THE ORGAN		THE PERSON	
Structural change at the organ level	Functional change at the Organ level	Skills, Abilities (ADL) of the individual	Social, Economic Consequences
Eye Health	Visual Functions	Functional Vision	Quality of Life

(Near-)Normal Vision	Range of Normal Vision
	Mild Vision Loss
Low Vision	Moderate Vision Loss
	Severe Vision Loss
	Profound Vision Loss
(Near-) Blindness	Near-Blindness
	Blindness

VISUAL STANDARDS

VISION REQUIREMENTS for DRIVING SAFETY

with Emphasis on Individual Assessment

Report prepared for the
International Council of Ophthalmology
at the 30th **W**orld **O**phthalmology **C**ongress
Sao Paulo, Brazil, February 2006

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SECTION 1 – **EXECUTIVE SUMMARY**

Section 2 – **Preamble**

In 2002 the International Council of Ophthalmology (ICO) issued a report, discussing **Visual Standards, Aspects and Ranges of Vision Loss** *with Emphasis on Population Surveys* [1].

The current report addresses *individual assessment* of visual functions and their relation to functional vision in the context of **Vision Requirements for Driving Safety.**

The purpose of this report is not to provide a set of uniform rules that can be implemented unchanged in any jurisdiction. Rather, it is aimed at providing a set of considerations for use by any group contemplating the development or refinement of driving license requirements.

The 2002 ICO report distinguished several **aspects** of vision loss, notably **Visual Functions**, which describe how the eye functions and **Functional Vision**, which describes how the person functions in vision-related activities.

For each of these aspects, various **ranges** of functioning can be identified, ranging from **normal** functioning, over **mild**, **moderate**, **severe** and **profound** loss to **total** loss. The traditional, simplistic, black-and-white distinction between those who are sighted and those who are blind is not tenable. A 2002 resolution by the International Federation of Ophthalmolological Societies denounced the use of the word “blindness” for those who have useable residual vision [1].

The relationship between visual functions and functional vision is complex and can be influenced by many factors. While population statistics may define average performance, *individual* functioning, as will be discussed in this report, can be considerably better or considerably worse than the *statistical* average.

Traditional clinical tests determine a performance threshold. Real-life performance requires sustainable, supra-threshold performance. Establishing driving license criteria therefore is an exercise in establishing a *safety margin* between performance on clinical tests and performance in actual traffic, rather than a cut-off value between competence and incompetence.

Ultimately, driving safety does not depend so much on what is seen, but rather on how quickly and how adequately drivers respond to what is seen.

Section 3 – **Vision Loss and Driving Safety**

In our society losing one’s driving license has major social consequences. Vision is the most important source of information during driving and many driving related injuries have been associated with visual problems. Visual assessment for driving is thus a major health issue.

This paper was developed to explore ways in which the ICO could contribute towards global harmonization in this important area. It lists many sensitive questions.

A **literature review** shows that there is a relationship between the safety margin established by vision-related driving license requirements and actual driving performance, but that this relationship is generally weak.

Section 4 – **Which Visual Functions might be tested?**

This section discusses various visual functions, among them:

- Visual acuity, which is commonly tested.
- Contrast sensitivity, which is significant, but rarely tested.
- Visual field, for which requirements vary and testing methods are rarely specified.

Other visual functions include: glare sensitivity, Useful Field of View (UFOV), diplopia, color vision and night vision.

A survey of current requirements can be found in **Appendix 1** and **2**.

Section 5 – **Suggested Criteria and Rules**

This section discusses suggested criteria and rules. It stresses the need for **binocular** (both eyes open) measurements and the need for a **gray zone** in which decisions will be based on **individual consideration**, rather than on the application of strict numerical criteria. It also stresses the interaction of visual and non-visual parameters.

For **visual acuity** the commonly used threshold of 20/40 (0.5, 6/12) is accepted.

For **visual fields** a binocular field of at least 120° horizontal and 40° vertical is suggested.

Contrast sensitivity screening is listed as desirable.

The use of **restricted licenses** is advocated.

Periodic renewal is advocated, especially for older subjects.

Section 6 – **Summary and Recommendations**

This section summarizes the recommendations.

Appendix 1 – **Survey of Driving License Requirements** in various countries, except the USA

Appendix 2 – **Survey of Driving License Requirements** in various states in the USA

Appendix 3 – **Suggestions for Additional Tests**

Traditional clinical test were developed and refined to facilitate the diagnosis of underlying disorders. They generally measure threshold performance for a single parameter in a static environment.

This section list some suggestions for non-traditional tests, aimed at estimating functional performance. They may assess several parameters in one test and consider reaction speed in a timed environment

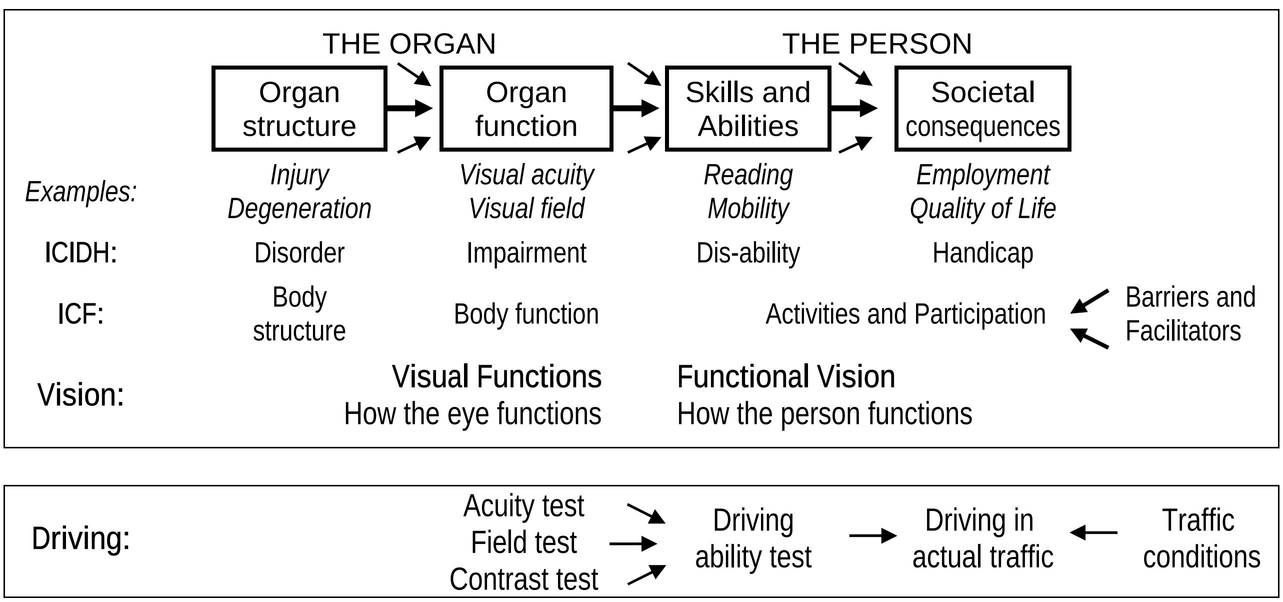
SECTION 2 – **PREAMBLE**

A previous report, prepared for the International Council of Ophthalmology, discussed Visual Standards, Aspects and Ranges of Vision Loss *with Emphasis on Population Surveys* [1]. In such surveys statistical averaging smoothes out the differences between individuals.

The current report addresses *Individual assessment* in the context of **Vision Requirements for Driving Safety.** It is appropriate to start this report with several caveats.

To discuss the relations between driving performance and various parameters of visual function, it is helpful to recognize the four aspects of functioning used in ICIDH [2] and ICF [3]. Of these aspects, two describe how organs or body systems function; two describe how the person functions. In the field of vision, we use **"Visual Functions"** to describe how the eye functions and **"Functional Vision"** to describe how the person functions in vision-related activities [4]. Table 1 shows various links; these links are not fixed, since for each link there are multiple causal factors and therefore multiple possible outcomes. The bottom part of the diagram shows the application of these principles to driving-related functioning.

Table 1 – **ASPECTS OF VISION-RELATED FUNCTIONING**



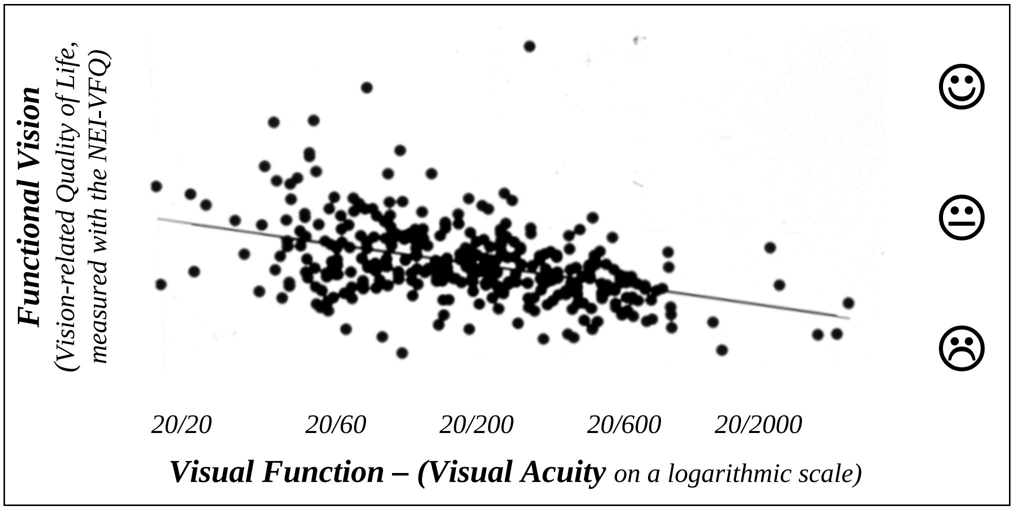
Visual functions, such as acuity, field, contrast, color, night vision, etc. can be measured as part of an eye examination. Functional vision includes performance of daily living skills, reading ability, mobility skills, driving skills, etc. Since such activities are not easily measured in the office, the measurement of visual functions is often used as a substitute from which to *estimate* functional vision; this estimate of functional vision is then used to derive a further estimate of driving safety. For this purpose, visual acuity is measured often, visual field sometimes and contrast sensitivity rarely. When estimating predicted driving performance on the basis of a few parameters, we should realize that many other factors, such as training, experience and familiarity with the driving environment can affect the prediction. Non-visual medical conditions are important also; a recent AMA publication provides a good overview [5]. The combination of several minor limitations may be more important than any one limitation by itself.

Another factor to take into consideration when estimating functional vision from visual functions is the fact that visual function measurements are usually *threshold* measurements. Functional vision, on the other hand, requires *supra-threshold* performance that can be maintained over time (compare running a 100m dash with running a marathon). One would not want to read a paper with a marginal print size and marginal contrast under marginal illumination. Similarly, drivers performing near the limit of their visual capabilities are probably not safe drivers.

Therefore, driving license requirements must include a *safety margin*. Just as a bridge designed for 5-ton vehicles should not collapse at 5.5 tons, so a person who meets the driving license requirement under stationary conditions and good illumination in the office, should still be expected to be a safe driver in a moving vehicle, at night, in rain or fog, or under other adverse conditions.

The uncertainty in relating visual functions to functional vision may be demonstrated by the diagram in Table 2 that relates a visual function measurement (visual acuity on a logatithmic scale) to a measure of functional vision (NEI-VFQ responses, after Roth analysis) [6]. A similar diagram for driving is not possible, since driving data do not exist over such a wide acuity range. There is no reason, hower, to expect a different relationship for driving.

Table 2 – **QUALITY OF LIFE and VISION LOSS**



Data from Donald C. Fletcher, MD
Presentation by Robert W. Massof, PhD

We note that (a) the regression line is smooth. This means that choosing any specific “cut-off” value is a *policy* decision, not a scientific one. Wherever the “cut-off” is placed, average performance on the left will be better than average performance on the right. A similar conclusion was reached in a recent extensive report on vision and disability in the USA [7]. The wide spread of individual points further means that (b) even if *average* functioning can be predicted, predicting *individual* functioning is not possible,. For any visual acuity value, some individuals are near the top, and some near the bottom of the scale. That the regression line is straight when visual acuity is expressed on a logarithmic scale, is (c) a strong argument for the use of a logarithmic progression (as on ETDRS charts).

Ultimately, driving safety does not depend so much on what is seen, but rather on how quickly and how adequately drivers respond to what is seen.
Finally one must also stress that Driving is a privilege not a right and that the primary responsibility of those who assess potential drivers is to the public not to the applicant.

SECTION 3 – **VISION LOSS and DRIVING SAFETY**

Driving license requirements

In our society losing one's driving license means a major limitation of one's independence and, especially for older persons, a marked restriction in social contacts. Depending on the development and accessibility of public transport the consequences may vary tremendously from country to country, but in every case the decision to deny any person the right to drive must not be taken lightly.

Notwithstanding the caveats mentioned in the preamble, one must realize that motor vehicle accidents are the leading cause of injury related deaths among 65 to 75-year olds. Vision is the most important source of information during driving and many driving related injuries have been associated with visual problems. Visual assessment for driving is thus a major health issue.

This paper was developed to explore ways in which the ICO could contribute towards global harmonization in this important area.

General considerations

Driving is a demanding activity. The various stages can be summarized as follows:

Perception	central	⇒	fixation
	peripheral	⇒	scanning
Interpretation			
Decision		⇒	reaction time
Action		⇒	motor abilities

Drivers must see obstacles or hazards, straight ahead or in their peripheral visual field (e.g.; a person crossing the road), consider the possible reactions of this person, estimate the distance, decide whether they have to slow down or stop and then react accordingly.

Thus, driving safety depends on many external factors as well as on the condition of the driver.

External factors

Visual characteristics of the obstacle
(size, color, contrast, etc.)
State of the vehicle (windshield,
rear view mirrors, etc.)
Irrelevant information (publicity
along the roads, etc.)
Reduced visibility (night, fog, rain, etc.)
Condition of the road

Driver related factors

Visual performance: Visual acuity
Visual field
Contrast sensitivity

Age, Experience, Risk assessment
Motivation, divided attention
(cell phone use, talking to passengers, anxiety)
Fatigue, Alcohol, drugs and medication

Note that the first three are probably constants, and therefore testable; the last ones are just as important, yet, are not testable in advance, since they may vary from trip to trip.

Questions

There are a large number of questions.

1. Do the visual requirements for obtaining a driving license reflect the parameters needed for driving safety?
2. Are the usual tests adequate or should other visual functions be considered also, e.g. contrast sensitivity?
3. Should one consider the introduction of restricted licenses where they are not yet allowed?
4. Should the use of spectacle-mounted telescopes (bioptics) be allowed in traffic?
5. What should be the duration of the license validation?
6. Who should be responsible for the visual tests: the ophthalmologist, the general practitioner, a low vision specialist, or the department responsible for road safety?
7. Who is responsible for reporting to the authorities that a person does not qualify any more for a driving license?
8. Who is responsible for granting, denying or restricting a driving licence?

These are very sensitive issues and we will not be able to provide an answer that will be valid for every single country. However some guidelines can be deducted from scientific studies and proposed to the official authorities responsible for traffic safety.

Age

There is a relationship between age and driving safety. According to Keltner & Johnson (1987) **[8]** the California Department of Motor Vehicles Driver Record Study reported in the period 1972-1974 an incidence of 2 accidents /100.000 miles in 20 year old drivers. This number regressed to 1/100.000 for the age group 30-60 years and rose again after that age to reach 2/100.000 at the age of 70 years. As regards traffic violations speeding is most common at the age of 20 (3,5/100.000 miles) and regresses gradually to 0,5/100.000 miles at age 70. Disregard of traffic lights, which is found in 1,25/100.000 miles at 20 years, diminishes to 0,5 at 35 years and increases again from the age of 60 years to reach 1,3 at 70 years. In the age group 60+ one notices a gradual increase of failure to yield the right-of-way. Younger drivers take more risks especially in speeding, whereas older persons are probably more rapidly distracted or fail to appreciate a potentially dangerous situation. These are all non-visual factors. The person's physical condition, hearing and slowing of reactions with age also play a role [9].

Visual Impairment

In most published studies the statistical correlations between vision and traffic accidents are weak. The recent AMA publication "Physician's Guide to Assessing and Counseling Older Drivers" (2003) **[5]** points explicitly to the interactions of various deficits, where vision is only one of the relevant parameters, while visual acuity is only one parameter of vision. It must be remembered that the decisive factor is not what drivers see, but how they react to what is seen.

Still, after (momentarily) divided attention, visual problems, which are permanent and therefore easily tested, are probably important among the reasons for accidents and traffic violations. They may be particularly important in those older persons who are not aware or do not want to admit that they do not fulfill the visual requirements anymore or who do not wish to abandon driving. In a study published in 1988 Paetkau et al **[10]** studied the prevalence of illegal motor driving among visually impaired elderly in Alberta. Of 491 patients aged 65 or older 22 (4%) with vision below legal limits persisted in driving a car. Significantly more men (11%) than women (1%) were driving illegally and among the men a higher proportion of those aged 65 to 79 years (17%) than those aged 80 years or older (6%).

Visual acuity

Fonda (1989) in a paper with the provocative title "**Legal blindness can be compatible with safe driving"** [11, 12] states that some people with a stable ocular condition, a visual acuity of 20/200 (0.1) (which means < 20/100 (<0.2) on most traditional charts) and a visual field of 120° are capable of safe daytime driving at a speed restricted to 40 mph. He tested 8 legally blind persons. The subjects were instructed to approach a particular traffic sign on foot and to stop as soon as they could identify the sign correctly. The minimum distance was 115 feet for one subject and the average distance was 221 feet. This distance allows drivers with normal reaction time and good motor ability to safely stop their vehicle when traveling at 40 mph as determined by the US Bureau of Public Roads. This is an argument for allowing restricted licenses.

Szlyk et al (1993) [13] compared the driving performances of 20 patients with juvenile macular dystrophy (Stargardt disease or cone-rod dystrophy) and visual acuity between 20/40 and 20/70 with 29 control subjects with normal vision. Driving performance was defined by accident involvement based on self-report and state records and by evaluating performance on a driving simulator. The proportion of individuals involved in accidents in the central vision loss group was comparable to that of the control group. However on an interactive driving simulator the macular dystrophy group showed longer braking response times and a greater number of lane boundary crossings than the control group. Also for 12 of 20 subjects with central vision loss who did not restrict their driving to daylight hours, there was a greater likelihood of involvement in nighttime accidents.

Szlyk et al (1995) [14] also studied a group of 10 persons with age-related macular degeneration and average visual acuity of 20/70 and compared their driving skills with those of 11 age-matched persons with normal vision. The rate of accidents in a 5-year period was obtained from a self-report questionnaire and from the state records of accidents. The subjects underwent a road test and a test on a driving simulator. The state records indicated no accidents in either group; however 4 of 11 control subjects had one or more traffic violations, most commonly speeding, whereas none of the ARMD patients had state convictions. Six of the eleven controls also reported accidents as compared to only one ARMD patient. As could be expected higher cognitive abilities were related to better performances on the simulator and on the road test. In the simulator the performances of the ARMD group were poorer with delayed braking response to stop signs, slower speed, more lane boundary crossings and more simulator accidents. In the road test this group drove more slowly and had significantly more points deducted for not maintaining proper lane position. The contradiction between the situation in a test environment and the number of accidents and traffic violation in the ARMD group is explained by compensatory attitudes in this group: 1. not driving in unfamiliar areas. 2. driving at slow speeds. 3. limitation of driving to daylight conditions. 4. taking fewer risks such as not changing lanes. These findings point to the importance of making subjects fully aware of their limitations and advising them about ways for compensation.

The same group also studied the driving performance of 21 retinitis pigmentosa patients with visual acuity of 20/40 or better as compared to 31 normals with comparable age, years of driving experience and miles driven per year (1992) [15]. A significantly greater proportion of RP patients reported accidents within a 5-year period and performed less well on the driving simulator. There was a statistically significant correlation between the severity of the field loss and the number of self-reported accidents. In the driving simulator a stop sign was initially presented at a location of 30° in the visual field to the right of the center of the screen in a curved portion of the road. This probably corresponded to a scotomatous area for most RP patients. A significantly greater proportion of RP patients had accidents on the driving simulator. They also showed an increase of braking response time and of brake pedal pressure. Interestingly 67% of the RP patients did not restrict their driving to daylight. In this subgroup the proportion of nighttime vs. daytime accidents was comparable with that of the control group. The authors concluded that visual field loss is a primary correlate of car accidents in RP patients.

Visual fields

Patients with visual field defects, whether they are due to glaucoma, a retinal disease or cataract, have double the incidence of road accidents or traffic violations as compared to persons with a full visual field according to a study of 10.000 persons (Johnson & Keltner, 1983) [16]. The incidence of visual field loss was 3.0 to 3.5 % in the age group 16-60 years and 13 % for the subjects older than 65 years. Even more important almost half of the persons with visual field loss were unaware of any problem with peripheral vision.

Monocular vision

It is important to be able to correctly judge distances. At the distances and speeds involved in automobile traffic, binocular stereopsis is not the most important depth cue. Persons who lost one eye will regain adequate distance judgements after an adaptation period, by taking into account the size or the interposition of objects, and noticing the shadows or the precision of details. The majority of patients who were enucleated for a malignant melanoma regained their ability to drive safely (Edwards & Schachat, 1991) [17]. Usually it took about 6 months.

Cataracts

In patients with lens opacities, the problems are not only the reduction of central vision and the visual field restrictions. Poor contrast sensitivity and glare also play an important role. Owsley et al. (2001) [18] studied the impact of cataract on driving in an older population (274 with cataract and 103 cataract free drivers). Drivers with a history of crash involvement were 8 times more likely to have a serious contrast sensitivity deficit in the worse eye (defined as a Pelli-Robson score of 1.25 or less) than those who were crash free. They concluded that severe contrast sensitivity impairment played a major role in car accidents even when it was present in only one eye. Wood et al (1993) [19] simulated three conditions of visual impairment in 14 young, visually normal, individuals: monocular vision, cataract and peripheral field restriction. Using modified swimming goggles the extent of visual fields and low contrast visual acuity were significantly decreased. In this study simulated cataract caused the greatest detriment to driving performance followed by binocular visual field restriction even though the drivers still satisfied the visual requirements for driving licensure. On the other hand monocular vision did not significantly affect the driving performance.

SECTION 4 – **WHICH VISUAL FUNCTIONS MIGHT BE TESTED?**

Some of the current visual requirements for obtaining or keeping a driving license are listed in the Appendices.

Appendix 1 lists the responses of members of the ICO to a questionnaire sent in 2002. **Appendix 2** surveys the situation in the USA.

These tables are, of course, incomplete and variable. However there are some general tendencies. The most common requirement is a visual acuity of 20/40 (0.5, 6/12). There appears to be a widespread consensus that this provides an adequate safety margin between visual acuity measured in the office and driving safety as practiced on the road. Requirements for visual field are more variable. Requirements for other visual functions are rare.

We will discuss various visual functions that might be tested.

Visual acuity

Visual acuity is the visual parameter that is most easily and therefore most widely measured. It is the reciprocal of the magnification needed to bring a high contrast detail to the threshold of visibility. It is often mistaken for a general measure of vision, although it only tests the small foveal area onto which the test letter is projected. For optical problems (defocus, opacities) this is adequate, since foveal blur predicts perifoveal blur. For retinal problems (also prevalent in an older population) visual acuity is only a partial measure, since foveal function does not predict perifoveal function.

The 20/40 (0.5, 6/12) standard is the criterion most widely used. We believe this to be reasonable, not because one becomes an unsafe driver at 20/50 (0.4, 6/15) but because it includes a safety margin for adverse conditions. This criterion implies that subjects who can read 20/40 on a well-lighted, stationary chart, are generally assumed to still be safe drivers in a moving environment and under adverse conditions, such as after dark, in rain or in fog.

Many consider 20/40 as "half of normal". This is not true; normal visual acuity is 20/16 (1.25, 6/5) or 20/12.5 (1.6, 6/4)), so a person with 20/40 needs 2.5 x or 3 times more magnification than normal. Drivers with 20/40 visual acuity must come 3 times closer to a road sign to read it and this reduces the time available to react to it to one third of normal.

Visual acuity measurement should of course be standardized. We make a plea for the use of charts with a logarithmic progression, such as in the EDTRS standard, as was recommended in the 2002 ICO/IFOS resolution [1].

Normal vision is binocular vision, as recently stressed by a WHO Consultation on Characterization of Vision Loss [20]. The criteria should thus be based on binocular vision (both eyes open). In the rare cases where binocular vision is worse (e.g. diplopia), good monocular acuity should <u>not</u> have precedence.

Contrast sensitivity.

Contrast sensitivity may be reduced due to optical factors, as in cataract patients. Contrast problems may also result from retinal problems (AMD, glaucoma, etc.) that are also common among the elderly.

If contrast sensitivity loss is caused by optical problems (defocus, scatter), both visual acuity and contrast sensitivity will be affected. When contrast sensitivity loss is caused by retinal problems, visual acuity loss and contrast sensitivity loss are not necessarily correlated. It is possible to have poor visual acuiy with good contrast vision; it is also possible to have good visual acuity with poor contrast vision. Brabyn et al. (2001) [21] showed that some people in an elderly population may have 20/20 (1.0, 6/6) acuity on a high contrast chart in good illumination, but may easily drop to 20/200 (0.1, 6/60) or below with low light, low contrast and glare. Mäntyjärvi & Tuppurainen (1999) [22] strongly suggest to include simple tests for contrast sensitivity and glare sensitivity in the requirements for a driving license in older drivers.

Various tests are available. The Pelli-Robson contrast sensitivity test chart is standardized, but not often included in clinical exams. A recent variant is the Mars chart for hand-held use (Arditi, 2004) [23. For any test the recommended safety margin for safe driving needs to be defined. Appendix 3 lists a suggestion for a cheap and simple screening test.

Glare sensitivity

Glare sensitivity may similarly result from optical problems, such as cataract, or from retinal problems. In the first case straylight and disability glare are important; in the latter case, glare recovery time is also important. A recent European study [24] validated the use of a new straylight meter in an international population study.

Visual field

A major peripheral impairment of the visual field is a reason for denying a driving license in most states in the USA and this condition is also included in the Guidelines of the European Commission [25]. Central scotomata reduce visual acuity and are thus caught under the visual acuity requirement. No good data exist on the effect of mid-peripheral scotomata.

Yet, some states do not list field requirements at all, and when requirements are listed the way the field should be measured is often not indicated. Financial considerations may play a role. Reliable testing is expensive and the yield in accidents prevented is limited.

Use of standardized nomenclature is important. We need to specify what we mean. To most ophthalmologists a “30° field” means a 30° radius, to non-ophthalmologists it may mean a 30° diameter. Does a 120° field require 60° to the left and 60° to the right, or does 30° left and 90° right suffice? Some US rules specify “70° in either eye”. They probably intended 70° to either side of fixation, especially if it is followed by “140° binocularly”.

Clinical visual field testing is aimed at the diagnosis of underlying disorders. Sophisticated field testing equipment and algorithms have been developed for this purpose; each eye is tested separately and eye movements invalidate the test. Yet, functional vision is binocular vision and functional use of the visual field is impossible without an effective scanning strategy.

As stated before, functional criteria should be based on binocular vision, i.e. vision with both eyes open. This is especially important for visual fields, where good areas in one eye may compensate for scotomata in the other eye. Since there is no equipment that allows binocular testing with binocular monitoring, monocular testing with later superimposition of the monocular fields can be used as recommended in the Vision-99 Guide [26] and in the current AMA Guides to the Evaluation of Permanent Impairment (5th edition, 2001) [27]. However, this does not yet address the importance of adequate scanning strategies [28, 29].

Appendix 3 contains a suggestion for a type of field test aimed at detecting functional consequences, rather than at diagnosing underlying disorders.

Useful Field of View (UFOV).

This test evaluates to what extent an object in the periphery of the visual field is not only seen but also perceived. As such, it evaluates a combination of visual and non-visual factors (attention). According to a study by Owsley (1994) [30] the UFOV test had better sensitivity and specificity than visual sensory or mental status tests in identifying older drivers at risk for accidents. Perceived driving disability (PDD) assessed by a questionnaire, was strongly correlated with visual acuity, contrast sensitivity and UFOV (van Rijn et al., 2002) [31]. These studies, however, need to be confirmed. The UFOV test has, as far as we know, not yet been accepted for general use and is not incorporated in the European guidelines.

The UFOV test points to the importance of factors, such as attention, that are not strictly visual.

Diplopia

A few jurisdictions mention diplopia. A recent Canadian proposal recommends the absence of diplopia within the central 40° (ie: 20° left, right, above and below fixation).

Individuals vary greatly in the degree to which they are bothered by diplopia. Some are able to suppress the unattended image when looking through a monocular telescope or other monocular device, others close one eye. Traditional tests do not address this issue. We recommend that this issue be left to the gray zone of individual consideration.

Color vision.

The Guidelines of the European Commission [25] have dropped color vision requirements. They are still in use in some states in the USA, in Bulgaria, Columbia and provinces in Canada. Studies by Verriest et al (1980) [32] have shown that abnormal color vision is not incompatible with safe driving. The problem of recognizing traffic lights is overcome by the standardized position of the different lights, appropriately chosen colors and in some countries by the differences in their sizes.

Night vision.

Problems with night vision are not limited to hemeralopia. Patients with hemeralopia are aware of their problems and will usually avoid driving at night.

Patients with IOL's or who underwent refractive surgery may experience glare problems and contrast loss when a wide pupil exposes the edges of the IOL or of the ablation zone. Such problems will never be detected in daylight testing. Also, patients with cataract will complain of glare and be extremely handicapped by the lights of cars driving towards them.

Especially older drivers will be blinded by oncoming cars because of increased intra-ocular light scattering and glare sensitivity, but also because of prolonged photostress recovery time (Mainster & Timberlake, 2003) [33].

There are a number of tests that evaluate problems with night vision, including the Mesotest (Oculus) and the Nyktotest (Rodenstock) (van Rijn et al, 2002) [31]. None of them are included in guidelines, although some countries include a crude estimation of night vision in their criteria.

SECTION 5 – SUGGESTED CRITERIA and RULES

Visual Acuity

A review of the tables in Appendix 1 and 2 shows that **binocular** (both eyes open) **acuity of 20/40** (0.5, 6/12) is the most common screening criterion for an unrestricted license. We believe that this provides a reasonable safety margin for general drivers with no other problems. Note, however, that this does not imply that a person with 20/40 acuity is necessarily a safe driver.

Requirements for professional and commercial drivers are not considered in this report. It is common to require a wider safety margin for this group, not because their visual environment is more complex, but because they may be responsible for passengers and/or for heavier equipment that can inflict more damage in an accident.

Some jurisdictions have also defined a visual acuity level beyond which not even a restricted license should be granted. We are comfortable with a 20/200 level, considering that on traditional, non-logarithmic charts 20/200 (0.1) actually means < 20/100 (< 0.2).

Our recommendations for **visual acuity** can be summarized as follows:

20/40 (0.5) or better	No visual acuity-based objection to an unrestricted driving license, *even if acuity could be further improved with glasses or contact lenses.*
< 20/40 (< 0.5) to 20/200 (0.1)	Individual consideration, which may result in restrictions or denial. *Evaluation should include visual and non-visual factors and a road test when in doubt. Some licenses may be granted, some will not.*
< 20/200 (< 0.1)	No driving license

Visual field

Visual field criteria are more variable. As a screening criterion, we recommend a **binocular** (both eyes open) **visual field of 120° in the horizontal meridian** with no obvious interruptions and approximately evenly divided to the left and right of fixation. No consensus exists about the instrument, target size or method to be used in screening for field defects. The assumption generally is that a fairly large / strong stimulus should be used, such as III4e (Goldmann) or 10 dB (Humphrey).

A vertical criterion of 20° above and below fixation (40° total) has also been proposed, but to our knowledge it has not yet been incorporated in any requirements. We know of no rules that set an absolute minimum visual field size. Attentional problems should be considered; hemi-neglect is probably more dangerous than hemi-anopia without neglect.

Our recommendations for **visual field** can be summarized as follows:

120° horizontal, 40° vertical or better	No visual field-based objection to an unrestricted driving license, *provided that the field is about evenly divided around fixation and that no attention-related problems were identified.*
Worse	Individual consideration, may include restrictions. *Evaluation should include visual and non-visual factors and a road test. Some licenses may be granted, some will not.*

While visual acuity screening with the presenting correction can be done easily and inexpensively, visual field screening is more involved. The cost of screening all applicants should be weighed against the number of accidents prevented. In many situations screening and testing may be done only for selected applicants, e.g. only for those who have already been referred for an eye examination because of visual acuity loss, those in whom field loss is suspected, and/or those involved in accidents.

Contrast sensitivity

Presently no contrast sensitivity requirements are listed in any jurisdiction. This does not mean, however, that contrast sensitivity is unimportant. When a simple, inexpensive screening test becomes available (see Appendix 3) and is validated, screening would be worthwhile, especially among the elderly. Those who fail the screening test should be referred for professional evaluation. Contrast problems due to optical causes are probably highly related to visual acuity loss, but contrast problems due to retinal causes (common in the elderly) can exist regardless of the visual acuity level.

Restricted licenses

As stated earlier, driving license requirements are meant to establish a safety margin between performance on a stationary letter chart in the office and performance in actual traffic situations under adverse conditions. For professional drivers the safety margin can be improved by imposing stricter requirements. For general drivers the safety margin can also be improved by prohibiting driving under certain adverse conditions. This is the purpose of issuing restricted licenses.

We feel strongly that issuing a driving license should not be an all-or-none, black-or-white decision, but that a *gray* area should be considered in which a license may or may not be issued. Factors other than vision may also affect that decision. It is not unusual that elderly drivers have multiple minor deficiencies, which in combination make driving inadvisable. The AMA report, mentioned earlier [5], discusses such cases.

If visual acuity cannot be brought to the 20/40 level on a screening test, or if significant field defects are suspected, additional tests are indicated. This may include professional visual field testing, and testing of contrast sensitivity, glare sensitivity and night vision. After examination, the vision specialist can advise the licensing authority on possible license restrictions and on the re-assessment interval.

The licensing authority will consider this advice and possible additional information, such as other medical problems and past driving performance and may require an on-the-road test. The ultimate responsibility for issuing or not issuing a driving license, with or without restrictions, should rest with the licensing authority, not with the ophthalmologist or other organ specialist.

Various restrictions could be imposed, including the following.

1. Limitation to daylight driving
2. Restriction to a radius of …. Km from home
3. Restriction to familiar areas
4. Speed limitation
5. No highway driving
6. Requirement of more frequent testing, based on the prognosis of the condition.

Renewal and Recertification.

Renewal and recertification pose additional problems. In the United States all licenses have an expiration date. Restricted licenses may have a shorter renewal period, based on the prognosis for progression of any medical problems.

Applicants for a restricted license should be re-assessed for each renewal; however, this may not be feasible under all circumstances. Additional re-assessments could be imposed for persons provoking car accidents, even if they meet the visual criteria.

For older drivers, we recommend that all drivers should undergo vision screening at age 65 and 70 and every 3 years thereafter, or at the closest renewal date. The vision tests should include visual acuity, visual field, contrast sensitivity, glare sensitivity and ocular motility. These tests should, ideally, be performed by an ophthalmologist, but in many countries this is pure utopia. There is a need for simple screening devices that can be used in the department responsible for issuing motor vehicle licenses.

Use of bioptics.

Some states in the USA allow the use of bioptic telescopes (bi-optic = small telescope for occasional viewing, mounted in the top half of a regular spectacle lens). Use of bioptics is not intuitive and requires a considerable training period. Only when the person has become comfortable with the use of bioptics can he/she be considered for a restricted license. Peli & Peli (2002) [34] established a list of recommendations for people driving with a telescope. They insist on the need to prepare a travel plan, keeping clean windshields and rear mirrors, being certain not to have to check the gas level, etc. These persons should limit their driving depending on traffic conditions and refrain from driving in poor weather conditions.

The benefit of telescopes is primarily in reading road signs at a greater distance, thus providing more time to react; however shifting back and forth between the carrier lens and the telescope takes time and thus limits the benefits. Driving in familiar surroundings where orientation is by landmarks rather than by road signs avoids the need for telescopes and may be a condition for a restricted license. Some users, especially older ones with limited driving needs, may find telescopes more cumbersome than helpful in driving. Licensing a bioptic driver should never be based on performance on a stationary letter chart only; it should always include an extended actual driving test by a qualified examiner to demonstrate that the applicant can drive more safely with a bioptic telescope than without one.

Can training improve visual performances in driving?

Coeckelbergh (2002) [28] has shown that some patients with retinal scotomata can benefit from training. About half qualified for a driving license after 12 training sessions. Tant (2002) [29] has shown that training can also improve the performance of patients with homonymous hemianopia, although these patients did not reach the criteria for a driving license. Studies are under way to test the use of prisms in patients with hemianopia.

Again, training may help in some, but only an on-the-road driving assessment will determine whether an individual patient can be allowed to drive.

SECTION 6 – **SUMMARY and RECOMMENDATIONS**

1. There is a definite need to make the driving license requirements more uniform.
2. For an unrestricted (non-commercial) license we recommend that, with both eyes open, the applicant should have a **visual acuity** of 20/40 (0.5, 6/12) or better and an uninterrupted **visual field** of 120° or better in the horizontal meridian.

20/40 (0.5) or better	No visual acuity-based objection to an unrestricted driving license, *even if acuity could be further improved with glasses or contact lenses.*
< 20/40 (< 0.5) to 20/200 (0.1)	Individual consideration, may result in restrictions or denial. *Evaluation should include visual and non-visual factors and a road test when in doubt. Some licenses may be granted, some will not.*
< 20/200 (< 0.1)	No driving license

Persons who do not meet the screening criteria should be referred for further evaluation by a vision specialist. If refractive correction can bring the visual acuity to 20/40 or better, and the visual fields appear normal, no further action is required.

3. In older drivers testing of glare and **contrast sensitivity** should be considered.
4. A compromise may have to be found between ideal testing and economic feasibility.
5. Driving licenses should have a defined renewal period.
6. The visual and driving performance of older drivers should be assessed regularly, we recommend starting at the age of 65 years.
7. There is a need for **restricted licenses**. The purpose of allowing restricted licenses is to improve the safety margin (inherent in the standard requirements) through avoidance of hazardous conditions, especially for those who have prior driving experience and a good driving record.
8. Although the European criteria only date from 1998, a group of the European Union has updated these criteria [25]. Their studies [24] and considerations have contributed to this report. We propose to cooperate with the European group and see with them whether their proposals could be adopted worldwide.

Acknowledgments.

The authors express their gratitude to Bruce Spivey, General Secretary for his support and to the board members of the ICO for the information provided. They want to acknowledge especially the valuable comments of P.Watson (Cambridge), A.Kooijman (Groningen), L.van Rijn (Amsterdam), D.P.Anderson (Ottawa) and M.Tant (Brussels).

Appendix 1 – **SURVEY of DRIVING LICENSE REQUIREMENTS** (except USA)

This tabulation is based on data provided by members of the International Council, as indicated.

Country	Visual Acuity, both eyes	Monocular vision	Visual fields	Color vision	Restr. License possible
Algeria (Hartani)	0.8	1.0 (+ 2 rear mirrors)			
Australia (F.Martin)	6/12	6/12	120° hor. by confrontation	No	Yes
Bulgaria (Markov)	0.6			Yes	
Belgium (Off. journal)	0.5	0.6	120° no diplopia	No	Yes
Canada [35,.36] (Casson et al, 2000, D.P.Anderson 2005)	20/50 (Quebec 20/50)		120° (Quebec 100° hor; >30° each side)	Some yes Some no	Yes
Colombia (Rodriguez)	20/40		120°	Yes	
Denmark (Norregaard)	0.5	0.6	Nl. for hand movements		
European Union (e.g. Belgium)	0.5	0.6	120° no diplopia	No	Yes
France (J.P.Adenis)	0.5	0.6	120° no diplopia	No	
Gambia (H.Faal)	6/9		No		
Germany (Steuhl, M.Korth)	0.5 0.2	0.6	Yes		Yes
Hungary (Hatvani)	0.8; 0.25 1.3	1.0	Defect of less than 30°		Yes
India (Rao, Vasavada)	6/18				
Israel (J.Pe'er)	6/12		Yes		
Italy (Secchi)	0.5		Yes		Yes
Japan (Shigeaki)	0.7 binoc. 0.3 lesser eye		150°		
Mexico (Graue)	20/25				Yes
Netherlands (Kooijman)	0.5	0.6	140°	No	Yes
New Zealand (Peart)	6/12	6/12	140°	No	Yes
Nigeria (Hassan, Abiose)	6/12 6/9		Yes		Yes

Slovekia (Cernak)	0.5		Yes		Yes
South Africa (T.Murray)	20/40		Yes		Yes
Sweden (Hedin)	0.5	0.6	One normal	No	Yes
Switzerland Jenny)	0.6; other 0.1	0.8	140° no diplopia		Yes
UK (P.Watson)	car number plate at 25 yds (6/12 to 6/18)		120°, tested if driver declares eye disease		
Venezuela (Cortez)	20/40		Normal on confrontation	Semaphor	Yes
European Commission	0.5	0.6	120° no diplopia	No	Yes

The criteria vary from country to country. Most countries agree with a visual acuity in the better eye of 0.50 (20/40; 6/12). If the driver has only one functional eye, the vision requirement in that eye is higher than for binocular drivers in Belgium, Denmark, Germany, Hungary and Switzerland.

Only the UK specifies the way visual acuity must be measured. Section 92 of the Road Traffic Act of 1998, states "*The inability to read in good light (with the aid of corrective lenses if necessary) a registration mark fixed to a motor vehicle and containing letters and figures 79.4 mm high at a distance of 25 yards).*"

This test, of course, lacks standardization and a study by Kiel et al (2003) [37] showed that the results depend on the reading difficulty. T174ILE is easier to decipher than M528CBY. Drivers with 20/40 visual acuity failed the test.

The Belgian guidelines have been modified by the Royal Decree of 23 March 1998 and follow the Guidelines of the European Commission [25]. As such they are representative for the situation in the whole European Union. A candidate presenting an acute or chronic ocular condition, which may influence driving safety, is not allowed to drive. If he/she suddenly loses the vision of one eye, has been operated on one eye or presents an oculomotor palsy provoking diplopia in primary gaze, the ophthalmologist must determine when the candidate is apt to drive. Next to visual acuity and visual field, night vision is also considered. However protanopia, which was an exclusion criterion before 1998, is no more considered a reason to deny a driving license.

Appendix 2 – **DRIVING LICENSE REQUIREMENTS in the USA**

This information was taken from the "AMA's "Physician Guide to Assessing and Counseling Older Drivers." (2003) [5].

Where applicable: U = unrestricted license, R = restricted license, may list additional criteria.

State	VA each eye	VA both eyes	Monoc. Vision	Abs. min.	Bioptics	Min. ext. vis. fields	Color vision	Restric. License
Alabama	20/40	20/40	20/40	20/60	No	110°	New dr.	Yes
Alaska	20/40	20/40	20/40	20/100	Cond.	None	None	Yes
Arizona	20/40	20/40	20/40	20/60 day only	No	70°/35°	Prof. drivers	Daylight
Arkansas	20/40 w/o corr.	20/50 w. corr.	20/40	20/40 U 20/60 R	Yes	105°	None	Yes
California	20/70	20/40	20/40	20/200	Daylight	None	None	Yes
Colorado	20/40	20.40	20/40	None	Yes	None	None	Yes
Connect.	20/40	20/40	20/40	20/70 U 20/200 R	No	100° mon. 140° bin.	None	Yes
Delaware	20/40	20/40	20/40	20/50	Daylight	None	None	Daylight
D.C.	20/40 lesser eye 20/70		20/40	20/70 requires 140° fld	No	130°	New drivers	Daylight
Florida	20/40 lesser eye >20/200		20/40	20/70	No	130°	None	Yes
Georgia	20/60	20/60	20/60	20/60	Yes	140°	None	Yes
Hawaii	20/40	20/40	20/40	20/40	Yes	70°	None	Yes
Idaho	20/40	20/40	20/40	20/40	Yes	None	None	Yes
Illinois	20/40	20/40	20/40	20/40 U 20/70 R	Yes	105° one 140° both	None	Yes
Indiana	20/40	20/40	20/50	20/40	Yes	70° one 120° both	Prof. and bioptic	Daylight only
Iowa	20/40	20/40	20/40	20/200 R	No	140°	None	Yes
Kansas	20/40	20/40	20/40	20/40 20/60 R	Yes	110° both 55° monoc	None	Yes
Kentucky	20/40	20/40	20/40	20/200 R	Yes	120° E 80° N	None	Yes
Louisiana	20/40	20/40	20/40	20/100	No	None	None	Yes
Maine	20/40		20/40	20/70 R	Yes	140° U 110° R	None	Yes
Maryland	20/40	20/40	20/40	20/100 R	Yes	140° U 110° R	Prof. only	Daytime
Massach.	20/40	20/40		20/40 U 20/70 R	Yes	120°	Yes	Daytime
Michigan	20/40	20/40	20/50 ?	20/70 R	Yes	110-140°	None	Yes
Minnesota	20/40	20/40	20/40	20/80 R.	No	105°	None	Yes

Mississipp	20/40	20/40		20/70	Yes	140° both T 70°,N 35°	None	Yes
Missouri	20/40	20/40	20/50 ?	20/160 R	Yes	55° both 85° one R	None	Yes
Montana	20/40	20/40	20/40	20/100 R	Yes	Prof. only	Prof. only	Yes
Nebraska	20/40	20/40	20/40	20/70	Yes	140° both 100° R		Yes
Nevada	20/40	20/40	20/40	20/50	Yes	140° U 110° R	None	Daytime
New Hampshire	20/40		20/30	20/70	Yes	None	None	Daytime
New Jersey	20/50	20/50	20/50	20/50	Yes	None	None	Yes
New Mexico	20/40	20/40	20/40	20/80	No	120° temp 30° nasal	None	Yes
New York	20/40	20/40	20/40	20/70	Yes	140°	None	Yes
North Carolina	20/40	20/50	20/30	20/100 R	No	60°	None	Yes
North Dakota	20/40	20/40	20/40	20/80 R	Yes	105°	None	Yes
Ohio	20/40	20/40	20/30	20/70	Yes	70° temp	Yes	Daytime
Oklahoma	20/60	20/60	20/50	20/100	No	70°	None	Yes
Oregon	20/40	20/40	20/40	20/70	Yes	110°	None	Daytime
Pennsyl-vania	20/40	20/40	20/40	20/100 R	Yes	120°	None	Yes
Rhode Island	20/40	20/40	20/40	20/40	?	?	None	No
South Carolina	20/40	20/40	20/40 outside mirrors	20/70 + > 20/200 20/40 + < 20/200	Yes	140°	None	Yes
South Dakota	20/50	20/40	20/40	20/60 R	Yes	None	None	Yes
Tennessee	20/40	20/40	20/40	20/60 R	Yes	Prof. only	Prof. drivers	Yes
Texas	20/40	20/59	20/25	20/70 R	Yes	None	New drivers	Yes
Utah	20/40	20/40	20/40	20/100 R	No	120°hor+ 20°vert.U 90° hor.R	None	Yes
Vermont	20/40	20/40	20/40	20/40	Yes	Each 60°	None	Yes
Virginia	20/40	20/40	20/40	20/200 R	Yes	100° U 70° R	None	Yes
Washing-ton	20/40	20/40	20/40	20/70 R	Yes	110°	New and prof.	Yes
West Virginia	20/40		20/40	20/60	No	None	None	No
Wisconsin	20/40		20/40	20/100	Yes	70°	Prof. only	Yes
Wyoming	20/40	20/40	20/40	20/100 R	Yes	120°	None	Yes

This table shows that the situation in the USA, where legislation varies from state to state, is as diverse as among countries in Europe. Since bioptic telescopes are allowed in some states this information has been included as well.

Apparently there are some strange rules. In Indiana and in Michigan a monocular patient could be allowed with a vision of 20/50 (0.4, 6/15) whereas the requirement for binocular drivers is 20/40 (0.5, 6/12).

All States indicate a limit of license validation:

> *4 years* in 18 states (Alabama, Arkansas, Georgia, Idaho, Illinois, Indiana, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Nevada, New Jersey, North Dakota, Ohio, Oklahoma, Pennsylvania, Wyoming).
> Reduced to 3 years at age 75 in Indiana and to 2 years at age 65 in Pennsylvania.
>
> *5 years* in 18 states (Alaska, California, Delaware, District of Columbia, Iowa, Maryland, Massachusetts, Nebraska, New Hampshire, North Carolina, Rhode Island, South Carolina, South Dakota, Tennessee, Utah, Virginia, Washington, West Virginia).
> Reduced to two years at age 70 in Iowa and in Rhode Island.
>
> *6 years* in 6 states (Connecticut, Hawaii, Kansas, Maine, Missouri, Texas).
> Reduced to 4 years at age 65 in Kansas and in Maine, to 3 years at age 70 in Missouri and to 2 years at age 72 in Hawaii
>
> *8 years* in 4 states (Montana, New York, Oregon, Wisconsin).
> Reduced to 4 years at age 75 in Montana.
> After age 50 vision screening is required every 8 years in Oregon
>
> *10 years* in Colorado (reduced at 5 years at age 61)
>
> *12 years* in Arizona (reduced at 5 years at age 65)

Variable limits:

> *2-4 years* in Vermont
>
> *4-6 years* in Florida, depending on driving history
>
> *4-8 years* in New Mexico (each year after age 75)

It must be stated that vision testing at the time of renewal is not required in Alabama, Connecticut, Kentucky, Oklahoma, Pennsylvania, Tennessee, Vermont and West Virginia. In Maine the vision must be tested at age 40, 52, 65 and every 4 years thereafter, in Oregon vision testing is required only after the age of 50 years and only after the age of 65 years in Utah.

There are no age-based renewal procedures in 30 states. Renewal by mail is not accepted at age 65+ in Colorado and Connecticut, and at age 69 or 70 in Alaska, Arizona, California, Idaho, and Louisiana. At age 70 the applicant must submit a letter from his/her physician stating that he/she is medically fit to drive (vision, physical and mental status), in the District of Columbia and in Maryland. In Nevada a vision test and a medical report are required for renewal at the age of 70, vision testing is required at license renewal at age 65+ in Utah. New Hampshire requires a road test at the age of 75. In Florida vision testing is required at each renewal from age 79 on. Illinois does not allow renewal by mail after the age of 75. A vision test and an on-the-road test are required at each renewal, drivers aged 81-86 must renew each 2 years and at age 87+ every year. In North Carolina drivers age 60 and older are not required to parallel park on their road test. In Pennsylvania drivers aged 45+ are requested to submit a physical and vision exam prior to renewing.

Appendix 3 – **SUGGESTIONS FOR ADDITIONAL TESTS**

Clinical tests of *visual functions* were developed to clarify underlying causes of vision loss. In the context of driving safety, however, we are interested in tests of *functional vision* that explore not the causes, but the consequences of vision loss. Based on psychophysical principles, visual function tests typically test only one parameter at a time in a static, uncluttered environment. Functional vision, on the other hand, typically involves multiple parameters in a dynamic, usually cluttered environment.

There is a need for screening tests that do not require highly trained personnel and that assess functional vision, based on a wider array of visual functions than visual acuity alone. We encourage the development of tests that may assess a combination of parameters. The following paragraphs, provided by Colenbrander, provide examples of potential ideas.

It should be stressed again that these tests (like any of the other tests discussed) are screening tests, not tests of driving competence. It is assumed that persons who fail the test in the licensing office will be referred for further assessment. The vision professional will then advice the licensing office. The licensing office may require an on-the-road test (the only test that assesses actual driving competence) and will make the ultimate decision.

Proposed screening test for contrast sensitivity

A simple screening test for contrast sensitivity could be based on the Mixed Contrast reading card (Colenbrander, Fletcher, 2005) [38. This card is a regular reading card with alternating black and gray lines in each paragraph. It was found that the difference between the number of lines read with high-contrast and with low-contrast provides a simple measure of contrast sensitivity that is independent of visual acuity. The card is meant for use in general practice where the high-contrast section would replace regular reading cards. With 10% contrast for the low-contrast lines a difference of 1 or 2 lines is normal; in patients differences up to 10 lines or more have been recorded.

The card uses a reading task rather than letter recognition, since reading involves a larger retinal area and contrast losses do not necessarily start at the fovea. Patients with contrast sensitivity deficits often feel that “something is wrong”, but cannot pinpoint the cause; they appreciate the card as a vivid demonstration of the consequences of contrast sensitivity loss.

A modification of this card could be made with a smaller contrast difference, calibrated so that the black and gray lines would be equally difficult for persons with normal contrast sensitivity. Any person who experiences a greater difficulty reading the gray lines than the black lines would be referred to a vision specialist for further testing.

Proposal for a combined test for visual field, scanning strategy and reaction time

Existing diagnostic visual field tests are monocular and exclude eye movements. A test of the functional field of view must be binocular, must allow scanning eye movements and must include reaction speed. Clinical field testing equipment cannot accomplish this.

A proposed test would present stimuli in different parts of the (binocularly viewed) visual field; the subject would push a button a soon as the stimulus is seen. Another stimulus would then be presented after a variable interval. The score is the sum of the reaction times for all stimuli. If a stimulus is presented in a scotoma, the reaction time will be prolonged. An inefficient scanning strategy will further prolong the reaction time. Subjects with a generally delayed reaction time will fail also.

A similar test for the central field, presented on a computer screen, has shown good correlations with reading performance. For a wider field the stimulus could be presented with a digital projector or in virtual reality glasses. Failure on the screening test would require referral to a vision specialist.

Proposal for a combined screening test for attention, contrast and night vision

This more elaborate, computer-based test would screen for deficits in attention, contrast and night vision, yet would not require highly trained personnel.

The subject is asked to look at a dim computer display in an enclosure that promotes dark adaptation. If the curtain is not closed properly, stray light makes the test more difficult; thus the subject will want to close the curtain. On the screen a bright dot moves slowly at unpredictable intervals in unpredictable directions. The subject uses a mouse or joystick to move a black disc around to keep the bright spot covered. Fixation and attention will thus stay with the moving spot.

From time to time a dim letter (or other object) appears in a random position. These targets would be above threshold when seen alone. If the bright spot is not adequately covered, it will hinder their recognition. Display time, brightness and size may vary. When the subject recognizes the letter or the object, he/she presses a button or clicks the mouse (for timing) and names the letter or object. The computer records the position of the stimuli presented and the reaction time. Since the fixation point can move around to the edges of the screen, the diameter of the field that can be tested is equal to twice the width of the screen.

Interpretation

- Failure to keep the bright spot covered may indicate problems in hand-eye coordination and manipulative skills.
- Extended reaction times would show up in all responses.
- Missing targets close to the bright spot (when not covered) may indicate glare problems.
- Targets detected, but not recognized may indicate focusing problems in night vision (such as night myopia from pupil dilation).
- Missing the dim targets, but not the brighter ones may indicate dark adaptation/ contrast problems.
- Missing targets in one area may indicate a scotoma.
- Missing peripheral targets may indicate restricted attention.
- Missing targets on one side may indicate hemi-neglect.

Scoring would be done by the computer. A simple printout showing the location of the targets seen and of those missed, would give a clear record to convince the subject and would be kept for documentation in the file. Failures on this screening test would need to be followed up with other clinical tests by a vision professional.

Since this test requires dark adaptation, it will catch problems that only become evident when the pupil is dilated. This may include problems due to the exposure of the edge of a decentered IOL or of a small ablation zone after refractive surgery.

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