

A PERSON WITH NORMAL trichromatic (three-color: red, green, and blue) vision can identify more than seven million different colors. But 8 percent of men (1 in 12) and 0.5 percent of women (1 in 200) in North America have a color vision deficiency. Because the overwhelming majority of these people can distinguish colors to some extent, it is inaccurate to label them as “color blind.”

What causes color vision deficiency? The human eye relies on 6 to 7 million cone cells and 100 to 130 million rod cells to produce normal vision. Located in the center of the retina, the cones receive the images focused on them by the lens, convert them to electrical signals, and send these signals to the brain. The cones perceive colors as combinations of red, green, and blue, and they are responsible for color vision, light adaptation, and fine detail. The rods are located in the periphery of the retina and are responsible for night vision, brightness perception, and distinguishing shapes.

There are different types of color vision deficiency, and red-green defi-

Red, Green & Blue

Color vision information for pilots

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ciency is the most common. Protanomaly is one of the mildest forms of this deficiency, and people suffering from it perceive blue-green and red-purple as an indistinct grayish shade. Deuteranomaly is another mild form, where people “see” green and red-purple as an indistinct shade of gray. Both of these defects are forms of anomalous trichromatism, which means that red, green, and blue cones are present, but the pigments contained within them are altered.

Half of the people with anomalous trichromatism can make precise color matches (but not as precisely as those with normal color vision) and are said to have a simple anomaly. The other half cannot make precise color matches and are said to have an extreme anomaly.

A more pronounced form of red-

green deficiency is dichromatism (two colors), in which one of the three cone types is absent. Dichromatism is divided into two subtypes: protanopia—where blue-green and red-purple are perceived as gray—and deuteranopia—where green and red-purple are perceived as gray.

Monochromatism (one color) is the rarest form of color deficiency, and it’s divided into rod and cone subtypes. A person with cone monochromatism has good central vision but confuses all colors because two of the three cone types are missing. A person with rod monochromatism, or achromatopsia (no color), has no cones at all and sees everything in shades of gray. People with achromatopsia have poor vision and difficulty adjusting to bright light, so it’s fortunate that this abnormality affects only one person in 33,000 in the United States.

Eye diseases and normal aging can cause color vision deficiencies, but the major cause is an inherited gene attached to the X chromosome. This is why men, who have only one X chromosome, are far more suscep-

tible to color vision abnormalities than women, who have two. An affected man passes the color-deficiency gene to all of his daughters, who become unaffected carriers; his sons get his Y chromosome and have normal color vision.

Each son of a carrier female has a 50-50 chance of getting the gene from his mother. In a typical sce-

nario, a man inherits the color-deficiency gene from his maternal grandfather. For a woman to be color deficient, she must have an affected father, and her mother must be a carrier. Even then, her odds of getting the gene would be only 50-50.

So what does this mean to you as a pilot? Color vision is essential for recognizing aircraft posi-

FAR Vision Requirements

Pilot vision requirements for first-, second-, and third-class medical certificates are spelled out in Federal Aviation Regulations 67.103 (first class), 67.203 (second class), and 67.303 (third class). The one requirement common to all three FARs is subparagraph "(c) Ability to perceive those colors necessary for the safe performance of airman duties." But it's not the only one that causes some people to think they can't become a recreational or professional pilot.

Visual acuity is perhaps the greatest point of confusion. Professional (paid) pilots need a first- or second-class medical certificate, and until 1996 their visual requirements included uncorrected 20/20 vision, meaning you had to be able to see 20/20 without your glasses or contacts. Because of this, and because military pilots must have 20/20 uncorrected vision, people naturally assumed all pilots must meet this requirement.

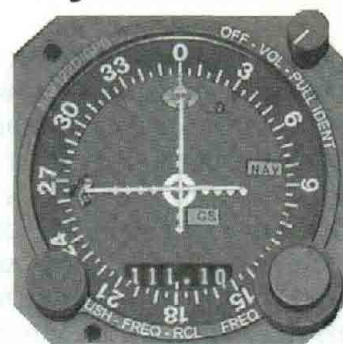
Wrong. When the FAA revised the medical certification requirements in 1996, it changed the first- and second-class "eye standards" to "(a) Distant visual acuity of 20/20 or better in each eye separately, with or without corrective lenses. If corrective lenses (spectacles or contact lenses) are necessary for 20/20 vision, the person may be eligible only on the condition that corrective lenses are worn while exercising the privileges of an airman certificate."

What about the third-class medical certificate, the one most pilots who fly for fun and personal business must hold? Don't they need 20/20 vision, too? Nope. FAR 67.303(a) requires "Distant visual acuity of 20/40 or better in each eye separately, with or without corrective lenses. If corrective lenses (spectacles or contact lenses) are necessary for 20/40 vision, the person may be eligible only on the condition that corrective lenses are worn while exercising the privileges of an airman certificate."

Another vision requirement that tends to catch pilots off guard, especially older pilots, is the near-vision requirement. Pilots who must hold a first- or second-class medical must meet the requirements of their respective subparagraph "(b) Near vision of 20/40 or better, Snellen equivalent, at 16 inches in each eye separately, with or without corrective lenses. If age 50 or older, near vision of 20/40 or better, Snellen equivalent, at both 16 inches and 32 inches in each eye separately, with or without corrective lenses" [emphasis added].

Pilots who must hold a third-class medical must have "(b) Near vision of 20/40 or better, Snellen equivalent, at 16 inches in each eye separately, with or without corrective lenses." Why a near-vision requirement? To make sure pilots can read their instrument approach and other charts. So when you go for your medical exam, make sure you take your bifocals or reading glasses with you.—S.M. Spangler

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tion lights, light-gun signals, airport beacons, approach-slope indicators, and chart symbols, especially at night. Part 67 of the Federal Aviation Regulations addresses medical standards for certification, and it says pilots must have "the ability to perceive those colors necessary for the safe per-

formance of airman duties" for all medical certification classes.

How can you find out if you have a color vision deficiency?

Many student pilots don't know they have a color vision deficiency because it doesn't affect their daily lives. Therefore, most learn about it during their first visit to an aviation

medical examiner (AME). This is unfortunate, because the AME is required by the FAA to prohibit anyone failing a color vision test from flying at night or by reference to light-gun signals.

Several websites offer crude color vision tests you can take (to access them, click on *EAA Sport Aviation* on the EAA website at www.eaa.org). The emphasis is on the word crude—these screening tools are not a substitute for an eye doctor's exam.

But, if your performance on one of these tests suggests a color vision abnormality, *before* you visit the AME have an optometrist or ophthalmologist evaluate your color vision with pseudoisochromatic (almost same color) test plates or with an FAA-approved alternative test (see tables on following page).

If possible, find an optometrist or ophthalmologist who uses the Dvorine or AOC test plates. People with color vision deficiencies usually find these easier to pass than the Ishihara plates.

Have your eye doctor record the results of these tests on FAA Form 8500-7, Report of Eye Evaluation, which you can download from the *EAA Sport Aviation* section of the EAA website. And since you're seeing the eye doctor, have him or her complete the rest of your FAA-required eye exam. That way your vision won't even be an issue when you see your AME.

Hand picking the color vision test you take is absolutely above board—if you select an FAA-approved test from the list on the following page. Most people with color vision deficiencies are only mildly affected and can easily perceive those colors necessary for the safe performance of airman duties. People who have a significant and potentially hazardous color vision problem will fail the color vision examination no matter which test they use.

How can you remove a color vision restriction from your

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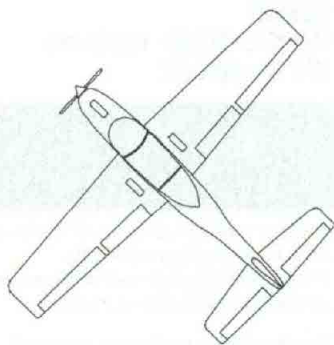
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Color Vision Tests

Pseudoisochromatic Test Plates

American Optical Company (AOC) 1965 edition
AOC-HRR 2nd edition
Dvorine 2nd edition
Ishihara 14-plate edition
Ishihara 24-plate edition
Ishihara 38-plate edition
Richmond 1983 edition

Disqualifying Number of Errors

7 or more on plates 1-15
Any on plates 7-11
7 or more on plates 1-15
6 or more on plates 1-11
7 or more on plates 1-15
9 or more on plates 1-21
7 or more on plates 1-15

FAA-Approved Alternative Color Vision Tests

These tests listed below may be used in lieu of pseudoisochromatic test plates.

Alternative Test

Farnsworth lantern
Keystone orthoscope
Keystone telebinocular
LKT Technologies APT-5

Disqualifying Number of Errors

Average of >1 error per series of 9 color pairs in series 2 and 3
Any errors in sic plates
Any errors in sic plates
Letter must be correctly identified in at least color vision tester 2 of the 3 presentations of each test condition
Any errors in sic plates (models 2000PM, 2000PAME, 200PI)
Any errors in sic plates
Any errors in sic plates (models TII, TIIS)
Any errors in sic plates (models T2A,T2S)

OPTEC 200 vision tester

Titmus vision tester

Titmus II vision tester

Titmus 2 vision tester

Note: Yarn tests are not approved by the FAA.

medical certificate? The best way is to successfully complete one of the FAA-approved tests listed in the above box. If you pass the alternative test, the FAA will issue you an unrestricted amended medical certificate and a letter documenting that you've satisfied the color vision standards.

If you do not pass, you can request authorization from the FAA Aeromedical Certification Division to take a color signal-light test, in which you must identify light-gun signals flashed from a control tower. If you pass the light-gun test, the FAA will issue you a Statement of Demonstrated Ability (SODA) and remove the restriction from your medical certificate.

If you do not pass, you can take the test once more. If the second attempt is unsuccessful, the color vision restriction becomes permanent. Therefore, it's a good idea to take a practice color signal-light test before scheduling the real thing with your local FAA Flight Standards District Office.



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