

# Medical Examiners' – Medical Manual

## Part 3 - Clinical Aviation Medicine

### 3.11 Ophthalmology

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GD:	Timing of Routine Examinations & Examination Procedures
ICAO Medical Manual:	<a href="#">Chapter 11</a>

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### 3.11.1 Introduction

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The aviation environment is visually complex and tri-dimensional. It includes poor visibility and contrast by day and night, extensive use of colours on maps, in instruments and at airports. The visual targets are small and moving. There is a plethora of small print information.

It is therefore evident that good visual performance is essential to flight safety. The ICAO SARPS and the CAR Part 67 vision standards reflect this necessity.

Approximately 50% of civilian pilots require refractive correction while flying, probably more in some Asian countries. Van B. Nkakagawara et al. (2002) studied the USA civilian aggregated data base of aviation incidents and accidents in which the use of an ophthalmic device was considered to have been a contributing factor. They found this to be the case in 45 out of 78216 events, or 0.06% of incidents and accidents. The distribution of the incidents causes were:

Spectacles lost or broken	11
New or inappropriate refractive correction	12
Refractive correction not worn when should	4
Lack or misuse of sunglasses	10
Eyewear interfering with protective breathing equipment resulting in hypoxia or impaired vision	2
Contact lenses displace or dislodged	2
	45

While these numbers are indeed very small, it is probable that a large number of minor but potentially serious incidents have not been documented in this series.

This chapter of the CAA medical manual aims to assist Medical Examiners in the assessment of applicants with a functionally impaired visual system.

## 3.11.2 Examination Techniques

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Examination techniques are described in:

The ICAO Medical Manual;

The General Direction - Examination Procedures:

[http://www.caa.govt.nz/medical/GD\\_Examination\\_Procedures.pdf](http://www.caa.govt.nz/medical/GD_Examination_Procedures.pdf)

As a reminder Visual acuity determination must be done with a 6 m chart presented at 6 m from the applicant (6m achieved at a distance of 3 m with the use of mirror is acceptable).

[http://www.caa.govt.nz/medical/GD\\_Examination\\_Procedures.pdf](http://www.caa.govt.nz/medical/GD_Examination_Procedures.pdf) (section 2.2.2(c))

A distance of 6 m obtained via a mirror is acceptable. The 6 m “equivalent” charts, used at 4 m are not acceptable.

### 3.11.3 Colour Vision

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#### 3.11.3.1 Considerations

The prompt and accurate recognition of colours is an integral part of safe aviation, increasingly so as colour-coded Electronic Flight Instruments Systems (EFIS) displays are becoming the norm. The advent of colour radar screens has rendered the interpretation of weather phenomena much easier.

The information showing on an EFIS is said to be redundant because it is readable even for someone with no colour perception. However faultless rapid data acquisition is important. Without adequate colour perception there is potential to confuse information, i.e. which beacon label relates to which pointer on the Horizontal Situation Indicator (HSI).

Colour coded approach, runway and taxi lights as well as gate parking aids involve multiple colours discrimination. The use of visual signals for clearances (red, green and white) by Air Traffic Controllers has become largely obsolete. Thus functional testing with those lights has become mainly irrelevant.

A US study demonstrated that mild colour deficient persons performed well for correctly and efficiently recognizing PAPI lights and coloured cockpit display symbology. However moderate and severely colour vision deficient persons fell far outside the range of normal response time and accuracy.

Colour vision deficiency affects around 8% of males and 0.5 to 1% of females.

#### Commonest Types of Colour Vision Deficiency in males:

- Protanomaly (1.0%): Reduced sensitivity to red lights.
- Extreme protanomaly (0.2%): Reduced sensitivity for red lights, reduced colour discrimination for red, yellow and green.
- Protanopia (1.0%): Reduced sensitivity for red lights; confusion of red, yellow and green.
- Deuteranomaly (4.5%): Colour matches different from those made by normals.
- Extreme Deuteranomaly (0.5%) Reduced colour discrimination for red, yellow and green.
- Deuteranopia (1.5%): Confusion of red, yellow and green.

#### Acquired Colour Vision Deficiency

Although much less common than congenital defects, acquired colour vision defects do occur. These may affect one eye more than the other and may be progressive. Blue colour perception is generally most affected. The Ishihara plates do not screen well for such deficiencies.

Causes include:

- a) Retinal degeneration and pigmentary retinopathies;
- b) Chorioretinitis from any cause including macular lesions;

- c) Optic neuropathy from any cause including advanced glaucoma;
- d) Drug toxicity affecting the macula or the optic nerve;
- e) Intra ocular lenses;
- f) Use of coloured contact lenses, etc.

For this reason colour vision tests should be repeated in case of any suspected eye disease and also following refractive surgery.

### 3.11.3.2 Examination Procedure

The ME must conduct a colour perception test on all first applicants, using the Ishihara printed plates in accordance with the [GD “Examination Procedure”](#) -section 11.

The use of X-Chrom, ChromaGen, Colorview, or similar lenses to improve colour vision discrimination **are not** acceptable.

The ME should conduct the test even if the applicant is to be referred to an optometrist or ophthalmologist.

The ME should be aware that an applicant with a known or suspected colour vision defect may have learned the plates which must be presented in random order.

If there is any doubt regarding the interpretation of colour vision tests, the ME should promptly seek advice from the CAA.

### 3.11.3.3 Disposition:

- A Class 1, 2 or 3 applicant who incorrectly identified Ishihara plates as specified in the [Examination Procedures GD](#), schedule 1, section 11, must be considered as having a colour vision deficiency.
- A Class 1 or Class 2 applicant with colour vision deficiency may be assessed as having a condition that is not of aeromedical significance if the certificate is endorsed in accordance with the Colour Vision GD – section 11
- A Class 1 or Class 2 applicant with colour vision deficiency who has undergone and failed further testing as outlined in the Colour Vision GD, section 10, may be assessed as having a condition that is not of aeromedical significance if the certificate is endorsed in accordance with the Colour Vision GD – section 11
- A Class 1 or Class 2 applicant with colour vision deficiency who has undergone and passed further testing, as outlined in the Colour Vision GD, section 10, may be assessed as having a condition that is not of aeromedical significance and issued an unrestricted certificate in accordance with the Colour Vision GD – section 11
- A Class 1 or Class 2 applicant with colour vision deficiency who has undergone and failed further testing may be assessed as having a condition that is not of aeromedical significance if the applicant has undergone and passed the relevant components of an Operational Colour Vision Assessment certificate and is endorsed in accordance with the Colour Vision GD – section 12



The following organisations can provide further testing:

School of Optometry, University of Auckland (CAD test and Optec 900 Lantern, an accepted Farnsworth Lantern equivalent);

Mr Frank Snell, optometrist in Auckland (Holmes-Wright type A Lantern);

Mr Peter Grimmer, Wellington, (Holmes-Wright type B Lantern);

Most optometrists: Farnsworth D15.

## 3.11.4 Anisometropia

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### 3.11.4.1 Considerations

Anisometropia is a difference in the refraction characteristics of the two eyes. It can exist with any type of refractive error detailed later in this manual. The different refractive corrections needed for the two eyes result in different image size. This is called aniseikonia. The brain may be unable able to “fuse” the images if the anisometropia is large. Contact lenses avoid this problem.

### 3.11.4.2 Information to be provided

A special eye report should be provided in the following circumstances:

- As required in the **Timing of Routine Examinations GD**;
- On the first occasion that an applicant presents with a known or suspected difference of refractive error between the two eyes, other than minor;
- On the first occasion that an applicant presents with contact lenses;
- On the first occasion that an applicant presents with uncorrected distance visual acuity of 6/60 or worse in either eye;
- Every five years if an applicant has uncorrected distance visual acuity of 6/60 or worse, in accordance with ICAO recommendation;
- Every 2 years or as determined by the ME, if an applicant is young and the ME suspects that the refractive error has not yet stabilised. Alternatively, in this latter situation, the ME may elect to review the applicant and only refer if the standards are not met.

### 3.11.4.3 Disposition

An anisometropia of 2.5 Dioptres or more should be considered as being of aeromedical significance.

A recent anisometropia (less than 6 months duration) of 2.0 Dioptres or more should be considered as being of aeromedical significance.

## 3.11.5 Myopia

### 3.11.5.1 Consideration

Myopia is the result of a long eye with the images focusing in front of the retina. Distance vision is affected and requires concave lenses for correction, thus reducing the images size on the retina. When myopes become affected by presbyopia they require bifocals or varifocal with reduced myopic correction in the lower segment of the spectacles lenses. Alternatively, if using contact lenses, they will need near vision half spectacles to be readily available.

Young myopes commonly see their refractive error increase until the age of about 25. Thus myopes under this age, particularly teenagers, should have their vision performance assessed more frequently, perhaps every two years.

### 3.11.5.2 Information to be provided

A special eye report must or should be provided in the following circumstances:

- As required in the **Timing of Routine Examination GD**;
- On the first occasion that an applicant presents with contact lenses;
- On the first occasion that an applicant presents with uncorrected distance visual acuity of 6/60 or worse in either eye;
- Every five years if an applicant has uncorrected distance visual acuity of 6/60 or worse, in accordance with ICAO recommendation;
- Every 2 years or as determined by the ME, if an applicant is young and the ME suspects that the refractive error has not yet stabilised. Alternatively, in this latter situation, the ME may elect to review the applicant and only refer if the standards are not met.

### 3.11.5.3 Disposition in case of myopia

An applicant with myopia who only meets the standards when using corrective lenses must have the medical certificate endorsed accordingly:

- Distance spectacles must be worn; or
- Distance spectacles must be worn, contact lenses permitted (if using contact lenses); and
- Spare spectacles must be readily available.

## 3.11.6 Severe Myopia

### 3.11.6.1 Considerations

Severe myopia, for the purpose of this manual can be arbitrarily defined as a refractive error of Dioptres of Sphere DS -6 and very severe myopia as a refractive error of DS-8 or worse. Under the ICAO SARPS applicants with high refractive errors should undergo a special vision examination every five years.

Correction of myopia with spectacles results in smaller images on the retina. Aberrations also occur. Contact lenses or high refraction index aspheric spectacles lenses, which are thinner, more comfortable and have reduced aberrations, should be used in cases of severe myopia.

### 3.11.6.2 Information to be provided

A special eye report must or should be provided in the following circumstances:

- As required in the **Timing of Routine Examinations GD**;
- On the first occasion that an applicant presents with contact lenses;
- On the first occasion that an applicant presents with distance uncorrected distance visual acuity of 6/60 or worse;
- Every five years if an applicant has uncorrected distance visual acuity of 6/60 or worse, in accordance with ICAO recommendation;
- Every 2 years or as determined by the ME, if an applicant is young and the ME suspects that the refractive error has not yet stabilised. Alternatively, in this latter situation, the ME may elect to review the applicant and only refer if the standards are not met.

### 3.11.6.3 Disposition in case of severe myopia

An applicant with severe myopia should be considered as having a condition that is of aeromedical significance if:

- The refractive error is in excess of DS -8 (very severe myopia, because of potential for complications); or
- If the severe myopia is combined with more than mild astigmatism; or
- When there is suspicion of eye disease; or
- If the applicant is not using either contact lenses or spectacles fitted with high refractive index aspheric lenses.

An applicant with severe myopia who is considered to meet the standards should have the medical certificate endorsed as follows:

- Distance spectacles must be worn, or
- Distance spectacles must be worn, contact lenses permitted - if using contact lenses; or
- Contact lenses must be worn; and
- Spare spectacles must be readily available.

### 3.11.7 Astigmatism

Astigmatism occurs when different refractive errors are present in different lens/eye meridians. Astigmatism requires cylindrical rather than spherical lenses for correction. The prescription typically includes the dioptre value correction and the cylindrical axis of the required lens. i.e. Dioptres of Cylinder DC: -1.5 x 75 [dioptres x degrees]. Astigmatism is most often combined with a spherical error, myopia or hypermetropia.

The equivalent spherical error is taken as the mathematical sum of any spherical refraction error plus half that of the cylindrical refraction error.

For instance an applicant with the following prescription:

DS -4.0 / DC -2.5 x 150 can be estimated to have a total error:  $-4.0 + (-2.5 \times 1/2) = -5.25$

One should be suspicious of keratoconus in applicants with worsening astigmatism. Keratoconus can be missed at the early stage, only to compromise a flying career later.

Thus an applicant with worsening astigmatism should be assessed for keratoconus. If present, the condition may progress and eventually render an applicant ineligible some years later, despite currently meeting the corrected visual acuity standards. In case of doubt a yearly optometrist or ophthalmologist report including corneal topography mapping should be obtained. The applicant should be well informed of the potential for future certification difficulties.

#### 3.11.7.1 Information to be provided

A special eye report must or should be provided in the following circumstances:

- As required in the **Timing of Routine Examinations GD**;
- On the first occasion that an applicant presents with progressive astigmatism (any previous reports by vision professionals must also be provided for comparison).
- At regular intervals subsequently if keratoconus is suspected;
- On the first occasion that an applicant presents with contact lenses;
- On the first occasion that an applicant presents with uncorrected distance visual acuity of 6/60 or worse in either eye;
- Every five years if an applicant has uncorrected distance visual acuity of 6/60 or worse, in accordance with ICAO recommendation;
- Every 2 years or as determined by the ME, if an applicant is young and the ME suspects that the refractive error has not yet stabilised. Alternatively, in this latter situation, the ME may elect to review the applicant and only refer if the standards are not met.

### 3.11.7.2 Disposition in case of Astigmatism

An applicant with astigmatism who meets the uncorrected or corrected visual acuity standards may be considered as not having a condition that is of aeromedical significance.

An applicant with astigmatism, who only meets the visual acuity standards while using spectacles, may be considered as having a condition that is not of aeromedical significance if the certificate is endorsed with:

- Distance spectacles must be worn, or
- Distance spectacles must be worn, contact lenses permitted - if using contact lenses;  
or
- Spare spectacles must be readily available.

## 3.11.8 Hypermetropia

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### 3.11.8.1 Considerations

Hypermetropia is the result of a short eye. It results in being “long sighted”. The eye must accommodate to see at distance. A degree of hypermetropia is physiological in children and tends to increase until the age of eight, to then decrease until stability is reached around the age of 25. However children affected by excessive hypermetropia need early diagnosis to prevent strabismus and/or amblyopia and reading difficulties.

With marked hypermetropia the eye cannot accommodate for near vision. The co-existence of hypermetropia and presbyopia means that an even stronger refractive correction is needed. The required lenses are convex.

Hypermetropia is easily missed, for instance in the young adult applicant who may still manage to accommodate to 30 - 50 cm. Hypermetropia may result in asthenopia (eye fatigue) and difficulties to sustain focus.

Hypermetropia can be detected by testing at distance while wearing a convex lens (power DS +1.0 to DS + 2.5) placed in front of the eye. The hypermetropic eye will still be able to see normally at distance. The emmetropic eye will have reduced vision in this situation as it has been made short-sighted.

### 3.11.8.2 Information to be provided

A special eye report must or should be provided in the following circumstances:

- As required in the **Timing of Routine Examination GD**;
- On the first occasion that an applicant presents with uncorrected distance visual acuity of 6/60 or worse in either eye;
- On the first occasion that an applicant presents with contact lenses;
- On the first occasion that hypermetropia is suspected;
- On the first occasion that an applicant presents with uncorrected near vision that does not meet the uncorrected vision standards;
- Every five years if an applicant has uncorrected distance visual acuity of 6/60 or worse.

### 3.11.8.3 Disposition in case of hypermetropia

An applicant with hypermetropia of DS+6 or more should be considered as having a condition that is of aeromedical significance.

An applicant with hypermetropia of less than DS+6 dioptres who meets the vision standards uncorrected may be considered as not having a condition that is of aeromedical significance if:



- There is no evidence of asthenopia;
- The muscle balance (phoria) is within acceptable limits.

An applicant with hypermetropia or less than DS +6, who only meets the vision standards and / or the phoria acceptable limits while using spectacles, may be considered as having a condition that is not of aeromedical significance if the certificate is endorsed with:

- Distance spectacles must be worn; or
- Distance spectacles must be worn, contact lenses permitted (if using contact lenses); and
- Spare spectacles must be readily available.

An applicant with hypermetropia of less than DS+6 and presbyopia (see also subchapter 3.10.8 Presbyopia) who only meets the vision standards and / or the phoria acceptable limits while using spectacles, may be considered as having a condition that is not of aeromedical significance if the certificate is endorsed with:

- Bifocal spectacles must be worn; or
- Bifocal spectacles (Varifocal spectacles permitted) - if using varifocal spectacles; or
- Contact lenses must be worn (if using contact lenses), and look-over spectacles must be readily available; and
- Spare spectacles must be readily available.

This ME should refer readily to CAA for advice in case of doubt or difficulty interpreting the eye report.

## 3.11.9 Presbyopia

### 3.11.9.1 Consideration (see also 3.11.10 Visual aids)

Presbyopia is the result of aging with progressive inability to accommodate. In the emmetropic eye, the need for near vision correction arises at around age 40 - 50.

The Myope will also need correction at about the same age if wearing their distance glasses. In practice myopes tend to either remove their spectacles to read or look under or over their spectacles frame. Alternatively they use spectacles with bifocal or varifocal lenses.

The Hypermetrope (Hyperope) who does not need spectacles to meet the distance vision standards will need near vision correction at a younger age, initially being able to use full frame corrective lenses, needing bifocal later.

### 3.11.9.2 Information to be provided

A special eye report must or should be provided in the following circumstances:

- As required in the **Timing of Routine Examination GD**;
- On the first occasion that an applicant Class 1 or 3 does not meet the uncorrected near vision standards;
- On the first occasion that an applicant presents with contact lenses.

### 3.11.9.3 Disposition in case of presbyopia

#### ***Class 1, 2 and 3 (ATC working in Tower)***

Under the ICAO SARPS, when near and distance correction are both needed, the applicant shall demonstrate that one pair of spectacles is sufficient to meet both distant and near vision requirements. CAA has adopted this recommendation as a policy (See 3.11.10 Visual aids).

A Class 1, 2 or 3 applicant with presbyopia who only meets the vision standards when using corrective lenses must have the medical certificate endorsed accordingly:

- Half spectacles must be readily available, if refractive correction is only needed to meet the near vision standards; or
- Bifocal must be worn, if refractive correction is needed to meet both distance and near vision standards; or
- Bifocal must be worn (varifocal permitted), if refractive correction is needed to meet both distance and near vision standards and such correction is in use; or
- Contact lenses must be worn and half spectacles must be readily available, if using contact lenses for distance vision; or
- Trifocal must be worn, if refractive correction is needed to meet distance, near and / or intermediate; and such correction is in use; or

- Trifocal must be worn (varifocal permitted) if refractive correction is needed to meet distance, near and / or intermediate vision, and such correction is in use; and
- Spare spectacles must be readily available.

**Note 1:** The ability for a myope to read over or under the distance spectacles is not an acceptable alternative to wearing suitable bifocal / multifocal refractive lenses.

**Note 2: Class 3 Applicant (ATC working in radar room)**

A Class 3 applicant working in the radar room and who meets the distance vision standards uncorrected but only meets the intermediate / near vision standards when using corrective lenses may use full frame spectacles that are adequate for the intermediate and near distance working conditions.

## 3.11.10 Visual Aids

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### 3.11.10.1 Considerations

Under the ICAO SARPS there are no dioptre limits for certification. However high refractive correction result in aberrations. High refractive correction should thus be achieved by means of contact lenses or high refractive index lenses that include aberration control (i.e. aspheric lenses). The ICAO Medical Manual Ophthalmology Chapter gives comprehensive information about the types of visual aids available and their use in aviation.

Coloured lenses are not permitted.

#### Need for distance and near correction

Under the ICAO SARPS, when near and distance correction are both needed, the applicant is required to demonstrate that **one pair** of spectacles is sufficient to meet both distant and near vision requirements. This is to allow effective outside vision to be maintained together with the ability to read charts and instruments without changing spectacles. CAA has adopted this recommendation as a policy (see Presbyopia). If this requirement is not appropriate for some types of operations, i.e. helicopter long line work, CAA should be contacted for advice.

The combination of contact lenses and look-over spectacles is acceptable as this allows both distance and near vision without the need to remove or change spectacles.

#### Progressive and multifocal lenses spectacles

*Bifocal or Trifocal* spectacles may be necessary to achieve the distance, intermediate and near vision standards with one pair of spectacles. Please refer to the ICAO medical manual for the various configuration options.

*Progressive power lenses*, also called *varifocal lenses* may be permitted following a period of adaptation on the ground. This usually takes days to about one month.

They have a narrow field of sharp vision and require precise head movements to orientate the visual axis as necessary. In addition they may create unwanted visual illusion in the periphery. Some people are unable to adapt to this type of visual aids.

The use of varifocal spectacles is more likely to be problematic in small aircraft or helicopters because of the seating closer to the ground and the greater use of peripheral vision during landing.

Once comfortable, applicants using progressive spectacles should be advised to initially fly dual with an instructor or check pilot while wearing their progressive spectacles to ensure good visual judgement.

#### Spare spectacles

ICAO SARPS require spare spectacles to be available when refractive correction is needed to achieve the vision standards. CAA policy now requires medical certificate holders to have spare spectacles readily available (see also sunglasses on next page).

## Contact Lenses

Contact lenses are permitted if well tolerated. Under ICAO SARPS contact lenses must be non-tinted and multifocal contact lenses are not permitted.

An applicant who is starting to wear contact lenses should demonstrate good tolerance after a period of adaptation. This is particularly important for long haul pilots who spend long hours in a very dry environment. Occasionally applicants present wearing *multifocal lenses*. An applicant who insists on using this type of lenses should be assessed as not meeting the vision standards.

*Monovision* contact lenses, aiming at giving satisfactory distance vision in one eye and satisfactory near vision in the other eye **are not** acceptable.

*Monovision* achieved by way of refractive surgery, by rendering one eye myopic, is an increasingly common practice used to achieve freedom of glasses. This **is not** acceptable.

## Orthokeratology contact lenses

Orthokeratology (Ortho-K) is the use of rigid gas-permeable contact lenses that reshape the cornea to reduce refractive errors, normally worn only during sleep, to improve vision through reshaping of the cornea. It is used as an alternative to refractive surgery or for those who prefer not to wear contact lenses while awake. The correction is not permanent and the visual acuity will regress while not wearing the Ortho-K lenses. There is no reasonable or reliable way to determine whether visual standards continue to be met for the entire period the lenses are removed. Those lenses require several weeks to adapt to and some users may experience initial difficulties such as ghosting, contrast problems and double vision. There may also be issues with corneal hypoxia.

The FAA requires applicants who use Ortho-K lenses to meet the applicable vision standard while wearing the Ortho-K lenses and to wear the Ortho-K lenses while piloting.

The NZ CAA generally has a more restrictive approach and MEs should specifically inquire about the use of Ortho-K lenses.

The use of orthokeratology lenses **is not** acceptable and should be considered as being of aeromedical significance. Applicants using such lenses should be considered under the flexibility process. It is unlikely that they will be issued a medical certificate unless they revert to other forms of acceptable refractive correction.

## Sunglasses

ICAO SARPS recommend the use of neutral grey tint to avoid altered perception of surroundings. The use of *transition lenses* is discouraged due to their sluggish light transmission change characteristics when moving into dim lighting conditions. They must not be used by night. If used by day, clear spare spectacles, allowing the vision standards to be met, should be also carried. *Prescriptions sunglasses* are acceptable as third pair of corrective lenses in addition to the main and spare corrective lenses which should both be clear lenses. The use of Polaroid lenses is not acceptable as further polarisation through the windscreen or instrument glass can lead to unexpected loss of outside or instruments vision.

## 3.11.11 Refractive Surgery - Radial keratotomy

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### 3.11.11.1 Considerations

Young applicants who undergo any type of refractive surgery for myopia before the refractive error has stabilised are at risk of recurrence of myopia, albeit to a lesser degree.

Radial keratotomy is a procedure rarely used these days being mostly limited to treating severe astigmatism. It consists in radial incisions of the cornea, allowing it to flatten.

Radial keratotomy may result in fluctuating visual acuity and sensitivity to glare. This can cause difficulties in the healing phase.

The long-term consequences of radial keratotomy are difficult to predict. Applicants should be reminded of this uncertainty as it may affect their chances of employment in the aviation industry.

Following radial keratotomy, the refraction takes time to stabilise to its new value. Flying is not permitted while the refraction is susceptible to change.

Evidence of stability generally requires:

- A waiting period since surgery of at least three months;
- A visual acuity remaining within standards for the Class sought when tested at different times, whether corrected or uncorrected;
- Absence of problem with haze, glare or contrast sensitivity.

### 3.11.11.2 Information to be provided

An applicant who first presents with a history of radial keratotomy should provide:

- All reports by the surgeon who undertook the procedure;
- Documentation indicating the pre-surgery refractive error;
- A special eye report, from an accredited optometrist, completed not earlier than three months post-surgery. This must include information about haze, glare, contrast sensitivity and all visual acuity and refractive error determinations done since the procedure. Measurements are to include early morning and late in the day determinations.

#### Note:

MEs should have a low threshold for seeking advice by the CAA in cases of radial keratotomy.

Testing of visual performance with a bright light shining at the applicant should be sufficient to demonstrate any excessive vision impairment under glare condition. A formal determination can also be done by some optometrists.

### 3.11.11.3 Disposition following radial keratotomy

An applicant who has undergone radial keratotomy in the past one year should be assessed as having a condition that is of aeromedical significance.

An applicant who has undergone radial keratotomy more than one year ago may be assessed as having a condition that is not of aeromedical significance if:

- The applicant meets the vision standards with or without corrections; and
- The visual acuity remains within standards for the Class sought when tested at different times, whether corrected or uncorrected; and
- There is no corneal haze; and
- There is normal contrast sensitivity; and
- The applicant does not suffer from glare.

Provided that the certificate is endorsed as follows:

- The appropriate endorsements requiring corrective lenses are applied if the standards can only be met while wearing corrective lenses; and
- Surveillance is imposed requiring yearly special eye report until five years have lapsed since surgery;
- Surveillance every five years thereafter should also be undertaken.

## 3.11.12 Refractive surgery - Laser Surgery - all forms

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### 3.11.12.1 Considerations

Young applicants who undergo any type of refractive surgery for myopia before the refractive error has stabilised are at risk of recurrence of myopia, albeit to a lesser degree.

There are different Laser procedures, all with their pros and cons. The results of refractive Laser surgery are generally excellent. However applicants should be reminded of occasional complications as it may affect their chances of employment in the aviation industry.

The Small Incision Lenticule Extraction laser procedure (SMILE) is a more recent surgical technique, made possible by the development of femtosecond lasers. This technique limits the surgical damage to peripheral corneal nerves. This can be expected to reduce the incidence of dry eye and other side effects. The localisation of the treatment to intrastromal corneal depths beneath the anterior elastic lamina can be expected to improve the strength of the treated cornea. However the loss of tissue volume inside the cornea rather than on the surface might result in complications not seen before. The Kamiya et al (2015) study has showed good stability of the correction with no change over 0.5 D over 12 months. Blum et al (2014) reported stability within +/- 1 D over five years. While the safety and outcomes of this technique are thought to be good, the full picture will only be available when longer term follow up studies are published. Meanwhile, CAA will impose stricter surveillance conditions following SMILE surgery than for other types of laser surgery. Please consult with CAA for any such cases.

Following Laser surgery, the cornea takes time to heal and the refraction takes time to stabilise to its new value. Flying is not permitted while the refraction may still change.

Evidence of stability generally requires:

- A waiting period since surgery of at least six weeks for refractive correction of 3 dioptres or less and three months for correction of more than 3 dioptres;
- A visual acuity remaining within standards for the Class sought when tested at different times, whether corrected or uncorrected;
- Absence of problem with haze, glare or contrast sensitivity.

### 3.11.12.2 Information to be provided

An applicant who first present with a history of refractive laser surgery should provide:

- All reports by the surgeon who undertook the procedure, if recent;
- Documentation indicating the pre-laser surgery refractive error or, if not obtainable, the pre-operative uncorrected and corrected visual acuity; and



- A special eye report completed not earlier than six weeks post-surgery (twelve weeks for correction of over 3 dioptres). This must include information about haze, glare, contrast sensitivity and all visual acuity and refractive error determinations done since the procedure (the latter unless the surgery occurred more than six months prior).

### 3.11.12.3 Disposition following refractive Laser surgery

**Note:** In case of SMILE laser surgery taking place within the past 12 months, please contact CAA for advice.

An applicant who has undergone refractive Laser surgery may be assessed as having a condition that is not of aeromedical significance if:

- The applicant meets the vision standards with or without corrections; and
- At least 6 weeks (three months for correction of over 3 dioptres) have lapsed since refractive surgery; and
- The visual acuity remains within standards for the Class sought when tested at different times, whether corrected or uncorrected; and
- There is no corneal haze; and
- There is normal contrast sensitivity; and
- The applicant does not suffer from glare.

Provided that the certificate is endorsed as follows:

- The appropriate endorsements requiring corrective lenses are applied if the standards can only be met while wearing corrective lenses;
- Surveillance is imposed requiring a special eye report at six months, one year and five years post-surgery for correction of less than 3 dioptres;
- Surveillance is imposed requiring a special eye report at six months, one year, two year and five years post-surgery for correction over 3 dioptres;
- Surveillance every five years thereafter should also be considered for Class 1 certificate holders.

**Note:** If the eyes are treated at different time, anisometropia may be an issue. Please refer to 3.1.4 *Anisometropia* subchapter.

### 3.11.13 Implantable Collamer Lenses (ICLs)

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#### 3.11.13.1 Considerations

These lenses are implanted in front of the crystalline lens. This type of lenses is more often used when laser surgery is contraindicated such as with very high myopia or thin cornea. They have essentially the same effect as contact lenses. This means that visual acuity is expected to be better than with spectacles in the case of myopes.

The ocular complications created by the extra bulk of an additional lens in the posterior chamber (behind the iris and in front of the crystalline lens) need to be monitored. As the natural lens continues to grow throughout life, the positioning and the safety of the ICL may be compromised. If the ICL is in contact with the natural lens there is a risk of cataract. In this case the ICL may need to be removed together with the natural lens and replaced by a traditional IOL. ICLs can also displace and no longer be centred on the visual axis.

The risk of retinal detachments is significantly increased with high myopia. This is not reduced by the implantation of corrective lenses. Binocularity should not be affected.

Providing the ICL does not become coated with any inflammatory materials as a result of uveitis etc, the clarity of the ICL should be maintained as should contrast sensitivity and glare sensitivity.

Collamer lenses are generally not acceptable because of their possible complications and the reasons for using them.

#### 3.11.13.2 Information to be provided

- All reports by the surgeon who undertook the procedure;
- Documentation indicating the pre-operative refractive error or, if not obtainable, the pre-operative uncorrected and corrected visual acuity;
- A special eye report completed by an accredited optometrist not earlier than six weeks post-surgery. This must include information about haze, glare, contrast sensitivity and fundus.

#### 3.11.13.3 Disposition

- An applicant who has undergone Collamer lens implantation should be considered as having a condition that is of aeromedical significance.

## 3.11.14 Substandard Vision in One Eye

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### 3.11.14.1 Considerations

Substandard vision in one eye exists, by definition, when that eye uncorrected vision is better than 6/60 but cannot be corrected to the standard applicable to the class of certificate that is applied for.

A common cause for substandard vision in one eye is amblyopia, but there are many other possible causes. Examples are trauma, corneal disease, cataract, retinal disease, toxoplasmosis, etc.

Substandard vision in one eye is often accompanied by decreased stereopsis. Binocular depth perception is effective at near such as when manoeuvring at the airport parking, during formation flying and for low levels helicopter operations. The necessity of good stereopsis for fixed wings aircraft landings is controversial.

### 3.11.14.2 Information to be provided

Applicants with substandard vision in one eye should provide:

- A special eye report on the first occasion they present with this condition; and subsequently as may be indicated; and
- A visual field determination;
- A special eye report every five years.

### 3.11.14.3 Disposition

- An applicant with substandard vision in one eye does not meet the CAR part 67 medical standards. Thus the issue of a certificate can only occur following the flexibility process.

#### ***Class 2 applicant:***

Under the flexibility process a Class 2 applicant with substandard vision in one eye is likely to be issued a certificate if:

- The uncorrected distance visual acuity in the good eye is 6/12 or better; and
- The corrected distance visual acuity in the good eye is 6/9 or better; and
- The applicant meets the near visual acuity standard with or without correction; and
- There is no visual fields impairment;
- The substandard vision is of more than 6 months duration and is stable;
- If requested, a medical flight test has demonstrated the applicant to be safe.

Providing that the medical certificate:

- Is endorsed with the requirement to wear or have readily available correcting lenses as necessary to meet the above conditions; and
- Is endorsed with the requirement to have readily available spare spectacles if required to have correcting lenses to meet the standards;
- Is endorsed with any other conditions or restrictions as may be imposed following the AMC.

### **Class 1 & 3:**

Under the flexibility process a Class 1 or 3 an applicant with substandard vision in one eye may be issued a certificate in some cases if:

- The uncorrected distance visual acuity in the good eye is 6/12 or better; and
- The corrected distance visual acuity is 6/6 or better; and
- The applicant meets the near visual acuity standard with or without correction; and
- There is no visual fields impairment; and
- The substandard vision is of more than 6 months duration and is stable;
- If requested, a medical flight test has demonstrated the applicant to be safe.

Provided that the medical certificate:

- Is endorsed with the requirement to wear or have readily available correcting lenses as necessary to meet the above conditions; and
- Is endorsed with the requirement to have spare spectacles readily available if required to have correcting lenses to meet the standards;
- Is endorsed with any other conditions or restrictions as may be imposed following the AMC.

### 3.11.15 Functional and True Monocularity

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#### 3.11.15.1 Considerations

Functional monocularity exists, by definition, when there is severe impairment of central vision, i.e. one eye cannot see better than 6/60. The visual fields may be preserved.

True monocularity exists when one eye is missing or is non-functional. There is restriction of the visual fields that must be compensated by head movements, thus requiring full cervical spine mobility and full visual fields in the good eye.

Monocular individuals have no stereopsis. Binocular depth perception is effective at near such as when manoeuvring at the airport parking, during formation flying and for low levels helicopter operations. The necessity of good stereopsis for fixed wings aircraft landings is controversial.

#### 3.11.15.2 Information to be provided

Applicants with monocularity should provide:

- Copy of any report relating to the loss of vision in one eye;
- A special eye report by an accredited optometrist on the first occasion that an applicant presents with monocularity;
- A special report every five years subsequently or as may be required;
- A visual field determination result encompassing a test for central vision and a test for the full field of vision, such as the Medmont driving test or Esterman test.

#### 3.11.15.3 Disposition

- An applicant with monocularity does not meet the CAR part 67 medical standards. Thus the issue of a certificate can only occur following the flexibility process.

#### ***Class 2:***

Under the flexibility process, a Class 2 applicant with monocular vision may be issued a certificate in some cases if:

- The uncorrected distance visual acuity in the good eye is 6/12 or better; and
- The corrected distance visual acuity is 6/9 or better; and
- The applicant meets the near visual acuity standard with or without correction;
- Visual fields determination demonstrates full central and peripheral visual field in the good eye; and
- The applicant has a full range of neck movements; and

- At least 6 months have lapsed since the monocular condition has occurred and the applicant is adapted to the new condition.

Provided that the Medical Certificate:

- Is restricted to student privileges until a successful medical flight test has been undertaken with a flight examiner for day and for night operations respectively; and
- Is endorsed with the requirement to wear or have readily available correcting lenses as necessary to meet the above conditions; and
- Is endorsed with the requirement to have spare spectacles readily available if required to have correcting lenses; and
- Is endorsed with the requirements to inform any other pilot of the applicant's vision deficiency; and
- Is endorsed with the requirement to wear protective lenses, goggles or visor as appropriate for the operation undertaken;
- The certificate is endorsed with any other operational conditions and restrictions as may be appropriate or as imposed following an AMC.

### **Class 1**

A Class 1 or 3 monocular applicant who first applies for a medical certificate is unlikely to be issued with a medical certificate 1 or 3.

An experienced Class 1 or 3 monocular applicant who re-applies for a medical certificate may be issued a medical certificate in some cases if:

- The uncorrected distance visual acuity in the good eye is 6/12 or better; and
- The corrected distance visual acuity is 6/6 or better; and
- The applicant meets the near visual acuity standard with or without correction; and
- Visual fields determination demonstrates full visual field in the good eye; and
- The applicant has a full range of neck movement; and
- At least 6 months have lapsed since the monocular condition has occurred and the applicant is adapted to the new condition;
- The applicant has substantial flying experience.

Provided that the medical certificate:

- Is endorsed with the requirement to wear or have readily available correcting lenses as necessary to meet the above conditions; and
- Is endorsed with the requirement to have readily available spare spectacles if required to have correcting lenses; and

- Is endorsed with the requirements to inform any other pilot of the applicant's vision deficiency; and
- Is restricted to student privileges by day and by night respectively until a successful medical flight test, has been undertaken with a flight examiner for each type of operation;
- Is endorsed with the requirement to wear protective lenses, goggles or visor as appropriate for the operation undertaken;
- The certificate is endorsed with any other operational conditions or restrictions as may be appropriate, or as dictated by the AMC.

### **Class 3**

A Class 3 monocular applicant who first applies for a medical certificate is unlikely to be issued with a medical certificate Class 3.

An experienced Class 3 monocular applicant who re-applies for a medical certificate may possibly be issued a medical certificate if:

- The uncorrected distance visual acuity in the good eye is 6/12 or better; and
- The corrected distance visual acuity is 6/6 or better; and
- The applicant meets the near visual acuity standard with or without correction; and
- Visual fields determination demonstrates full central and peripheral visual field in the good eye, and
- The applicant has a full range of neck movement; and
- At least 6 months have lapsed since the monocular condition has occurred and the applicant is adapted to the new condition;
- A functional assessment has demonstrated that the applicant's condition is unlikely to affect flight safety.

Provided that the medical certificate:

- Is endorsed with the requirement to wear or have readily available correcting lenses as necessary to meet the above conditions; and
- Is endorsed with the requirement to have readily available spare spectacles if required to have correcting lenses; and
- The certificate is endorsed with any other operational conditions or restrictions as may be appropriate or as dictated by the AMC.

### 3.11.16 Keratoconus

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#### 3.11.16.1 Considerations

Keratoconus is a deformity of the cornea leading to a conic, irregular deformity of the cornea, usually in its lower quadrant, and astigmatism. It is due to dysplasia of the cornea and generally develops in early adulthood. It may progress over time or may be stable. LASIK surgery is generally contraindicated.

The condition results in variable refractions through different parts of the cornea, possibly resulting in distorted and fluctuating vision, multiple images, sensitivity to light etc. Sudden hydrops of the cornea may occur. Corneal mapping demonstrates the abnormal cornea.

Keratoconus should be suspected in a young applicant who has progressive astigmatism and or a severe or rapidly falling uncorrected visual acuity, pinhole acuity better than can be achieved with best refractive correction, or the retinoscopy reflex is not as regular as normal.

Clinically it may be difficult to see the fundus, and there may be an irregular reflexion of the cornea. Fleisher rings and a Munson's sign may be seen.

Treatment may include hard contact lenses, cross linking laser UVA surgery to stop progression of the condition and / or insertion of a "keraring" to normalise the corneal shape.

#### 3.11.16.2 Information to be provided

- On the first occasion that an applicant presents with keratoconus or suspected keratoconus, a special eye report by an accredited optometrist must be provided;
- Copy of all reports by any ophthalmologist consulted, to include any corneal mapping report and images;
- An annual special eye report should be provided;
- If the condition remains mild and has proven itself to be stable over several years, a reduced surveillance may later be considered.

#### 3.11.16.3 Disposition in the case of keratoconus

- An applicant with keratoconus who first apply for a Class 1, 2 or 3 medical certificate should be considered as having a condition that is of aeromedical significance;
- An applicant with known keratoconus who re-applies for a medical certificate 1, 2 or 3, and who has an uncorrected vision of 6/24 or better in each eye, has corrected vision of 6/9 or better in each eye and has demonstrated stability over five years or more; may be assessed as having a condition that is not of aeromedical significance;

Applicants with keratoconus should be advised that the condition may deteriorate over time, possibly affecting their eligibility to a medical certificate at some time in the future.



### 3.11.17 Cataract

#### 3.11.17.1 Considerations

The development of cataract is common with aging and affects more people who have been particularly exposed to UV light. For this reason it is common in farmers and pilots. Smoking may be a risk factor.

##### **Nuclear cataract:**

This condition is seen principally with advancing age.

##### **Cortical cataract:**

Is less common and is found in a ratio of roughly 2:3 when compared to nuclear cataract. Exposure to UVB is a risk factor. Abdominal obesity also appears to add to the risk of developing cortical cataract. There is some evidence suggesting an association between cortical cataract and dementia.

##### **Subcapsular cataract:**

Is mainly seen in younger adults and is a posterior opacity. If central, the reduction in visual acuity can be severe and rapid. Systemic corticosteroid use, inhaled corticosteroid use after the fourth decade of life and alcohol use may increase the risk of developing subcapsular cataract.

##### **Cataract as a function of age:**

Age	Nuclear	Cortical Cataract
30 - 39	1%	1%
50 - 59	12 %	8 %
60 - 69	32 %	17 %
70 – 79	51 %	32 %
80 +	55 %	32 %

Cataract may result in problems with glare. In addition, if the visual axis is affected, visual performance may be severely impaired in bright light, when the pupil is narrow. In some cases deterioration well below Part 67 medical standards can occur in as little as six to twelve months.

For this reason the ME should look for any sign of cataract or decrease in vision in the aging pilot and refer for a special eye examination report if any is present or suspected. If present, frequent surveillance is warranted.

## Treatment

Treatment is surgical, via cataract extraction and most commonly Intra Ocular Lens Implant (IOL).

**Monofocal lens implants** are acceptable for certification providing that a special eye report at not earlier than 3 weeks post IOL implant demonstrates visual performance within the standards and absence of complications. Overall around 85% of patients achieved best corrected visual acuity of 6/12 or better at 3 months and 80% are within one dioptre of the expected refraction.

IOLs offer the opportunity to correct refractive errors at the time of surgery. Thus sufficient time must have elapsed since the surgery to allow for neuro-adaptation to the new refractive characteristics if these are markedly different. While a waiting time of four weeks is often sufficient prior to resuming duty, up to three months may be appropriate, depending on the change in refraction. New corrective lenses must generally be obtained.

Post-operative **anisometropia** must be considered. This is a condition by which there is a difference of refraction between both eyes. As surgery is often performed one eye at a time, there is potential for significant anisometropia, which may take time to adapt to. Anisometropia leads to aniseikonia (difference in images size) if wearing spectacles. Contact lenses avoid this problem.

An anisometropia of 2.5 Dioptres or more should be considered as being of aeromedical significance. A recent, less than 6 months duration, anisometropia of 2.0 Dioptres or more should be considered as being of aeromedical significance.

**Multifocal lens implants** are now in common use. Multifocal IOLs generally provide for adequate near and distant visual acuity if of the appropriate power, but may not provide adequate intermediate distance vision. The technology is still in development. Intermediate vision is sometimes dealt with by using trifocal IOLs or different types of multifocal lenses in each eye.

The ME should inquire specifically about the use of multifocal IOLs. This is because these lenses may result in halos and glare and provide for variable visual performance. In particular decreased contrast sensitivity is an inevitable consequence of this type of lenses. Some of the problems associated with IOLs implants are outlined in the following table, as found in one study:

<b>Glare</b>	Severe	Nil	
	Moderate	21.3 % 7.5 %	for multifocal for monofocal
<b>Halos</b>	Severe	5 % Nil	for multifocal, for monofocal
	Moderate	34%	for multifocal
		Nil	for monofocal

CAA considers the possible adverse visual symptoms as being of aeromedical significance and generally not acceptable.

The ME should suspect the presence of multifocal IOLs if the applicant is able to meet the near and distance visual standards without refractive correction. Checking the **intermediate**

distance visual acuity may be revealing, and should be performed in all cases of new IOLs implants, Class 2 applicants included. However some lenses may correct for intermediate distance as well. A clear statement by the ophthalmologist who has undertaken the procedure or a copy of the operating notes should be obtained to ascertain the type of IOLs that have been implanted. The exact type and model of IOL should be recorded for each eye.

### 3.11.17.2 Information to be provided

An applicant who has recently undergone an IOL implant should provide:

- A special eye report by an accredited optometrist, not earlier than three weeks post-surgery; This must include information about haze, glare and contrast sensitivity;
- Evidence of the type of IOL implant(s) inserted;
- Evidence of ownership of appropriate refractive correction.

### 3.11.17.3 Disposition following insertion of Monofocal IOL Implants

An applicant who meets the following criteria may be assessed as having a condition that is not of aeromedical significance if:

- There is no complication from the surgery and the applicant has fully recovered; and
- The IOL implants are **monofocal**; and
- Any anisometropia is less than 2.0 dioptres if recent or 2.5 dioptres if present for 6 months or longer, and is well tolerated; and
- The vision, meets the standards with or without correction;
- The applicant has updated their lenses prescription; and
- The applicant is comfortable with, and well adapted to, the new refractive correction used.

### 3.11.17.4 Disposition following implantation of multifocal IOLs

- An applicant who has been fitted with multifocal IOLs should be considered as having a condition that is aeromedical significance.
- An applicant who does not meet the above criteria should be assessed as having a condition that is of aeromedical significance.

An applicant with multifocal IOLs can expect to have to demonstrate adequate visual performance through specialised testing. If a certificate is issued under the flexibility process, the carriage of passengers commercially, night flying and IFR privileges may be curtailed.

Applicants, particularly commercial pilots, need to be aware of the likely restrictive implications or even ineligibility to a medical certificate following multifocal IOLs implantation.

### **3.11.17.5 Disposition following cataract extraction with no lens implantation**

If no implants have been used, the necessary refractive correction generally requires very high power convex corrective lenses. This is unlikely to be acceptable.

- An applicant who has undergone cataract extraction without being fitted with IOLs should be considered as having a condition that is aeromedical significance.

### 3.11.18 Eye Muscle Balance (Phoria)

#### 3.11.18.1 Considerations

Binocular vision provides for fine stereopsis at short distances of a few meters and gradually less so at longer distances. Beyond about 20 m binocular vision is relatively unimportant with regard to judgment of distances.

Normal eye muscle balance provides for adequate binocular vision and avoids the risk of asthenopia (eye fatigue) or diplopia. With normal eye muscle balance there may be a small heterophoria (misalignment between the eyes) that can be observed when one eye is covered and the need for exact alignment is thus removed. When uncovering the eye the eye muscle control system re-established fused binocular vision easily and quickly.

With poorer eye muscle balance (likely with large heterophoria) there may be eye strain while fusing images with a risk of breakdown of binocular fusion. This is more likely to occur when the visual system is fatigued after a long day's flying, and when there is diminished visual stimulus such as by night or flying in white or grey-out conditions.

Measurement of the phoria provides an indication as to how much strain is placed on the eyes during binocular vision. If the phoria measurements fall within the following parameters it is unlikely that asthenopia or diplopia will occur.

#### Acceptable phoria limits

<b>At distance</b>	Exophoria	< 12 Δ
	Esophoria	< 6 Δ
	Hyperphoria	< 2 Δ
<b>At Near</b>	Exophoria	< 12 Δ
	Esophoria	< 6 Δ
	Hyperphoria	< 2 Δ

#### Phoria beyond these limits

Some degree of heterophoria is common. However if phoria determination results fall outside these limits (but not to the extent of break-down of the binocular vision) a determination of **fusional reserves** (vergence reserves) should be obtained.

#### Fusional (vergence) reserves explained:

The result of this test will show the prism strength (measured in "prism dioptres", symbol Δ) that can be applied to a prism placed in front of the eye before a breakdown of binocular fusion occurs. Three values are generally provided in the form: blur / break / recovery:

- Blur:                    The prism value at which a blur occurs
- Break:                   The prism value at which a breakdown occurs
- Recovery:              The prism value at which fusion can be re-established.

The prism can be placed with its base laterally; this is called **Base Out** (BO), or medially, this is called **Base In** (BI). Values for both positions are recorded.

The prism can also be placed with its base vertically in front of the eye; this is called **Base Up Right eye (BUR)**, or **Base Down Right eye (BDR)** providing two readings. Values for both base up and base down in front of one eye are recorded.

**Example** – applicant with an heterophoria at distance of 7  $\Delta$  eso, at near 9  $\Delta$  eso [Tendency of one eye turning in, acceptable limit is < 6  $\Delta$  in both cases]

Fusional reserves determination – blur, break, recovery:

- At distance      BI -/13/8                      BO    24/40/24
- At near            BI 18/22/16                      BO    24/40/33

The interpretation of the significance of these results is beyond the competencies expected from Medical Examiners. It is best left to the CAA Medical Officers who sometime need to seek advice from expert optometrists.

Two criteria are useful to evaluate whether compensating vergence reserves are likely to be sufficient to prevent asthenopic symptoms and possible diplopia. Here is how these results may be interpreted in that case, using the following criteria:

### Sheard's criterion

The compensating vergence reserves should be 2x the magnitude of the heterophoria.

In this case where the esophoria is recorded as 7 prism dioptre at distance (the eye tends to turn in, the compensating vergence reserves are measured with a Base In (to determine how well the eye can turn out to regain fused binocular images). The findings are recorded as: - / 13 BI / 8 BI (blur, double vision, recovery). In this example the eyes go straight to a break without blur.

The compensating vergence reserve of 13 prism dioptres before break down of fusion occurs is not quite twice the magnitude of the heterophoria, but it is close. It should be 14 to satisfy this criterion.

### Percival's Criterion:

The required eye position (the demand line) for fused single binocular vision should lie in the middle third of the range that allows single binocular vision.

In the example above, the region of single binocular vision at distance is from 13 BI to 40 BO. This is a range of 53  $\Delta$  dioptres. According to this criterion the zero prism value must lie within the middle third of this range. The middle third range is  $53/3 = \sim 18 \Delta$  dioptres from each edge of the binocular vision determination. Thus this range is from 5  $\Delta$  BO to 22  $\Delta$  BO dioptres. The phoria at distance is 7 Eso and thus lies just inside that range.

By one criterion the applicant is likely to experience problems with asthenopia or double vision. By the other criterion, the applicant is borderline. Research has shown that Percival's criterion is more applicable to assessment of esophorias, so we would put more weight on the Percival's criterion result in this example of esophoria.

### **3.11.18.2 Information to be provided in case of heterophoria in excess of these values**

- Fusional Reserved determination at distance and near.

### **3.11.18.3 Disposition in case of heterophoria in excess or recommend values**

- The ME should not attempt to interpret the vergence reserves data submitted by an optometrist, given the difficulties in that interpretation, even if the optometrist opines on absence of diplopia or other problems;
- CAA can advise on the acceptability of the vergence reserve results;
- Heterophoria in excess of the recommend values should be considered as being of aeromedical significance, unless CAA is able to advise otherwise.

## 3.11.19 Strabismus (Tropia)

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### 3.11.19.1 Considerations

Strabismus or heterotropia is a manifest deviation of one eye from its normal position which occurs despite both eyes being open and uncovered.

A majority of squint sufferers who have excellent cosmetic results from surgery and good visual acuity in each eye may still lack normal stereopsis (binocular depth perception). They develop distance judgement by monocular cues and these are usually superior to those available to applicants who have lost an eye. However, their fine distance judgement for near distances is inferior to those with normal binocular vision.

A latent squint is likely to become manifest under the influence of such factors as illness, fatigue, stress, drugs or alcohol. A well conducted cover test on each eye should unmask latent squint. The tests described below are designed to detect those who lack binocular vision.

#### Cover Test

Test at near (30cm) and at six metres. Use an accommodation fixation target at both distances. (N5 size print at near and 6/12 letter at distance). Ask the subject to look at the fixation target, cover one eye and observe the other eye for a refixation movement. Repeat for the other eye. Any refixation movement indicates heterophoria, possibly squint.

#### Lang Stereo Test

Test at near (30cm). Hold card still and ask subject to name any pictures seen. Pass is three pictures i.e. cat, star and car. There are two Lang stereo tests. Lang 1 tests to 550 degrees of arc disparity. Lang 2 tests to 200 seconds of arc disparity. Normal stereoscopic thresholds are around 10 seconds of arc, thus this test is quite crude.

#### Worth Four Dot Test

The subject wears red/green goggles. A pass is identifying four lights, one red, two green and one white. Test at six metres only. Those who fail can undergo further tests, for example six-metre Vectograph or Bagolini lens test to confirm if they truly lack binocular vision.

The test is also useful to determine if an applicant has **alternating suppression**. This is when the input from one eye is suppressed alternatively with the other eye. The suppression allows an individual to use both eye alternatively so that diplopia does not occur. Such cases are seen more favourably for certification.

### 3.11.19.2 Information to be provided

- A special eye report by an accredited optometrist;
- Objective tests results indicating if there is suppression.



### 3.11.19.3 Disposition in case of strabismus:

- A Class 1 or 3 applicant with strabismus should be assessed as having a condition that is of aeromedical significance and be assessed under the flexibility process.

A Class 2 applicant with strabismus may be assessed as having a condition that is not of aeromedical significance if:

- Each eye meets the visual standards, with or without correction;
- Both eyes are used alternatively (i.e. no eye excluded by the squint);
- Any anisometropia is less than 2.5 dioptres;
- **Alternating** suppression had been **unequivocally** confirmed by appropriate testing. (An opinion of alternating suppression is not sufficient without objective testing).

If in any doubt the ME should consult the CAA Medical Unit.

## 3.11.20 Duane Syndrome

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### 3.11.20.1 Considerations

Duane's syndrome is a congenital type of strabismus characterized by the inability of one eye to turn outwards. Other names for this condition include: Duane's Retraction Syndrome, Eye Retraction Syndrome, Retraction Syndrome, Congenital retraction syndrome and Stilling-Turk-Duane Syndrome;

This conditions results in the inability to maintain binocular vision when looking towards the side of the affected eye. In day to day life this is generally well compensated for by head turn to avoid diplopia but may result in an unusual head posture.

The possibility of diplopia is however of concern to flight safety.

### 3.11.20.2 Information to be provided

- A special eye report by an accredited optometrist;
- Copy of any ophthalmologist report.

### 3.11.20.3 Disposition

An applicant with Duane syndrome should be considered as having a condition that is of aeromedical significance.

A certificate is unlikely to be issued.

## 3.11.21 Open Angle Glaucoma

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### 3.11.21.1 Considerations

The main aeromedical implications of glaucoma relate to the loss of visual fields. This is usually not realised by the affected individual until the loss is well advanced. It is a slow process that can be stopped by treatment following regular screening of intra ocular pressure and fundus assessment. In case of doubt Optical Computerised Tomography (OCT) can be performed to analyse the macula and the optic nerve. If glaucoma is suspected visual fields determination must be one.

### 3.11.21.2 Information to be provided:

Applicants who first present with a history of glaucoma or whom the ME suspects may have glaucoma, should provide:

- A special eye report;
- An ophthalmologist report;
- The result of visual fields testing.

Applicants who subsequently present with a history of glaucoma should provide, at each subsequent application:

- Copy of all follow-up reports and any other reports at the intervals recommended by their by their treating ophthalmologist.
- The ME or Director may seek further reports.

### 3.11.21.3 Disposition in case of open angle glaucoma:

- An applicant with untreated, or unstable glaucoma, or who has any bilateral deficit of the visual fields should be assessed as having a condition that is of aeromedical significance.

An applicant with open angle glaucoma that is effectively treated, stable, with normal intraocular pressures, and no more than a small unilateral visual field deficit, not overlapping the contralateral blind spot, may be considered as having a condition that is not of aeromedical significance if:

- The medication is well tolerated; and
- If beta-blocker eye drops are used, there are no respiratory, cardiac, or others side effects; and
- Regular ophthalmologist surveillance, including repeat visual fields determination as necessary, takes place, at least annually.

## 3.11.22 Narrow Angle of the Anterior Chamber & Narrow Angle Glaucoma

### 3.11.22.1 Considerations

The angle formed between the cornea and the iris gradually decreases with age as the crystalline lens thickens. This trend is more marked in people with brown eyes. The condition will generally be identified in a presbyopic applicant undergoing routine optometrist examination for the purpose of near vision prescription.

The existence of a narrow angle puts the applicant at risk of chronic glaucoma or acute angle closure, an incapacitating condition. Prophylactic office surgery by laser iridotomy or iridoplasty is generally effective. Cataract extraction is curative because the thin lens implant no longer puts pressure on the anterior chamber angle.

### 3.11.22.2 Information to be provided

Applicants who first present with a history of narrow angle or narrow angle glaucoma or whom the ME suspects may have a narrow angle, should provide:

- A special eye report;
- An ophthalmologist report;
- If glaucoma is present or suspected, the result of visual fields testing.

Applicants who subsequently present with a history of history of narrow angle of the anterior chamber or narrow angle glaucoma should provide:

- Follow up reports and any other reports at intervals as advised by their treating ophthalmologist. The ME or Director may seek further reports.

### 3.11.22.3 Disposition in case of narrow angle of the anterior chamber or narrow angle glaucoma

- An applicant with untreated narrow angle, or who has glaucoma should be assessed as having a condition that is of aeromedical significance.

An applicant with narrow angle may be considered as not having a condition that is of aeromedical significance only if:

- The applicant has undergone prophylactic treatment; and
- The ophthalmologist indicates a low residual risk of acute narrow angle closure; and
- Glaucoma is not present; and
- The applicant undertakes regular surveillance as advised by the treating specialist.

An applicant with narrow angle glaucoma that is treated, stable and has only a small unilateral visual field deficit, not overlapping the contralateral blind spot, may be considered as having a condition that is not of aeromedical significance if:

- The ophthalmologist indicates a low residual risk of acute narrow angle closure;
- If beta-blocker eye drops are used, there are no respiratory, cardiac, or others side effects; and
- If other medications are used, there are no side effects of aeromedical significance; and
- Regular surveillance, including repeat visual fields determination as appropriate, takes place as recommended by the treating ophthalmologist but at least annually.

In case of doubt the ME should seek advice from the CAA.

### 3.11.23 Secondary Glaucoma

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#### 3.11.23.1 Considerations

Medical assessments depend on the underlying disease and the effectiveness of control.

#### 3.11.23.2 Information to be provided

- A special eye report;
- A visual fields determination report;
- Copy of all specialist reports relating to the condition.

#### 3.11.23.3 Disposition

Applicant with secondary glaucoma should be assessed considering both the underlying condition and the secondary glaucoma.

- Most applicants should be considered as having a condition that is of aeromedical significance and considered under the flexibility process.

## 3.11.24 Retinal Detachment

### 3.11.24.1 Considerations

Retinal detachment most frequently is a posterior detachment and follows collapse of the vitreous gel. The symptoms are a sudden shower of floaters (caused by vitreous haemorrhage or pigment release) and flashing lights, due to vitreous traction on the retina. Urgent referral to an ophthalmologist is mandatory to exclude the presence of a retinal tear.

This may occur at any age although it is commoner in the elderly. High myopes are at increased risk. For this reason advice on the long-term prospect of an aviation career should be given to those with high myopic refractive errors.

If the retina is torn, but not yet detached, laser treatment may be used to seal the retinal tear before fluid from the vitreous cavity passes through it and detach the retina. Once the retina begins to detach, prompt surgery is necessary. If surgery can be undertaken before the retina detaches from the macula, the prognosis for maintained vision is excellent. Once the macula has been detached for more than a few hours, visual recovery is only partial.

In the young, retinal dialysis is the commonest type of detachment. It may occur after a blunt injury which causes a tear in the most periphery of the retina.

During retinal detachment surgery intraocular gases are often injected into the vitreous cavity. The most commonly used gases are air, Sulphur Hexafluoride (SF<sub>6</sub>) and Perfluoropropane (C<sub>3</sub>F<sub>8</sub>). While air takes three or four days to be reabsorbed, SF<sub>6</sub> persists for up to two weeks and C<sub>3</sub>F<sub>8</sub> for up to six weeks. **Air travel should be avoided** until the gas bubble completely reabsorbs as it will expand during ascend, leading to a possibly dangerous rise in intraocular pressure.

### 3.11.24.2 Information to be provided

An applicant who first applies with a history of retinal detachment should provide:

- A special eye report;
- A visual fields determination report;
- A copy of all reports by the treating ophthalmologist.

### 3.11.24.3 Disposition

An applicant with a history of retinal detachment may be considered as having a condition that is not of aeromedical significance if:

- A special eye report indicates that the applicant meets the visual standards; and
- An automated visual fields determination indicates absence of any visual fields defect; and
- An ophthalmologist opinion indicates unequivocally that the condition has been effectively treated, is stable and is unlikely to recur; and

- In case of a recent event, any gas bubble has resolved.

If uncertain or in the absence of those reports, the condition should be considered of as being of aeromedical significance and considered via the flexibility pathway.



### 3.11.25 Uveitis

#### 3.11.25.1 Considerations

Uveitis denotes inflammation of the uveal tract: the iris, ciliary body and choroid. Anterior uveitis is also known as iritis or iridocyclitis and affects the anterior chamber. Posterior uveitis is also known as chorioretinitis. Those conditions may be associated with systemic disease or infection.

<i>Ref: Cecil Textbook of Medicine.</i>	Infectious causes	Systemic illnesses
Anterior uveitis (iritidocyclitis)	Herpes zoster, zoster Hansen's disease	Ankylosing spondylitis, Reiter's syndrome, Rheumatoid arthritis
Posterior uveitis (chorioretinitis)	Toxoplasmosis, is, Toxacariasis Histoplasmosis, Measles	
Both anterior and posterior	Syphilis, Coccidioidomycosis, Onchocerciasis, Brucellosis	Sarcoid, Behçet's syndrome Inflammatory bowel disease

These conditions should be kept in mind when dealing with a case of uveitis, particularly if the condition is recurrent.

#### 3.11.25.2 Information to be provided

An applicant who first apply with a history or uveitis should provide.

- A special eye report;
- A copy of all reports by the treating ophthalmologist;
- A copy of any other related illness or investigations reports.

#### 3.11.25.3 Disposition

- An applicant who presents with a history of recurrent uveitis should be considered as having a condition that is of aeromedical significance.

An applicant who presents with a history of iritis may be assessed as having a condition that is not of aeromedical significance if:

- The episode was a first and only episode, occurring more than 6 months ago;
- The condition has settled in full;
- No systemic illness has been identified.

## 3.11.26 Demyelinating Disease & Optic Neuritis

### 3.11.26.1 Considerations

Multiple Sclerosis (MS) is a central demyelinating disease involving multifocal demyelination of white matter. It often affects young people under 40 years of age. A secured diagnosis requires multiple attacks of demyelination separated in time and anatomical locations. A thorough neurological history is important at the time of presentation. Nuclear magnetic resonance imaging (MRI) offers some help in diagnosis but does not substitute for good history taking.

The most common ocular manifestation of MS is optic neuritis. It is the presenting feature in 25% of cases and occurs during the course of established disease in 70% of cases. Between 50% and 70% of patients in the 20 - 40 years age group presenting with optic neuritis subsequently develop systemic demyelination.

Optic neuritis typically presents as sudden unilateral blurred vision progressing over a few days. The vision is often described as being "washed out". Colours appear desaturated and there is often retro/peri-ocular pain aggravated by eye movements. Signs include reduced acuity of variable severity from minimal to "no perception of light"; an afferent pupillary defect (pupil dilates during the "swinging light" test); and dyschromatopsia (poor colour discrimination performance).

The most common visual field defect is a central scotoma. Ophthalmoscopy may reveal a swollen optic disc although the disc is often normal in the retrobulbar type of MS. Optic atrophy (from previous attacks) may be found in the ipsi- or contra-lateral eye. Visual recovery is slower than the initial loss and usually takes four to six weeks. About 90% of sufferers recover normal visual acuity. Minor defects in colour vision and brightness appreciation may persist. The effects of subsequent attacks are additive. There is no correlation between the degree of visual defect during the attack and the final visual outcome.

### 3.11.26.2 Information to be provided

- A special eye report, to include colour vision determination;
- An automated visual fields determination;
- An ophthalmologist opinion confirming the diagnosis and indicating if the condition has resolved, its stability and likelihood of recurrence;
- CT scan and / or MRI may be required;
- A neurologist report is likely to be required.

### 3.11.26.3 Disposition

An applicant with a suspected or confirmed history of Multiple Sclerosis, or a history of optic neuritis should be considered as having a condition that is of aeromedical significance.

## 3.11.27 Macular Disease

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### 3.11.27.1 Considerations

The symptoms of macular disease include blurring and distortion of vision with micropsia or macropsia, which can be assessed with an Amsler grid. (This consists of a piece of paper showing a 10cm square divided into 5mm squares with a central fixation dot). The subject is asked to fixate on the central dot, with each eye separately, at one third of a metre and to mark on the chart with a pencil, scotomata or areas of distortion. When abnormalities are present, immediate referral to an ophthalmologist should be done. The commonest conditions affecting the macula are Disciform Macular Degeneration and Central Serous Retinopathy.

#### Macular Degeneration

This condition typically affects the elderly but inherited forms may affect younger people. Ophthalmoscopy may show small grey, yellow or white lesions, like small crystals, at the macula. These are called "Drusen" (German, druse = nodule). The visual acuity is usually well preserved, 6/9 or 6/12, until a further complication occurs, the development of a subretinal neovascular membrane that spreads under the macula and reduces vision to 6/60 or less. To prevent the visual acuity from deteriorating below standard, regular follow-up is essential. In the early stages when the vision is distorted, but the acuity well preserved, the subretinal membrane can be obliterated by argon laser treatment.

#### Central Serous Retinopathy

The condition can affect healthy young adults. Only one eye is usually affected and reduction of acuity is mild (6/12 or 6/18). Direct ophthalmoscopy shows dulling of the macular reflex, representing a shallow central retinal detachment. Vision recovers spontaneously within six weeks in 90% of cases. Stereoacuity is temporarily lost and pilots should not fly until full recovery occurs. Laser treatment has been shown to speed the resolution of symptoms, but does not improve the final visual performance. No treatment is usually advised. The condition recurs in 20 to 30% of cases and the second eye is affected in 20%.

### 3.11.27.2 Information to be provided

- A special eye report;
- An ophthalmologist report.

### 3.11.27.3 Disposition

- An applicant with a history of Macular Degeneration should be assessed as having a condition that is of aeromedical significance.

An applicant with a history of Central Serous Retinopathy may be assessed as having a condition that is not of aeromedical significance only if:

- An ophthalmologist report indicates complete resolution of the condition; and
- A special eye report indicates that the applicants meets the visual acuity standards; and
- The applicant undergoes surveillance.

## 3.11.28 Diabetes

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### 3.11.28.1 Considerations

An applicant with diabetes should present evidence of regular retinal screening as recommended under New Zealand recommended best medical practice.

### 3.11.28.2 Information to be provided

An applicant with a history or findings of diabetic retinopathy should provide:

- A special eye report, to include colour vision determination;
- An ophthalmologist report or a copy of any previous report;
- A visual fields determination report.

### 3.11.28.3 Disposition

- An applicant with a visual field deficiency or more than mild retinal disease should be assessed as having a medical condition that is of aeromedical significance.

The ME should also consider in details whether there is other end-organ pathology of aeromedical significance.

## 3.11.29 Other Conditions

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### 3.11.29.1 Considerations

This manual cannot be exhaustive. Eye conditions are numerous and many are too rare to warrant detailing them here.

### 3.11.29.2 Information to be provided

An applicant should provide all existing reports relating to the condition under consideration.

### 3.11.29.3 Disposition

Many of the conditions not listed in this chapter do require special considerations and expert input.

Applicants with conditions not listed in this ophthalmology chapter should generally be considered as not meeting the medical standards unless clearly of no aeromedical significance.

Alternatively the CAA Medical Officers should be consulted for advice.