional alcohol nystagmus.

H.B. Murphree et al., *Effect of Congeners in Alcohol Beverages on the Incidence of Nystagmus*, 27 Q.J. Stud. on Alcohol 201 (June 1966). (Congeners are organic molecules found in varying amounts in alcoholic beverages.)

Nathan et al., E*ffects of Congeners Differences in Alcohol Beverages on the Behavior of Alcoholics*, 5 Q.J. Stud. on Alcohol 87 (May 1970). (Congeners are organic molecules found in varying amounts in alcoholic beverages.)

Nuotto et al., *Naloxone Ethanol Interaction in Experimental and Clinical Situations*, 54 Acta Pharmacol. Toxicol. 278 (1984). (Naloxone is a narcotic antagonist that is used in the management and reversal of overdoses caused by narcotics.)

C.O. Nylen, *Positional Nystagmus: A Review and Future Prospects*, J. Laryngology and Otology 295 (June 1950).

W.J. Oosterveld, *Effect of Gravity on Positional Alcohol Nystagmus (PAN)*, 41 Clinical Aviation and Aerospace Med. 557 (May 1970).

W.J. Oosterveld & W.D. Van Der Laarse, *Effect of Gravity on Vestibular Nystagmus*, 40 Aerospace Med. 383 (1969).

W.J. Oosterveld et al., *Quantitative Effect of Linear Acceleration on Positional Alcohol Nystagmus*, 45 Aerospace Med. 695 (July 1974).

Appendix C

D. Paige, S*enescence of Human Visual-Vestibular Interactions: Smooth Pursuit, Optokinetic, and Vestibular Control of Eye Movements with Aging*, 98 Exp. Brain Res. 355 (1994) (selected sections). Examining the deterioration of smooth pursuit with advancing age.

C. Denise Pensyl & William J. Benjamin, *Borish's Clinical Refraction*, ch. 10, "Ocular Motility," 335 (1998).

Antti Penttila & Martti Tenhu, *Clinical Examination as Medicolegal Proof of Alcohol Intoxication*, 16 Med., Sci. and the Law 95 (April 1976). Conducting a clinical examination of a variety of tests used to determine the degree of intoxication of the subject. Nystagmus is one of those tests.

Antti Penttila et al., *Nystagmus and Disturbances in Psychomotor Functions Induced by Psychotropic Drug Therapy*, Psychiat. Fenn. 315 (1974).

Antti Penttila et al., *Examination of Alcohol Intoxication in Cases of Suspected Drunken Drivers II*, Liikenneturva, Iso Roobertinkatu 20, 00120 Helsinki 12, Finland (1974).

Antti Penttila et al., *Clinical Examination for Intoxication in Cases of Suspected Drunken Driving*, Statistical and Research Bureau of TALJA, Iso Roobertinkatu 20, Helsinki 13, Finland (1971).

Police Praise Test for Drunkenness, N.Y. Times, Jan. 3, 1988. Newspaper article reporting on the use of the HGN test by police officers.

Martina Poletti & Michele Rucci, *Eye Movements Under Various Conditions of Image Fading*, 10 J. Vis. 1 (2010).

Amy J. Porath-Waller and Douglas J. Beirness, *An Examination of the Validity of the Standardized Field Sobriety Test in Detecting Drug Impairment Using Data from the Drug Evaluation and Classification Program*, Traffic Injury Prevention (2014).

C. Rashbass, *The Relationship Between Saccadic and Smooth Tracking Eye Movements*, 159 J. Physiol. 326 (1961) (selected sections). Examining whether saccadic and smooth tracking eye movements are independent or part of the same system. Author uses barbiturates and its effects on the two eye movements in determining the relationship.

Steven D. Rauch, *Clinical Hints and Precipitating Factors in Patients Suffering from Meniere's Disease*, 43 Otolaryngol Clin N Am 1011 (2010).

Donald Chalmas Reynolds, *The Validity of a Screening Test*, 59 Am. J. of Optometry & Physiological Optics 67 (1982).

Jack E. Richman & John Jakobowski, *The Competency and Accuracy of Police Academy Recruits in the Use of the Horizontal Gaze Nystagmus Test for Detecting Alcohol Impairment*, 47 New Eng. J. Optometry 5 (Winter 1994). Examining the ability of newly-trained police officers in the horizontal gaze nystagmus test to detect impaired drivers. The study found that the newly-trained officers were correct over eighty-seven percent of the time in detecting subjects under the influence of alcohol.

Appendix C

David A. Robinson, *Eye Movement Control in Primates*, 161 Science 1219 (Sept. 1968). Examining the four oculomotor subsystems—smooth pursuit, saccadic, vestibular and vergence.

Nagint Sarvananthan et al., *The Prevalence of Nystagmus: The Leicestershire Nystagmus Survey*, 50 Investigative Ophthalmology & Visual Science 5201 (2009).

K. Savolainen et al., *Effects of Xylene and Alcohol on Vestibular and Visual Functions in Man*, Scan J. Work Environ. Health 94 (Sweden 1980).

D.J. Schroeder, *Effects of Alcohol on Nystagmus and Tracking Performance During Laboratory Angular Accelerations About the Y and Z Axes*, 44 Aerospace Med. 477 (1973).

Seelmeyer, Nystagmus, *A Valid DUI Test*, Law and Order 29 (July 1985).

James Sharpe et al., *Familial Paralysis of Horizontal Gaze*, 25 Neurology 1035 (Nov. 1975). Studying the hereditary nature of scoliosis, facial paralysis and horizontal pendular nystagmus.

Jeffrey Slapp, *The DUI Case Preparation Manual for the Florida Law Enforcement Officer*, Institute of Police Technology and Management 14 (1996 ed.). Overview for law enforcement of HGN and other types of nystagmus and eye disorders. Also covers the administration of the HGN test.

John S. Stahl, Gordon T. Plant, & R. John Leigh, *Medical Treatment of Nystagmus and Its Visual Consequences*, 95 J. of the Royal Society of Medicine 235 (2002).

June Stapleton et al., *Effects of Alcohol and Other Psychotropic Drugs on Eye Movements*, 47 Q.J. Stud. on Alcohol 426 (1986). Exploring various regions of the brain that alcohol may have an influence upon in order to effect eye movement. These eye movements may not only be indicative of alcohol and other drug impairment, but the effect that alcohol and other drugs have on these eye movements may impair the subject's ability to see.

Jack Stuster, *The Standardized Field Sobriety Test Battery: A Summary of Issues*, Impaired Driving Update, Vol. 9, No. 3–4, 63–70, 75–76, 89–92 (2005).

Jack Stuster, *Validation of the Standardized Field Sobriety Test Battery at 0.08% Blood Alcohol Concentration*, Human Factors, Vol. 48, No. 3, 608–614 (Fall 2006).

Martti Tenhu & Antti Penttila, *The Value of Nystagmus Tests in the Practical Examination of Suspected Drunken Drivers*, 8 Forensic Science 199 (1976). Study showing significant correlation between the existence of nystagmus and the subject's impairment.

Van Tharp et al., *Limited Field Testing of a Standardized Sobriety Test Battery*, Proceedings, Conference of the Am. Ass'n of Automotive Med. (1981). Concluding that, based on a limited field test, the standardized field sobriety test battery is highly effective in detecting impaired drivers.

Appendix C

Van Tharp et al., *Circadian Effects on Alcohol Gaze Nystagmus*, Paper Presented at the 20th Annual Meeting of Society for Psychophysiological Research (abstract in 18 Psychophysiology (March 1981)).

H. Tianwu et al., *Effects of Alcohol Ingestion on Vestibular Function in Postural Control*, 519 Acta Oto-laryngol 127 (Sweden 1995). Study concluding that alcohol affects not only the oculomotor system but the vestibular system as well.

David J. Tiffany, *Optometric Expert Testimony: Foundation for the Horizontal Gaze Nystagmus Test*, 57 J. Am. Optometric Ass'n 705 (1986). Legal article written to assist optometrists and other experts preparing to testify about the HGN test in criminal prosecutions.

James Unsworth, *The Eyes Have it: HGN Review and Update*, 3 The DRE 4 (July/Aug. 1991). Addressing possible cross-examination questions that law enforcement officers may face on the stand regarding their administration of the HGN test and appropriate responses. Also addresses several common defense arguments that both law enforcement and prosecutors should be aware of regarding the HGN test and possible responses to those arguments.

Dan Watson & Richard Studdard, *Gaze Nystagmus and Psychophysical Testing*, Proceedings, International Symposium, Driving Under the Influence of Alcohol and/or Drugs, Federal Bureau of Investigation, Quantico, VA (1986). Overview of psychophysical testing written by law enforcement to detect drug and alcohol impairment, with some focus on gaze nystagmus.

Chad A. Whyte, Anne Marie Petrock, & Michael Rosenberg, *Occurrence of Physiologic Gaze-Evoked Nystagmus at Small Angles of Gaze*, 51 Investigative Ophthalmology & Visual Science 2476 (2010).

Dale Whiting, *State v. Witte, Questioning HGN's Frye General Acceptance Under Blake*, 5 The DRE 7 (Spring 1993). Legal article analyzing *Kansas v. Witte* and the studies used by the court to reach its decision. Article concludes that the *Witte* court was incorrect in holding that the relevant scientific community does not generally accept the HGN test and based its decision on legal, rather than scientific, articles.

I.M.S. Wilkinson et al., *Alcohol and Human Eye Movement*, 97 Brain 785 (1974). Studying the effects of alcohol on eye movement and concluding that there is "no doubt that alcohol has a profound effect on eye movement."

D.S. Zee et al., *The Mechanisms of Downbeat Nystagmus*, 30 Arch Neurol. 227 (March 1974) (one-page chart).

V. Zikmund & F. Jagla, *Changes in the optokinetic nystagmus cessation limit under the influence of ethanol and caffeine*, 31 Activ. Nerv. Super 223 (1989).

Vera C. Zingler et al., *The Effect of Nicotine on Perceptual, Ocular Motor, Postural, and Vegetative Functions at Rest and in Motion*, 254 J. of Neurology 1689 (2007).

Zyo, *Medico-legal and Psychiatric Studies on the Alcohol Intoxicated Offender*, 30 Japanese J. Legal Med. 169 (1976).

Appendix C

PUBLICATIONS CRITICAL OF HGN

Stephanie E. Busloff, *Can Your Eyes be Against You? The Use of the Horizontal Gaze Nystagmus Test in the Courtroom*, 84 The J. Crim. L. & Criminology 203 (1993). Attorney-written article criticizing the use of HGN as a roadside sobriety test.

Spurgeon Cole & Ronald Nowaczyk, *Field Sobriety Tests: Are They Designed for Failure?*, 79 Perceptual and Motor Skills 99 (1994). Studying the ability of law enforcement to detect a subject's impairment by watching videotapes of several sobriety tests. The HGN test was not among the tests given on the videotapes.

Jonathan Cowan & Susannah Jaffee, *Field Sobriety Tests: The Flimsy Scientific Underpinnings*, 5 DWI J. 1 (Dec. 1990). Excerpted from Cowan & Jaffee, *infra*.

Jonathan Cowan & Susannah Jaffee, *Proof and Disproof of Alcohol-Induced Driving Impairment Through Evidence of Observable Intoxication and Coordination Testing*, 9 Am.J.Proof of Facts 3d 459 (1990). A critical look at the development of the standardized field sobriety test battery.

L.F. Dell'Osso, *Nystagmus, Saccadic Intrusions/Oscillations and Oscillopsia*, in 2, Current Neuro-Ophthalmology (L. Simmons & J.T.W. van Dalen eds. 1990).

Richard Erwin, *1 Defense of Drunk Driving Cases*, §§ 8A:06, 8A:08 (3d ed. 1992).

Charles R. Honts & Susan L. Amato-Henderson, *Horizontal Gaze Nystagmus Test: The State of the Science in 1995*, 71 N.D. L. Rev. 671 (1995).

D. Nichols, *2 Drinking/Driving Litigation*, § 26:01 (1991 & 1992 Supp.). Attorney-written analysis of the use of alcohol gaze nystagmus as a test for evaluating suspected drinking drivers.

Jim Norris, *The Correlation of Angle of Onset of Nystagmus with Blood Alcohol Level: Report of a Field Trial*, California Ass'n Criminalistics Newsletter 21 (June 1985). Studying the reliability of determining BAC based on the angle of onset of HGN prior to forty-five degrees.

William A. Pangman, *Horizontal Gaze Nystagmus: The New Drunk Driving Alchemy*, 11 The Champion 6 (April 1987). Reprint from Pangman, *infra*.

William A. Pangman, *Horizontal Gaze Nystagmus: Voodoo Science*, 2 DWI J. 1 (March 1987). Attorney-written analysis of the use of HGN evidence in the prosecution of impaired drivers.

Mark Rouleau, *Unreliability of the Horizontal Gaze Nystagmus Test*, 4 Am.J.Proof of Facts 3d 439 (1990). Attorney-written critique of the use of HGN evidence in the prosecution of impaired drivers.

Yoshio Umeda & Eiji Sakata, *Alcohol and the Oculomotor System*, 87 Annals of Otology, Rhinology & Laryngology 392 (May-June 1978). Determining that HGN is the last type of eye movement to manifest itself (compared with caloric eye tracking pattern, PAN and eye tracking abnormalities) after the ingestion of alcohol.

APPENDIX D
American Optometric Association HGN Resolution

American Optometric Association
243 N. Lindbergh Blvd. • St. Louis, MO 63141 • (314) 991-4100
FAX: (314) 991-4101

The American Optometric Association ("AOA") has adopted a Resolution to recognize the validity and reliability of the Horizontal Gaze Nystagmus (HGN) Test as a component of a Standard Field Sobriety Test when administered by properly trained and certified police officers and when used in combination with other evidence. Following extensive and in-depth review during 2010 and 2011, the AOA's House of Delegates passed the Resolution by majority vote at the House of Delegates session on June 18, 2011 during AOA's annual meeting in Salt Lake City, Utah. The text of the Resolution is below. With the adoption of the Resolution, Optometry once again demonstrates that it is the relevant scientific and/or medical community with regard to the HGN Test, and AOA confirms that it supports Optometrists as consultants for the law enforcement community's efforts to improve public health, safety, and welfare by identifying and reducing the number of impaired drivers on the nation's roadways. Questions or comments can be addressed to the American Optometric Association, 243 N. Lindbergh Blvd., St. Louis, MO 63141.

AOA HOD RESOLUTION 1901
HORIZONTAL GAZE NYSTAGMUS AS A FIELD SOBRIETY TEST

WHEREAS, drivers under the influence of alcohol pose a significant threat to the public health, safety, and welfare; and

WHEREAS, optometric scientists and the National Highway Traffic Safety Administration have shown the Horizontal Gaze Nystagmus (HGN) test to be a scientifically valid and reliable tool for trained police officers to use in field sobriety testing; now therefore be it

RESOLVED, that the American Optometric Association acknowledges the scientific validity and reliability of the HGN test as a field sobriety test when administered by properly trained and certified police officers and when used in combination with other evidence; and be it further

RESOLVED, that the American Optometric Association supports doctors of optometry as professional consultants in the use of HGN field sobriety testing.

APPENDIX E
Predicate Questions: Arresting/SFST Officer

1. State your name for the record.
2. Where are you employed?
3. What is your current assignment with the police department?
4. How long have you been assigned to traffic patrol?
5. Were you on duty _____ (date)?
6. Did you stop a _____ (description of car)?
7. When you walked up to the car what did you see?
8. Did you notice anything else about the defendant?

   NOTE: There may be several foundation questions or questions surrounding the stop that a prosecutor may want to ask the officer. This list of predicate questions is strictly to assist with the admission of the HGN test at trial. A prosecutor may want to develop his own questions for other areas of examination.

   NOTE: Many officers also have paramedic or emergency medical technician training (EMT). A prosecutor should be sure to ask if the officer was trained to look for nystagmus as a part of any paramedic or EMT training. If so, he should be sure to examine the officer on this training and experience.

9. Did you ask the defendant to perform field sobriety tests?
10. What are field sobriety tests?
11. Were you trained in administering these tests?
12. Officer, I want to ask you specifically about a test known as horizontal gaze nystagmus or HGN. Are you familiar with this test?
13. What part of the body are you observing when you give this test?
14. Have you received specific training in the administration of the HGN test?
15. What is HGN?
16. Where did you receive your training in the administration of the HGN test?

Appendix E

17. How many hours of training did you receive?
18. When did you receive this training?
19. Who were the instructors?
20. Was there an alcohol workshop as part of your training?
21. What is an alcohol workshop?
22. So, you know at the workshop that people have probably been drinking. Do you know how much an individual has had to drink before you test him/her?
23. Do all the subjects at the alcohol workshop drink?
24. Do you know before administering the field sobriety tests whether a subject has been drinking or not?
25. Other than the alcohol workshops, have you given the HGN test to persons that you knew were sober?
26. Under what circumstances?
27. What differences have you observed in the eye movements of sober persons vs. impaired persons in doing this exercise?
28. When you learned the HGN test, were you required to pass a practical skills examination?
29. Please describe this examination.
30. As a result of your training, did you receive any certificates?
31. From what organization(s) did you receive this certificate?
32. Do you have this certificate here today?

    NOTE: If a prosecutor wishes to have the certificate entered into evidence, he should be sure to have a photocopy to submit. The officer should bring the original in case there are questions about authenticity, however, enter the photocopy into evidence. Otherwise, the officer may not get the certificate back for months.
33. Have you had any additional training in the administration of the HGN test other than that which you have just described?
34. Please describe that training.
35. Approximately how many times have you given the HGN test?
36. Do you keep a log of the times you have administered the HGN test?

    (This is not required, and the officer may not maintain a log. Be sure to check this in advance.)

37. What is your purpose in maintaining this log?
38. Officer, based on your training and experience, is the presence of HGN a reliable indicator that a person has consumed alcohol?
39. Is there a standard way in which the test for HGN should be given?
40. Please describe the test.

    NOTE: A prosecutor may want to offer as demonstrative evidence a videotape of the HGN test. However, some courts may find such evidence too prejudicial.
41. What specifically are you looking for when you administer this test?
42. Did you give the test to the defendant in the same way that you have described?
43. Did you ask the defendant if s/he understood what s/he was supposed to do?
44. Did s/he indicate that s/he understood?
45. Did the defendant have any difficulty in following your directions?
46. Officer, I would like to ask you about the six clues you previously testified that you are looking for when you give this test. What is the first clue of the HGN test?

    (Lack of smooth pursuit)
47. Can you describe for the jury what you mean by a lack of smooth pursuit?
48. When you gave this part of the test to the defendant, what did you see?
49. What is the second clue of the test?

    (Distinct nystagmus at maximum deviation)
50. How long do you hold the stimulus at the point of maximum deviation?
51. Why?
52. When you gave this part of the test, what did you see?
53. What is the final part of this test?

    (Angle of onset)
54. How is this part of the test done?
55. How do you estimate the angle of onset?
56. When you gave this part of the test to the defendant, what did you see?

57. What did your observations of the defendant's performance on this test indicate to you?

    NOTE: If the court has determined that HGN is admissible only on the issue of probable cause, the officer's testimony will be limited to his observations and opinion that the test results gave him reason to continue with the investigation. However, if the court allows HGN evidence as substantive evidence of impairment and allows the officer to testify about the correlation between HGN and impairment, continue with the following questions:

58. In your experience, is there a connection between horizontal gaze nystagmus and the amount of alcohol a person has consumed?

59. What is that connection?

    NOTE: A prosecutor should be clear before trial that he is not asking the officer to indicate that a specific angle of onset equals a specific BAC. The information sought is that people who have been drinking tend to show nystagmus and the more they have had to drink, the easier the nystagmus is to see. A prosecutor may even have a judge allow the officer to state that the earlier the angle of onset, the higher the BAC but a prosecutor should be careful not to sound as if a numeric correlation is being made.

60. Officer, are the clues you saw when you administered the test to defendant indicative of alcohol impairment?

61. Based on your training and experience, what does the presence of all six clues indicate?

62. And how many clues did you see when you gave the test to the defendant?

Although HGN is the most effective and reliable field sobriety test, do not allow the defense to turn the trial into a referendum on HGN. The HGN test is only one of many pieces of evidence that the prosecution has to prove that the defendant was impaired. It will be a rare case where the police have no evidence other than the results of the HGN test.

APPENDIX F
Predicate Questions: Researcher in the Area of Alcohol Impairment

EVIDENTIARY HEARING

Prior to the evidentiary hearing, a prosecutor should submit as part of the Memorandum of Points and Authorities, copies of any articles he wants the court to consider. He should be sure to have copies of any studies or articles about which he intends to question the witness. The NHTSA study, as well as other validation studies, should be marked and entered into evidence through the witness. If these studies were submitted previously as part of his memorandum, however, he should be sure to note on the record that the studies were submitted as attachments to the memorandum and are part of the court file.

1. Please state your name for the record.
2. What is your occupation?
3. By whom are you currently employed?
4. How long have you been employed in this field?
5. Please explain the nature of your work.
6. Do you specialize in studying a particular subject?
7. What is your educational background?
8. Are you a medical doctor?
9. Do you belong to any professional organizations?
10. Please tell the court what those organizations are.
11. How does one become a member of those organizations?
12. As a result of your research, have you written articles or research studies?
13. Have any of your articles or studies been published?

14. Please name some of your publications and where the material has been published.

    NOTE: The expert's curriculum vitae (CV) should be marked and offered into evidence. The CV will generally include a list of publications and presentations. If not, the expert should prepare a list of publications and presentations to attach.

15. Are these articles peer reviewed before publication?

16. Please explain what it means to have an article "peer reviewed".

17. Have you given presentations on the results of your research findings?

18. Please tell us some of the organizations to which you have given presentations.

19. How long have you been working in your current position?

20. What are your responsibilities?

21. Have you testified in court before on the horizontal gaze nystagmus (HGN) field sobriety test?

22. Have you been qualified as an expert in court on the HGN test?

23. How many times?

24. In what courts or states?

25. Approximately how many times have you testified on HGN?

    NOTE: If you have not already done so, move to have the witness recognized as an expert.

26. Are you familiar with the research that has been done regarding field sobriety testing (FST)?

27. Specifically, are you familiar with the research conducted by the Southern California Research Institute (SCRI) for the National Highway Traffic Safety Administration (NHTSA)?

28. How many studies on FSTs has SCRI conducted for NHTSA?

29. Have you read all of those studies?

30. Are you familiar with the FST known as horizontal gaze nystagmus?

31. What is horizontal gaze nystagmus?

32. How did you become familiar with the HGN test?

33. Were you aware of the use of the HGN test in law enforcement agencies prior to your study of it?

34. Do you know how HGN came into use as an FST prior to SCRI's research?

35. You testified previously that SCRI did three studies for NHTSA on field sobriety tests. When was the first study conducted?

36. What was the purpose of the first study?

    NOTE: If the 1977 NHTSA study has not been previously introduced into evidence, it should be marked and entered into the record as an exhibit. Otherwise, it should be noted for the record that it was previously submitted.

37. As a result of this study, was a recommendation made regarding a specific battery of tests that should be given by police officers to determine a suspect's level of impairment?

38. What were the tests recommended by SCRI?

39. Were these tests later adopted by NHTSA as its standard battery of field sobriety tests?

40. Please describe the methods used in determining that these three tests were the best at assessing alcohol impairment.

41. Referring specifically to the HGN test, what were the conclusions about its usefulness as a field sobriety test?

42. When was the second study for NHTSA done?

    NOTE: It is recommended the prosecutor follow the same procedure for admission of the 1981 study as described above (following question 36).

43. What was the purpose of the second study?

44. What methodology was used in conducting the second study?

45. In the 1981 study, were the officers trained in the use of the HGN test before the study?

46. How were they trained to administer the test?

47. What was the criteria for assessing the results of the study?

48. What were the results of the second study?

49. Could you explain what you mean by a "correct" decision?

50. What was the BAC level that was used in this study to determine if the officer's arrest decision was correct?

51. Would a decision to not arrest a suspect who later tested at a .10 BAC or greater be scored as incorrect under the criteria of the study?

52. Would a decision to arrest someone who was not at a .10 BAC or greater also be incorrect under the criteria of the study?

53. Based on the two studies conducted for NHTSA, were conclusions drawn about the accuracy of the HGN test?
54. What are those conclusions?
55. Was SCRI involved in any other studies for NHTSA regarding the field sobriety tests?
56. Do you know what the purpose of the 1983 study was?
57. Have you read the 1983 study?
58. Are you familiar with the contents of the study?

    NOTE: Mark and move for admission the 1983 study as explained above (after question 36).
59. How was the 1983 study conducted?
60. What did the study conclude?
61. Are you familiar with the 1995 Colorado Validation Study?

    NOTE: Mark and move for admission the 1995 Colorado Validation Study (as described previously).
62. What did that study conclude?
63. How is the HGN test administered?
64. Is the procedure for administering the test currently used by police officers the same as the procedure that was tested?
65. What are the specific clues the officer is looking for in administering the HGN test?
66. Please explain what you mean by a “lack of smooth pursuit.”
67. What is “maximum deviation”?
68. What is meant by the “angle of onset”?
69. How does an officer determine the angle of onset?
70. Have you been involved with any training programs for officers in administering the HGN test?
71. What has been your involvement?
72. How long does it take to train a police officer to administer and accurately interpret the HGN test results?
73. Are you familiar with the training procedure recommended by NHTSA?

74. Have you seen officers administer the HGN test in the field under actual working conditions?
75. Do you have an opinion about the ability of a police officer to administer the HGN test?
76. What is that opinion?
77. Do you have an opinion about an officer's ability to interpret the HGN test?
78. What is that opinion?
79. Does an officer need to understand the process by which alcohol ingestion creates nystagmus in order to properly administer and interpret the test?
80. Why not?
81. Are people able to voluntarily control nystagmus?
82. Does a person know that he has alcohol induced nystagmus?
83. Does a person's vision, such as nearsightedness, affect the ability to do the test?
84. Does the fact that the suspect may be wearing contact lenses affect the accuracy of the test results?
85. For purposes of clarification, we have been speaking about horizontal gaze nystagmus. Are there other types of nystagmus?
86. How did you become aware of the other types of nystagmus?
87. Could you explain what other types of nystagmus there are?
88. How does alcohol induced nystagmus appear to the observer?
89. What is the relationship of alcohol ingestion to horizontal gaze nystagmus?
90. You have testified previously about other forms of nystagmus. Does nystagmus occur naturally in some people?
91. Would a person with a natural nystagmus exhibit all six clues that the officer is looking for?
92. Have you reviewed the NHTSA manuals regarding the standardized field sobriety tests?
93. Are there conditions under which the HGN test should not be administered?
94. Can the test be given to a suspect who is sitting down?
95. Can it be given to a suspect who is laying down such as an individual who has been in a traffic crash?

96. Do you keep current on the literature involving the use of HGN as a field sobriety test?
97. Are there any studies which refute your findings as reported in the NHTSA studies of 1977? 1981? 1983?
98. Are you aware of any scientific publications which refute the findings?
99. Are there any scientific publications which dispute the connection between alcohol consumption and horizontal gaze nystagmus?
100. Do you have an opinion as to what fields of study or professions would be interested in the use of the HGN test as a measure of alcohol impairment?
101. Are there other drugs in addition to alcohol which cause HGN?
102. Are these also impairing drugs?

TRIAL

The testimony of the expert at trial does not need to be as extensive as that for the evidentiary hearing. At the evidentiary hearing, the court should have ruled on the admissibility of the HGN test. At trial, there should be enough testimony to establish the witness' credibility and foundation for the expert opinion. After laying the foundation, the expert should give his opinion as early as possible. Do not bore the jury with a lot of meaningless detail. Be sure that the testimony of the experts and exhibits from the evidentiary hearing are part of the court record in the event of an appeal.

1. Please state your name for the record.
2. What is your occupation?
3. How long have you been employed in this field?
4. Where are you currently employed?
5. Please explain the nature of your work.
6. What is your educational background?
7. Do you belong to any professional organizations?
8. Please tell us what they are.
9. Have you authored any publications, specifically dealing with the effects of alcohol on the human body?
10. Have you authored any publications on field sobriety testing?
11. What are field sobriety tests?

12. What is their purpose?
13. Have your publications on FSTs been published in "peer reviewed" journals?
14. Can you describe for the jury what it means to have an article published in a "peer reviewed" journal?
15. Have you been asked to give presentations to any professional organizations on the effects of alcohol?
16. Please tell us when and to whom these presentations were given.
17. Have you given presentations on field sobriety testing?
18. Please tell us when and to whom these presentations were given.
19. How long have you been working in your current position?
20. Are you familiar with the research conducted for the National Highway Traffic Safety Administration (NHTSA) regarding field sobriety testing?
21. Who did NHTSA fund to conduct the FST research?
22. What was the purpose of these studies?
23. How many field sobriety test studies were conducted for NHTSA?
24. Please tell us when these studies were conducted.
25. I want to direct your attention to the field sobriety test known as the horizontal gaze nystagmus or HGN test. Are you familiar with this test?
26. How did you become familiar with the HGN test?
27. What is horizontal gaze nystagmus?
28. Was the HGN test being used by law enforcement agencies to determine that a suspect might be under the influence of alcohol before the 1977 NHTSA study was conducted?
29. Do you know how long the test had been in use by law enforcement prior to 1977?
30. How did the HGN test get selected as one of the tests to be studied?
31. What, if any, other studies were conducted by SCRI for NHTSA regarding FSTs.
32. Was the HGN test also researched as part of a 1981 research study?
33. What type of research was done for the 1981 study?
34. What type of research was done for the 1983 study?

NOTE: It is unnecessary to have the expert go into a long explanation about the NHTSA studies. Let the defense attorney bore the jury with all the details.

What is important is that the expert has extensively studied HGN, is familiar with the connection between alcohol and HGN, the HGN test is a reliable indicator of alcohol consumption, and that police officers are qualified to administer and interpret the test.

35. Do you know what the National Highway Traffic Safety Administration did with the results of the 1977, 1981, and 1983 studies?

36. Have you been involved in any training programs for officers in the administration and interpretation of HGN test results?

37. Is the HGN test as currently given by the police, the same as the test that was studied by SCRI for NHTSA?

    NOTE: If not already done, the prosecutor should move the court to qualify the witness as an expert. In most jurisdictions, an expert may rely on hearsay evidence in forming an opinion. The expert may also give an opinion about the ultimate issue.

38. Did any of this training involve observing the officers administering the HGN test out on the roadside under the officer's actual working conditions?

39. How long does it take to train someone to administer and interpret the test?

40. How is the test administered?

41. What specifically are the officers looking for?

42. Please describe what is meant by "maximum deviation".

43. What is meant by a "lack of smooth pursuit"?

44. What is the purpose for determining an angle of onset?

45. How is the angle determined?

46. Can the angle be accurately determined without a measuring device?

47. Does an officer need to know why drinking alcohol causes nystagmus in order to properly administer the test and interpret the results?

48. Why not?

49. Can a person voluntarily control nystagmus?

50. In your experience, is nystagmus visible in persons who have not been drinking alcohol?

51. Do other drugs cause nystagmus?

52. Are these drugs impairing?

53. Do contact lenses have an effect on the HGN test results?

54. Does poor vision have an effect on the HGN test results?

Appendix F

55. Are there other causes of nystagmus?
56. Do some people have nystagmus naturally?
57. Is a natural nystagmus the same as horizontal gaze nystagmus?
58. Would a person with a natural nystagmus exhibit the six clues that the officer is looking for?
59. Do you keep current on the literature involving field sobriety testing?
60. Do you keep current on the literature involving the HGN test specifically?
61. Are you aware of any scientific publications that dispute the validity of the HGN test as a measure of alcohol impairment?
62. Do you have an opinion as to the ability of a properly trained police officer to administer and interpret the HGN test?
63. What is that opinion?
64. Do you have an opinion as to the validity of HGN test as a measure of an individual's impairment by alcohol?
65. What is that opinion?
66. Upon what do you base your opinions?

APPENDIX G
Predicate Questions: SFST Instructor

This is a sample of a generic examination of an SFST instructor. Each officer may have slightly different qualifications. The advantage of calling an instructor in addition to the officer who administered the test to defendant is the instructor's ability to talk more extensively about the training and the widespread use of the HGN test.

1. Please state your name for the record.
2. Where are you employed?
3. How long have you been employed as a police officer?
4. What are your specific duties?
5. How long have you been involved in traffic enforcement?
6. Have you had any specialized training beyond that of a regular police officer in impaired driving enforcement?
7. Please describe that training.
8. What are the standardized field sobriety tests?
9. How long has the standardized test battery been in use in this jurisdiction?

   (Check in advance to determine whether the witness knows the answer to this question.)
10. Approximately how many people have you administered the SFSTs to in the past _____ years?
11. Are you certified as a standardized field sobriety test instructor?
12. By whom are you certified?
13. How long have you been an SFST instructor?
14. How many SFST courses have you taught?
15. For whom have these courses been taught?
16. What do you have to do to maintain your certification as an SFST instructor?

Appendix G

17. Is one of the tests that you teach the horizontal gaze nystagmus test?
18. Approximately how many officers have you taught to administer the HGN test?
19. How long have you personally been using the HGN test?
20. What specific training was given to you in administering the HGN test?
21. Are you familiar with the National Highway Traffic Safety Administration (NHTSA) studies regarding the SFSTs?
22. Are you a drug recognition expert (DRE)?
23. What is that?
24. How long have you been a DRE?
25. Are your certified?
26. By whom?
27. What must you do to maintain your certification?
28. Are you also a DRE instructor?
29. How long have you been a DRE instructor?
30. What must you do to maintain your certification as an instructor?
31. For whom have you taught?
32. When were those courses held?
33. Is the HGN test a part of the drug recognition evaluation?
34. Have you testified in court about the HGN test?
35. How many times?
36. Have you been qualified as an expert?
37. In what courts?

    NOTE: Move to have the witness qualified as an expert.

38. As an instructor, do you use the Standardized Field Sobriety Test Manual published by NHTSA?
39. Do you teach officers to administer and interpret the HGN test in accordance with the NHTSA instructions?
40. Have you administered the test to persons that you knew were impaired by alcohol?

41. How did you know prior to administering the test that the subject had been drinking?

42. Have you also given the test to persons that you knew had not been drinking?

43. How did you know that they had not been drinking?

44. Do you see any differences in the existence of nystagmus in those who you knew had been drinking as opposed to those you knew had not been drinking?

45. Have you administered the HGN test out on the street when you did not know whether the person had been drinking?

46. How often have you given the test in an actual arrest situation as opposed to a training setting?

47. Do you keep a log of the times you have administered the HGN test with your scoring of the suspect's results?

    NOTE: This is not required unless the officer is a DRE. Be sure to check with the witness in advance.

48. Do you also keep a log of the actual BAC these same suspects had as shown by a chemical test?

    NOTE: If the officer has a log, submit a copy into evidence after authenticating the copy. The officer may not get his original back if it is put in the court record. Although the evidence of the log and results should be admissible in the evidentiary hearing, the court may not allow it into evidence at trial as irrelevant and prejudicial. After all, this is not the officer who administered the test to the defendant.

49. In your experience, is the HGN test difficult to administer in the field?

50. Please describe how the test is given.

51. How do you estimate the angle of onset?

52. What if the suspect is unable to hold his head still?

53. Have you seen nystagmus in persons who were not impaired by alcohol or other drugs?

54. If a person has alcohol induced nystagmus, does s/he usually know it?

55. Can people voluntarily control nystagmus?

56. Do you have an opinion about whether police officers can be trained to accurately administer the HGN test?

57. What is that opinion?

58. Upon what is that opinion based?

59. Do you have an opinion as to whether police officers can accurately interpret the test results?

60. What is that opinion?

61. Upon what is that opinion based?

62. Do you have an opinion as to whether the HGN test is a reliable indicator of alcohol impairment?

63. What is that opinion?

64. Upon what is that opinion based?

    NOTE: Many police officers also have training as emergency medical technicians (EMT's) or paramedics. If so, be sure to ask the officer whether the use of the HGN test was taught as part of the training and whether s/he uses the test in his/her emergency medical response.

APPENDIX H
Predicate Questions: Optometrist

The testimony of an optometrist will be essentially the same whether at the evidentiary hearing or at trial. Review questions carefully in advance to determine which questions are applicable to your expert. In addition, the witness may suggest questions that should be asked, particularly if he has testified on other cases.

1. Please state your name for the record.
2. What do you do for a living?
3. What education is required for your profession?
4. Where did you go to undergraduate school?
5. What was your course of study?
6. Where did you go to optometry school?
7. Please tell the court about the curriculum in optometry school.
8. Did any of your course work involve the effects of alcohol on the central nervous system?
9. Describe that training.
10. Have you had additional professional training after optometry school on the effects of alcohol on the central nervous system?
11. Please describe that training.
12. Did you learn specifically about the effects of alcohol on eye movements?
13. Where are you employed?
14. What are your specific duties?
15. Does one have to be licensed as an optometrist?
16. By whom are you licensed?
17. Are you a medical doctor?
18. How does an optometrist differ from an ophthalmologist?

19. Do you belong to any professional organizations?
20. What are those organizations?
21. Have you received any professional recognition or awards from any of these organizations?
22. Have you done any clinical research into the effects of alcohol and/or other drugs on the central nervous system?
23. Has any of your research focused on the effect of alcohol on eye movements?
24. Have you published the results of your research?
25. Where has it been published?
26. Is that a "peer reviewed" journal?
27. What does it mean to be published in a "peer reviewed" journal?
28. In addition to your research results, have you published other articles?
29. Where have they been published?
30. Are these "peer reviewed" journals?
31. Are you affiliated with any teaching institutions?
32. Please tell the court what those are.
33. Are you involved in any consulting work?
34. What do you consult on?
35. How long have you been doing consulting?
36. Have you lectured on the effects of alcohol and/or drugs on eye movements?
37. To whom have you lectured?
38. When was that?

    NOTE: If you have not already done so, it would be appropriate to move the court to recognize the witness as an expert.

39. Are you familiar with the term nystagmus?
40. What is nystagmus?
41. Is nystagmus a topic that is covered in the literature relevant to the field of optometry?
42. Is nystagmus a newly discovered phenomenon?
43. Do you check for nystagmus in your practice?
44. Why?

Appendix H

45. What causes nystagmus?
46. How long has it been known that alcohol consumption causes nystagmus?
47. Are there other types of nystagmus?
48. Can they be distinguished from alcohol caused nystagmus?
49. Is nystagmus a phenomenon that occurs naturally in some people?
50. About what percentage of the population would have a naturally occurring nystagmus?
51. Can a person familiar with nystagmus distinguish alcohol induced nystagmus from a naturally occurring nystagmus?
52. How do you test for nystagmus in your profession?
53. To what extent does alcohol consumption affect nystagmus?
54. Is it accurate to say that the more alcohol that is consumed the more pronounced the nystagmus?
55. Is it difficult for someone to administer this test?
56. Does it require medical training to administer and interpret the results of a test for nystagmus?
57. Are there other drugs which cause nystagmus?
58. Would these also be drugs that impair a person's ability to drive?
59. Why do alcohol, central nervous system depressants, inhalants, and PCP cause nystagmus?
60. Are you familiar with the field sobriety test used by police officers known as horizontal gaze nystagmus?
61. What is the horizontal gaze nystagmus test?
62. How did you become familiar with this test?
63. What is the purpose for administering this test?
64. Have you seen police officers give this test?
65. Under what conditions?
66. Is the HGN test given by police officers like the test you use in your profession to test for nystagmus?
67. Do you have an opinion about whether a police officer can be trained to accurately administer and interpret the HGN test results?
68. What is that opinion?

Appendix H

69. On what is that opinion based?
70. What is meant by a “lack of smooth pursuit”?
71. Why would a lack of smooth pursuit be an important observation?
72. What is “maximum deviation”?
73. Is there any significance to the presence of nystagmus at maximum deviation?
74. What is meant by the “angle of onset”?
75. Why is it important to determine an angle of onset?
76. Is it accurate to say that the earlier the angle of onset, the higher the suspect’s blood alcohol level is likely to be?
77. Is it difficult to determine an angle of onset?
78. Can a person voluntarily control nystagmus?
79. Does a person know when they have alcohol induced nystagmus?
80. Do contact lenses affect the results of the HGN test?
81. Does poor eyesight affect the ability to do the HGN test?
82. Do you have an opinion as to whether the presence of nystagmus is a reliable indicator of the use of a central nervous system depressant, such as alcohol?
83. What is that opinion?
84. Upon what is that opinion based?
85. Are you aware of any scientific publications that state there is no correlation between alcohol consumption and the presence of nystagmus?
86. Are you a member of the American Optometric Association?
87. What is that organization?
88. Are you familiar with the 1993 or 2011 resolution “Horizontal Gaze Nystagmus as a Field Sobriety Test” passed by the House of Delegates of the American Optometric Association?
89. Is this a copy of the resolution?
90. Please read it to the court.

APPENDIX I
Predicate Questions: Emergency Room Physician

Several medical specialties use a form of nystagmus testing in diagnosing patients, for example, emergency room physicians, ophthalmologists, neuro-ophthalmologists. Although not necessary, the testimony of a medical expert supports the use of the HGN test in the broader community, not just law enforcement, and gives the weight of medicine to the validity of the test. It is preferable to use an expert with an interest in the subject beyond just testifying as an expert and who has actually witnessed officers administering the test.

NOTE: The following examination is intended only as a sample. It is adaptable to any medical expert you intend to call. Be sure to discuss the questions in advance with your expert to determine his ability to answer all questions. Delete those which are not appropriate for your expert. Depending on your expert's experience and training, there are many more questions you could ask to qualify the witness as an expert. Do not diminish your expert's credibility by underplaying the qualifications.

1. Please state your name for the record.
2. What is your occupation?
3. Where did you attend college?
4. What did you study?
5. Where did you go to medical school?
6. When did you graduate?

   NOTE: If the witness received any special recognition in medical school, e.g. valedictorian, be sure to ask about it.
7. What is your area of practice?
8. Is emergency room medicine a specialty?
9. Is there a board certification for ER medicine?
10. Are you board certified?
11. How long have you been an ER doctor?
12. Where are you currently employed?

13. How long have you been employed at _____?
14. Please describe what you do as an emergency room doctor?
15. As an ER doctor, are you required to be familiar with symptoms associated with other medical specialties?
16. Why is that?
17. Do you see many patients who are under the influence of alcohol or other drugs?
18. Approximately how many patients a week do you see that are under the influence of alcohol or other drugs?

    NOTE: If you have not already done so, this would be an appropriate time to move the court to recognize the witness as an expert. If the witness has testified in court previously about HGN, be sure to ask when, how often, what courts, and whether the witness was qualified as an expert?
19. What are the symptoms of alcohol impairment?
20. Are you familiar with the term "horizontal gaze nystagmus"?
21. When did you first become aware of HGN?
22. Is HGN a valid medical phenomenon?
23. Please explain what horizontal gaze nystagmus is.
24. Do doctors test for the presence of HGN?
25. How long has HGN testing been in use in the medical community?
26. Do you ever test for the presence of HGN in the emergency room?
27. How often?
28. How do you test for it?
29. Is HGN difficult to identify?
30. What is your purpose in looking for HGN?
31. Are you trained in the effects of alcohol and/or other drugs on the central nervous system?
32. What effect does alcohol have on the presence of HGN?
33. Is it necessary to be a doctor or have medical training to identify HGN?
34. Can non-medical people be trained to identify HGN?
35. Have you ever trained anyone to detect HGN?
36. About how long did it take?

37. Can police officers be trained to test for HGN?

    NOTE: Ideally your witness is familiar with the HGN test administered by police through personal observation. If not, be sure that he has had adequate time before the hearing or trial to review the NHTSA training manuals on the standardized procedures for the administration of the HGN test.

38. Are you familiar with the procedures used by police officers to detect HGN?

39. Have you had the opportunity to review the material in this manual related to the administration and interpretation of the HGN test?

    NOTE: Show the witness a copy of the police officer training manual in use in your jurisdiction.

40. Have you specifically reviewed page _____ through _____ which specifically refer to the HGN testing and interpretation procedure?

41. Is the procedure used by the police a reliable method of testing for the presence of horizontal gaze nystagmus?

42. Is there adequate time in the training for the officer to learn to administer and interpret the test results?

43. Is HGN voluntary?

44. Can a chronic user of alcohol suppress or control the symptoms of nystagmus?

45. Have you seen a police officer administer the HGN test at roadside?

    NOTE: Only ask this question if the witness has actually seen police officers administer the test under field conditions to impaired drivers or in a controlled setting such as a DRE evaluation or alcohol workshop.

46. Do you have an opinion about the ability of a police officer to administer the HGN test?

47. Upon what is that opinion based?

48. What is that opinion?

49. Do you have an opinion about the ability of a police officer to interpret the test results?

50. Upon what do you base your opinion?

51. What is that opinion?

52. Are there other causes of nystagmus?

53. What are some of these causes?

54. Do you see these causes in the emergency room?

55. Are these other causes more or less common than alcohol induced nystagmus?

56. Referring specifically to other causes of nystagmus, does the nystagmus (bouncing of the eyes) appear the same as alcohol caused nystagmus?

57. Do you know the rate of occurrence of nystagmus in the general population of the various pathologic causes of nystagmus that you have just mentioned?

58. How difficult is it to tell the difference between alcohol caused nystagmus and some of the other causes that you have mentioned?

59. Is a police officer who has been trained in the administration of the HGN test using the NHTSA scoring procedure, looking for 6 clues (3 in each eye), likely to mistake alcohol induced nystagmus for other types of nystagmus?

60. Does caffeine cause nystagmus?

61. Does nicotine?

62. Does fatigue?

63. What is the most common cause of horizontal gaze nystagmus?

64. You testified previously about some of the common symptoms of alcohol impairment?

65. What functions of the body does alcohol affect?

66. Can a chronic user of alcohol develop a tolerance to alcohol?

67. Can he learn to compensate for some of the behaviors associated with impairment, such as poor balance?

68. In your opinion, which is a more reliable indicator of alcohol impairment, the presence of HGN or some of the other commonly associated signs such as slurred speech? poor balance? lack of coordination?

69. Why?

70. Would HGN be visible after one drink?

71. By the time HGN is visible, what effect would there be on the suspect's judgment? ability to process information? coordination?

72. Do you have an opinion about the HGN test as a reliable indicator of alcohol impairment?

73. Upon what is that opinion based?

74. What is your opinion?