

Joint Aviation Authorities



JAA Manual of Civil Aviation Medicine

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Chapter 0 – List of Contents and Check List
Formerly in JAR-FCL 3 – Section 2

Chapter	Title	Page	Amendment	Stage
	Cover	00- 1 to 00- 2	Amendment 6	01.06.07
00	List of Contents and Check List	00- 3 to 00- 4	Amendment 6	01.06.07
00	Authors and Preface	00- 5 to 00- 8	Amendment 6	01.06.07
01	General	1- 7 to 1- 16	Amendment 6	01.06.07
	- The concept of aeromedical fitness	7		
	- The aeromedical health examination	9		
	- The concept of aeromedical risk assessment	11		
	- Differences from provisions	13		
	- Review procedures	15		
02	Aviation Cardiology	2- 17 to 2- 42	Amendment 5	01.11.06
03	The Respiratory System	3- 43 to 3- 50	Amendment 5	01.11.06
04	The Digestive System	4- 51 to 4- 56	Amendment 5	01.11.06
05	Metabolic, Nutritional and Endocrine Systems	5- 57 to 5- 66	Amendment 6	01.06.07
06	Haematology	6- 67 to 6- 72	Amendment 5	01.11.06
07	The Urinary System	7- 73 to 7- 76	Amendment 5	01.11.06
08	Sexually transmitted diseases and other infections	8- 77 to 8- 78	Amendment 5	01.11.06
09	The reproductive system	9- 79 to 9- 82	Amendment 5	01.11.06
10	The musculoskeletal system	10- 83 to 10- 86	Amendment 5	01.11.06
11	Aviation Psychiatry	11- 87 to 11-112	Amendment 5	01.11.06
12	Aviation Neurology	12-113 to 12-148	Amendment 6	01.06.07
13	Aviation Ophthalmology	13-149 to 13-200	Amendment 5	01.11.06
14	Aviation Otorhinolaryngology	14-201 to 14-224	Amendment 5	01.11.06
15	Aviation Psychology	15-225 to 15-236	Amendment 5	01.11.05
16	Dermatology	16-237 to 16-258	Amendment 5	01.11.05
17	Oncology	17-259 to 17-268	Amendment 5	01.11.06
18	Tropical medicine	18-269 to 18-312	Amendment 5	01.11.06
19	Medication and Flying	19-313 to 19-326	Amendment 6	01.06.07

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Chapter 00 – AUTHORS AND PREFACE

Chapter	Title	Author	Last Revision by
01	General (10/2000)	Pearson R	Siedenburg J (11/2006)
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03	The Respiratory System (12/2000)		Siedenburg J (11/2006)
04	The Digestive System (12/2000)	Årva P	Siedenburg J (11/2006)
05	Metabolic, Nutritional and Endocrine Systems (06/2003)	Hardicsay G, Johnston R	Siedenburg J, Muff S (11/2006, 06/2007)
06	Haematology (12/2000)	Köstler W	Siedenburg J (11/2006)
07	The Urinary System (12/2000)		Siedenburg J (11/2006)
08	Sexually transmitted diseases and other infections (12/2000)		Siedenburg J (11/2006)
09	The reproductive system (12/2000)		Siedenburg J (11/2006)
10	The musculoskeletal system (12/2000)	Oksanen P, Evans ADB	Siedenburg J (11/2006)
11	Aviation Psychiatry (12/2000)	Braz de Oliveira F, Baloescu V	Baloescu V, Siedenburg J (11/2006)
12	Aviation Neurology (06/2002)	Pearson R, Manfroni P	Markou I, Siedenburg J (11/2006, 06/2007 JS)
13	Aviation Ophthalmology (12/2000)	Hedin A	Stern C, Evans ADB, Siedenburg J (11/2006)
14	Aviation Otorhinolaryngology (06/2002)	Vesterhauge S	Siedenburg J (11/2006)
15	Aviation Psychology (12/2000)		Goeters KM, Siedenburg J (11/2006)
16	Dermatology (12/2000)	Perry I	Siedenburg J (11/2006)
17	Oncology (06/2003)	Janvrin S	Evans S (11/2006)
18	Tropical medicine (08/2005)	Siedenburg J	Siedenburg J (11/2006)
19	Medication and Flying (12/2000)	Gourbat JP	Siedenburg J Evans S Perry I Johansson L Koestler W (08/2005, 06/2007 JS)

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Preface

Safety is the paramount principle of aviation. Aviation medicine is a major element of aviation safety. In a regulatory context it has to make sure that pilots have the physical capacity to fly and that the risk of a medical incapacitation is neglectable (i.e. not exceeding the acceptable level).

JAR-FCL 3 is a set of aeromedical requirements, drafted and adopted by the Joint Aviation Authorities (JAA). The member states of JAA have committed themselves to implement and to use them as sole codes. Mutual recognition of medical certificates, licences throughout the member states requires codes accepted by all members, their implementation and standardised application. JAR-FCL 3 are based on ICAO Annex 1, pre-existing national requirements and the discussions in the Medical Sub-Committee, later rechristened Licensing Sub Sectorial Team.

The aeromedical examiner (AME) assesses the fitness to fly and the aeromedical disposition of an applicant. JAR-FCL 3 provides the requirements concerning the required examinations and the standards to be applied. The manual has been a part of the requirements previously. It has been decided to promulgate them as a stand-alone document, attached to the JIP (Administrative and Guidance Material, Section 5: Licensing). The manual provides information on the scientific background of the requirements and gives guidance regarding the aeromedical examination and assessment and aeromedical good practice. It is a textbook of the practice of Aviation Medicine as well. When using it for aeromedical assessment the relevant chapter of the manual should be consulted together with the appropriate paragraph or annex of JAR-FCL 3.

The work on the manual started more than ten years ago. In the meantime we saw many advances in medicine and aerospace medicine in particular. The requirements have been amended significantly, reflecting need for change in the light of practical experience applying them for some years. Therefore, a major update of the JAA Manual of Civil Aviation Medicine became necessary as well.

Many thanks to all those, who participated in the up-date. The names of the authors are mentioned on the first page of this chapter.

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CHAPTER 1 - GENERAL

THE CONCEPT OF AEROMEDICAL FITNESS

What constitutes medical fitness for flying is not as simple as mere absence of disease. Good health does not always mean fitness for flying, nor does bad health necessarily mean unfitness. Sometimes a healthy person may be less fit for flying than a chronically ill person, and in some circumstances even a quite severe disease in an airman may not preclude him from being assessed as fit for flying. When interpreting the Requirements as they are laid down in JAR-FCL [] 3 (Medical) it is important to bear in mind the purpose of having a set of established standards and of performing aeromedical examinations to ensure that these requirements are met, namely to maintain flight safety at a level acceptable to society.

From the point of view of the certificatory authority, an airman is fit for flying if:

- 1 he is mentally and physically capable of performing his flying duties at or above the level required for safe flying under all conditions; and
- 2 if it is safe to assume that he will remain so for the period of validity of his certificate.

At the aeromedical examination it is to be considered good practice for the [Aeromedical] Examiner (AME) to assess whether the airman is likely to remain fit for the following two year period. If an AME is in doubt about whether a pilot's health condition will allow him to continue flying for the following two years, usually a serious underlying pathology is suspected or has already been diagnosed. In such a case the final decision should be left to the Authority Aeromedical Section (AMS) which may decide to continue the [aeromedical assessment] under certain provisos (as for example shorter intervals between aeromedical [revalidation or] renewal examinations).

Thus, an airman may be assessed as fit for flying if:

- 1 he is physically and mentally capable of performing his duties on board in a safe manner. This includes having full use of his faculties, i.e. his visual ability, his hearing and his colour perception shall meet the requirements as stated in JAR-FCL [] 3 (Medical);
- 2 he is free of disease which may suddenly render him incapable of performing his duties on board in a safe manner during on-going flight (acute incapacitation);
- 3 he is free of disease which may slowly, but within the period of validity of his certificate, reduce his capacity for performing his duties on board to below the acceptable level.

As all aeromedical assessments are based on medical opinion, which to some degree [is] subjective and may be imprecise and sometimes even incorrect, the final decision – the aeromedical disposition – should lean towards the side of safety. If error cannot be completely avoided it is important to err in favour of flight safety, even if this may sometimes seem (and perhaps also be) unjust to the individual airman.

If an airman falls ill during the period of validity of his certificate, he [shall] notify the Aeromedical Section of the Authority (JAR-FCL 3.040). Some medical conditions, though quite unacceptable in an airman, may go unnoticed by the airman himself and thus [] develop into a threat to flight safety. An example could be a borderline blood pressure becoming manifest hypertension or a slight myopia deteriorating into substandard vision. For this reason it is vitally important that the authorised medical examiner is particularly attentive to the first signs and symptoms of disease or malfunction, even if the condition does not necessitate sick leave or warrant medication or hospitalisation.

Any acutely incapacitating condition forms a major threat to flight safety. A disease like urolithiasis which may strike without warning and which may place the airman in a state of [severe] pain within minutes from onset, must clearly [disqualifies] him from all kinds of single seat flying duty, even if at the time of examination the airman may be totally asymptomatic. Classical migraine is another such condition. Although an attack may be preceded by certain warning symptoms, usually lasting 10–30 minutes, these are sometimes, per se, disqualifying and the fully developed attack with headache, nausea, photophobia etc. is clearly incapacitating and must entail unfitness for flying. Particularly dangerous, even in a multi-crew setting, are conditions which may develop slowly and

The concept of aeromedical fitness (continued)

insidiously and thus go unnoticed by the other flight crew members (subtle incapacitation). Some neurological disease (e.g. global amnesia, narcolepsy) could be mentioned here. Also psychiatric disease may be very dangerous. An airman in a hypomanic state may appear normal and energetic to his colleagues but may make a series of marginal decisions which are still acceptable to the other members of the crew but, when put together, may spell disaster.

To help avoid such situations and thus enhance flight safety is the ultimate goal of clinical aviation medicine as practised by AMEs and AMCs.

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THE AEROMEDICAL HEALTH EXAMINATION

Examining a healthy person may seem an easy task but also a rather futile thing to do, for what can you expect to find where nothing is wrong? In reality the periodic examination of airmen is both difficult and demanding, but may also be quite rewarding when performed with interest, care and thoroughness.

A licence holder is legally obliged to undergo regular health examinations, performed by either an [Aeromedical] Examiner (AME) or an Aeromedical Centre (AMC) – and he may resent the cost or the inconvenience of complying with the regulations. The airman may appear to be in perfect health, and more often than not will he himself believe this to be the case. At the same time he may reasonably fear that if something is wrong after all then this might cost him his medical certificate, i.e. his livelihood. This situation may lead the airman to feel nervous and tense at the examination, but almost invariably he will try to present himself as perfectly healthy. Fortunately most examinations will confirm that he is indeed in good health and fit for flying. But even if he is experiencing a mental or physical problem he may – consciously or subconsciously – repress it and in either case the AME may not receive the usual help from his examinee to guide him towards the site of any problem. To find a sign of early disease or malfunction under these circumstances takes skill, experience and the utmost thoroughness.

It is important that the aeromedical examination is performed in a way that encourages the airman to discuss freely and openly whatever problems – medical or otherwise – he may have, but the situation is not ideal for developing the usual doctor-patient relationship between AME and airman. An airman is not a patient and so has little encouragement to confide more than is required by the regulations. On the other hand, the AME gains little without the airman's confidence as most information of value is voluntary.

There is no specific route for the AME to follow in order to ensure an aeromedical examination of quality, but some important factors are:

- 1 Professional competence – as highly trained technical professionals all airmen appreciate professionalism in others.
- 2 Thoroughness – the airman himself may be unaware of the significance of minor signs and symptoms. It is of vital importance to review all systems at each examination and the airman's statement of 'unchanged since last examination' should only be the start rather than the end of any history. Often the airman will not be aware of anything wrong or that his minor symptoms are significant. In this latter situation only a very careful and thorough examination will reveal the problem. An unknown intestinal cancer may be suspected from a declining haemoglobin, still within normal range, and early diagnosis and intervention will most certainly improve the prognosis. Decreased visual acuity, reduced hearing, reflex anomalies, changes in blood picture or ECG are all signs and symptoms that may go unnoticed by the airman himself but which can be the first indication of serious underlying pathology. Further, there must be ample time to discuss the airman's employment (if professional air crew), or flying interest (if a private pilot) as information thus obtained is frequently as productive as the physical examination itself.

During the health examination [care should be taken] so that minor progressive changes can be noted at the earliest stages, often before symptoms become evident.

- 3 Openness – any abnormality found should be discussed, even if not apparently affecting certification, so that the airman realises that the AME remains primarily a physician throughout. Any such findings should be passed to the airman's family doctor for investigation and action, if appropriate, and full communication maintained with the Authority Aeromedical Section (AMS) concerning such actions.

- 4 Aviation knowledge – every effort should be made to appoint physicians with an aviation interest as the amount of time spent in aeromedical work is often disproportionate to other clinical activities. Sharing the airman's interest in flying is the most direct way to establish a relationship and yet another reason why time spent on the flight deck and in the flying club is an essential experience for the AME.

Although a good relationship between airman and AME is essential, it can occasionally cause the AME difficulty, as a physician he is required to maintain medical confidence and as an AME he is also required to communicate all information regarding the airman's physical and mental fitness for flying to the Authority. At the same time the AME may be the Company Doctor acting on behalf of the airman's employer and thus [pursue] the commercial [interests] of that organisation. Finally, he may be the airman's general practitioner. Despite all conflicting interests the AME must remember that:

- 1 he is appointed by the National Aviation Authority to verify that the individual airman examined by him meets the standards of JAR-FCL [] 3 (Medical) as required for the issuance or renewal of a medical certificate, and
- 2 the airman consulting him knows that in his role as an AME he is acting as the National Aviation Authority's approved medical examiner.

The individual AME therefore cannot assess [] an airman [fit] outside the requirements, nor can he withhold pertinent information from the AMS of the Authority. In either case the AME must realise that he is only an agent for the Authority and cannot act for it without prior consultation and agreement. At all times the AME must protect his professional integrity and remain aware of his responsibility towards flight safety.

When a pathological condition has been disclosed, many airmen will seek the advice and opinion of another physician, often a highly esteemed specialist, but usually without training or experience in aviation medicine. Almost invariably such a physician will take a more liberal stand to the importance of the disease or abnormality with regard to continued flying than would an aeromedical specialist or the aeromedical officer of the [] [Authority (AMS)]. Especially in cases where no effective treatment is possible and nothing can be done, most clinical practitioners try to comfort their patients with assurances that the condition is not very important or that the outlook is not so bad, etc. And, in fact, a disease may have a good prognosis *quo ad vitam*, but may still entail cessation of a flying career. In such cases as these, as in all situations where the airman's [aeromedical fitness] is in question, it is the AME's responsibility to consult with the AMS on the airman's behalf and, if considered appropriate, assist him in preparing his case for further assessment. The AME may play an important role as medical adviser to the airman and he may by prudent evaluation of the situation at hand, by explaining the specialists' statements, the information obtained from hospitals, the laboratory results etc. and by giving a balanced view of all aspects of the case, ensure that the airman fully and correctly understands his own condition and the aeromedical disposition it entails.

To act in this way while maintaining the confidence of his airman and the Authority is the art of the aeromedical examiner. By mastering this art he will serve flight safety and, at the same time, help keep his airmen flying.

THE CONCEPT OF AEROMEDICAL RISK ASSESSMENT

Professional Pilots

No human activity is totally free from risk. Transportation is such an activity and the risk attached varies widely according to mode. Aviation was initially a high risk, but with the introduction of modern jet passenger aircraft and improved instrument approach and landing systems the fatal accident rate has continuously fallen. The present rate world wide is better than 0.5 per 10^6 flying hours with some countries achieving 0.2 per 10^6 flying hours. The average flight time is approximately one hour and so it would seem reasonable to aim for an accident rate of 0.1 per 10^6 flying hours or 1 per 10^7 hours or 1 per 10^7 flights.

In this overall risk it is considered that no system (airworthiness, air traffic, operations) should contribute more than 1/10 of the total (1 per 10^8) and since the health of the pilot is only a small part of the operational risk, (e.g. 10%), medical cause for fatal accidents should occur no more often than 1 in 10^9 hours (10^{-9}).

If we consider the pilots of a large jet passenger aircraft, it has been proposed that a 1% per annum risk of their incapacitation would meet the target rate above. This proposed rate is roughly equivalent to the best experience following myocardial infarction or coronary artery by-pass surgery. Since cardiovascular disease accounts for about 50% of permanent loss of licence in Western European and North American aircrew, it is one of the most likely causes for sudden, complete incapacitation and therefore a good example of risk assessment. One per cent per annum is one incapacitating event per 100 pilot years or $100 \times 8\,760$ hrs. If 8 760 is approximated to 10 000 then this is 1 event in $100 \times 10\,000$ hours or 10^6 hours.

If a pilot with this risk of incapacitation is flying a large jet passenger aircraft with a qualified co-pilot, the theoretical risk to the flight is that of double incapacitation, less frequent than 1 in 10^{12} hours, or very long odds. Such an assumption is based upon perfect handover. Simulator testing would indicate that handover in such cases is virtually always successful but the real incapacitation is not always recognised and a 99% successful handover is suggested as being more realistic. A further factor is that incapacitation becomes critical only during landing or take-off, approximately 10% of an average one hour flight.

At worst case, a pilot with 1% per annum incapacitation risk, (where handover is not completed at the time of his incapacitation) poses a threat to the aircraft of one in 10^6 flying hr/flts. If only 10% of that flight is critical the odds lengthen by a factor of 10 (one in 10^7) and if only one per cent of handovers fail, the odds lengthen again by a factor of approximately 100 (one in 10^9 flying hr/flts). This is the figure quoted in paragraph 2 as an acceptable target rate for medical cause accidents and so the proposed 1% per annum risk of professional aircrew incapacitation appears justified and should be accepted.

Private Pilots

There are no world wide figures for fatal accidents to private pilots. Those North American and European statistics available would indicate a fatal accident rate one hundred times greater than that of large jet passenger aircraft. It would therefore seem reasonable to set a target accident rate for private flying a hundred times greater than that of public transport flights i.e. 1 per $10^7 \times 100$ or 1 per 10^5 flying hours.

If one again considers [that] the pilot is part of the operating system and his health only a part of the risk to that system, then the target for medical cause for accidents in private aviation should be less than 1 per 10^6 flying hours i.e. [the risk] 10^{-6} to 10^{-7} .

In general, private pilots do not fly with another qualified pilot and so acute incapacitation poses an immediate threat to the safety of the flight, throughout its duration. The risk of fatality arising from incapacitation in flight must therefore be that of the incapacitation (10^{-6} to 10^{-7}).

We have previously said that 1% per annum equates to 1 per 10^6 flying hours, therefore it would seem reasonable that a private pilot with a 1% per annum risk of incapacitation would meet the target rate for medical cause accidents in private flying. [This implies that a private pilot should follow the Class 1 assessment procedures. At the discretion of the AMS, a private pilot who has been assessed as meeting the requirements for Class 1 OML may be assessed as fit for Class 2 ([without limitation] or OSL / OPL) operations.]

The private pilot with a condition recognised as having a potential risk of 1% per annum or greater must expect the same investigation as would be required for an airline transport rated pilot in multi-crew operations. A lesser degree of investigation may be appropriate for a safety pilot limited certificate as the additional crew member would in some way alleviate any additional perceived risk.

Additional factors

- 1 If more than 10% of the pilot population is assessed as having an incapacitation risk of 1%, then the statistical population [] and present assumptions [will be] altered.
- 2 Due to the simple nature of most privately owned aircraft, it may be appropriate to assume a greater proportion of medical cause accidents than 1 in 100, however, even doubling that figure would not grossly disturb the target incapacitation risk.
- 3 Beyond age 65 the cardiovascular incident risk exceeds 1% per annum, therefore it would seem reasonable to request cardiological assessment at a centre acceptable to the AMS.

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[DIFFERENCES FROM PROVISIONS]

Standards

The physical standards outlined by ICAO in Chapter 6 of Annex 1 to the Convention on International Civil Aviation [] were written to outline the minimum physical requirements considered necessary to maintain high standards of flight safety. Each system was considered with respect to its importance in flight whether sensory, physical or related to the possibility of incapacitation. In each case, where measurements could be taken, a norm was set which was varied according to the privileges of licence and operational conditions.

Flexibility and Waivers

Flying requires physical co-ordination, a degree of mental agility and good vision, nonetheless an individual does not need to be physically perfect. As indicated in Note 2 introducing Annex I Chapter 6, 'Standards and Recommended Practices cannot on their own, be sufficiently detailed to cover all possible individual situations.' Accordingly, particular individuals were allowed to exercise the privileges of a licence with or without the imposition of Limitations [] where such activities were considered compatible with the requirements of flight safety [(ICAO Annex 1, Chapter 1, 1.2.4.8 - Flexibility Clause)]. These [differences] from the Standards were proposed under 'accredited medical conclusion' (more than one medical opinion) but generally were empirical, subjective and inconsistent internationally.

[] [Review Procedure]

Use of the Annex I '[flexibility]' clause (1.2.4.8) is outlined in the ICAO Manual of Civil Aviation Medicine but many States have developed their own approach[,] with many assessments being completed without any indication of flexibility having been applied [and others with a wide extension of flexibility]. In order to minimise [differences in the outcomes of aeromedical assessments] between JAA Member States, Annex I Chapter 6 was considered inadequate per se. JAR-FCL [] 3 (Medical) was therefore written in a more detailed fashion with Appendices outlining what degree of flexibility could be considered, at what level and after which investigations. The AMS therefore can be flexible in interpreting the requirements but must be seen to have completed what is considered as the minimum investigations necessary to demonstrate that this case falls within flight safety requirements and the parameters described in the JAA Manual of Civil Aviation Medicine.

Assessment

The aeromedical examination is detailed in JAR-FCL [] 3 (Medical) and an authorised examiner (AME) should recognise easily whether an individual meets clearly the requirements. If however, an individual does not meet clearly a requirement, or is marginal under several of them, the AME shall discuss the matter further with the Authority, [i.e. the] Aeromedical Section (AMS), which may provide or have access to further opinion and create 'accredited medical conclusion'. In all cases where an AME has refused or referred an assessment, the relevant data will be forwarded to the AMS in order that such data may be reviewed or made available to Aeromedical Centres (AMCs) and AMEs in other member States, should the individual decide to apply for a certificate elsewhere[(see 'Review Procedures')].

Special Investigations

Not all special investigations allow for specific measurement and in many cases their interpretation is subjective. Under such circumstances it will be necessary for the AMS to request the raw data or 'hard copy' as well as a specialist's report so that a further review can be made by external specialists briefed on aeromedical risk management.

Aeromedical Limitations []

In some cases an applicant will require assistance to meet the requirements, for example using contact lenses or spectacles. Under these circumstances [a respective limitation] should be placed upon the medical certificate and may be transferred to the licence []. If an applicant is assessed as requiring correction to meet the visual standards at initial assessment {and therefore require a 'VDL' or VNL limitation, it is possible that his vision may improve. An AME should not however add or remove that [limitation] without verifying the position with the AMS and normally a further full refraction will be required before a visual [limitation] can be changed. One exception here should be a normal progression into presbyopia which requires a simple reading addition and only requires spectacles to be available – under these circumstances the AMS should not require consultation.

Some [limitations] are operationally related e.g. 'as or with qualified co-pilot' and if maintained for longer than 6 to 12 months, should be transferred to the licence. If such action is taken the medical certificate should indicate this e.g. 'Refer to limitations on the licence'.

[If an applicant does not fully meet the requirements for a Class 1 medical certificate, but is considered by the AMS to be within the acceptable risk of incapacitation, according to accredited medical conclusion, the AMS may assess him as fit in a multi-pilot environment. The affected pilot can be either pilot or co-pilot. In case of an incapacitation the other pilot can take over. The **multi-pilot (Class 1 'OML') limitation** "valid only as or with qualified co-pilot" has to be added (see JAR-FCL 3.035 (d) and (e), IEM 3.100 (c)). The **safety pilot (Class 2 'OSL') limitation** is a similar limitation applying to Class 2 applicants. The affected applicants have to fly in an aircraft with dual controls. The safety pilot can take over control, if the pilot should become incapacitated (see JAR-FCL 3.035 (f), IEM 3.035).]

Medical Flight Tests

Where a physical deficiency is noted a cockpit check or medical flight test may be required. A cockpit check is appropriate where stature or deformity may be a consideration – for example, obesity can be a problem in smaller aircraft, particularly with floor mounted controls. Where fine movement and strength may be a concern, for example in an amputee, a medical flight test is appropriate and the AMS should brief the examiner concerning the problems that may be expected. In the case of lower leg amputation, toe brake operation may not be possible and with a forearm amputation, it may be necessary to specify which seat may be used. Any arm or hand disability must be carefully considered as the applicant must be able to maintain continuous control of primary flying surfaces at critical flight phases i.e., at landing or take-off. Simulators may be used instead of aircraft when the characteristics and cockpits accurately represent that aircraft and may allow more extensive challenge to the applicant than would be possible in actual flight. If an applicant is considered fit for a medical certificate following medical flight test a report should be made to the AMS and recommendation made by them to the Authority for any appropriate conditions such as 'restricted to demonstrated type'.

Given such procedures, flexibility may be applied to the requirements in a uniform manner and under varied operational conditions. By applying common assessment policies based on aeromedical risk assessment, flight safety should not be compromised and thus maintain the original concept of ICAO Annex I.

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REVIEW [] [PROCEDURES]

The Assessment

As indicated in the section concerning flexibility, JAR-FCL [] 3 (Medical) has been written in a form that is considerably more detailed and specific than ICAO Annex I. In doing so, the JAA FCL Medical Sub-Committee, [later rechristened Licensing Sub-Sectorial Team (Medical) (LSST(M))] has brought together many years of experience in interpreting Annex I with the aim of developing a common systematic approach to the investigation and assessment of cases including those of a marginal nature.

JAR-FCL [] 3 (Medical) Requirements and Appendices provide direction to [Aeromedical] Examiners (AMEs) in assessment and also indicate whether decisions should be referred to their national Authority [, i.e.] Aeromedical Section (AMS) for further consideration. This approach encourages the use of 'accredited medical conclusion' as it broadens the basis of what may, in many cases, be rather intangible risk management.

Refusal

The [Aeromedical] Examiner (AME) is therefore primarily responsible for deciding whether an applicant is within the Requirements (initial Class 2) or remains within the Requirements ([revalidation or] renewal Class 1 or Class 2). Any applicant who presents for examination must be examined unless the immediate history (epilepsy, psychosis or insulin dependent diabetes for example) obviously precludes any kind of certification. If full examination indicates that an applicant does not clearly meet the requirements, the AME must advise him of the area of concern and that a report of the refusal/referral will be forwarded to the national AMS without delay (JAR-FCL 3.035(c) and 3.100(e)). Any applicant rejected by an AME or Aeromedical Centre (AMC) will have his data forwarded to the AMS and may then request further review. Such a request will be treated in the same manner as a referral.

[] [Review Procedure]

Any case referred to the AMS nationally must be reconsidered against the Requirements, Appendices and, if necessary, the AMC. If further investigation or opinion is required the applicant should be advised of this need and how it may be achieved. While applicants should be free to choose their physician advisers, it is expected that the AMS will maintain a list of medical specialists with particular aeromedical interest or experience. On occasion it may be necessary for the AMS to direct the applicant to a specific physician (JAR-FCL 3.105(f)) for a further opinion. In all such cases relevant documentation must be provided to the specialist. [The AMS may assess applicants being outside the requirements of Subparts B or C, but within the requirements of the Appendices, as fit. Such fit assessments may be delegated to the AMC or the AME at the discretion of the AMS. In case of such fit assessments the AMS shall be informed of the details of such assessment. The AMS may create a list of conditions (subject to delegation or not). Furthermore, the AMS may revoke such a fit assessment, if it is established that it has not met, or no longer meets, the requirements of JAR-FCL 3 or relevant national law.]

Secondary Review

Upon completion of their review the AMS should make an assessment and advise the applicant in writing of that decision. In most cases the AMS will have sufficient additional expertise and operational experience to make a decision. However, some cases require careful consideration of complex studies, for example coronary angiograms. In such cases it may be advantageous for the AMS to bring together several cardiologists in order to gain consensus concerning interpretation of this data. A national Aeromedical Advisory group of this type will normally be chaired by a senior member of the AMS and may include medical representatives of the airline industry and aircrew associations with further operational expertise available. The assessments can then be demonstrated as having been given full consideration. The AMS does not delegate its authority to such medical advisers but may find their support invaluable. Any certificate issued under the Appendices and AMCs must be annotated as such and carry any appropriate [] Limitations. The AMS shall indicate where and when further examination is required.

Standardisation

All cases which are outside the Requirements and require consideration by the AMS under the Appendices and/or AMCs, are to be reported to the JAA [Licensing SubSectorial Team (Medical) (LSST(M))]. Such a report shall include identification details, age, type of licence held or requested, medical condition, Standard and or Appendix referred to and assessment recommended – including any [] Limitations applied. A short narrative indicating the clinical summary is required in order to follow the reasoning applied. Proper compilation of this data should support audit of the Requirements and Appendices and enable continuing review of the AMS' s function. [At least an annual summary of all review procedures should be forwarded to the JAA by each member state, using the table given in the associated procedures, for discussion in the LSST(M)].

Amendment of Common Policy

Some cases may be outside the Requirements and Appendices but may still be considered a reasonable risk by an AMS. Such cases should be presented to the JAA [] [Licensing Sub Sectorial Team (Medical)] with all supporting data and if favourably assessed may lead to [an exemption or] amendment of Requirements, Appendices or JAA Manual of Civil Aviation Medicine.

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CHAPTER 2 - AVIATION CARDIOLOGY

1 INTRODUCTION

Over the past few years attitudes towards medical [assessment] have been based increasingly on the risk of event. In certain conditions, however, the event may be of less prognostic importance than its physiological and/or psychological consequences. Thus, whereas it may not be difficult to predict the risk of cardiac death within a population, a more empirical assessment of the importance of symptoms is needed, for example, in paroxysmal atrial fibrillation which can have a variable effect both on different individuals, and on the same individual at different times.

The [general] JAA Class 1 cardiovascular requirements are explicitly stated in JAR-FCL 3.130(a). [A Class 1 fit assessment] implies that [an applicant is meeting] these requirements, [i.e. not possessing any abnormality likely to interfere with his duties as a pilot]. [This] bears the implication that the licence holder is fit for single-pilot operations, in which the medical cause accident rate is likely to equal the incapacitating event rate [and below an acceptable level]. In cardiovascular terms this event rate is highly age-dependent.

The assessment of fitness permitting multi-pilot, but not single-pilot, operation (as described in JAR-FCL Part 3 Appendix 1 [in detail for the particular cardiovascular examinations and in general in Chapter 1 of this manual - The Concept of Aeromedical Risk Assessment] is based on the target risk of major incapacitating event not exceeding a notional 1% per annum [(see Chapter 1 of this manual - The Concept of Aeromedical Risk Assessment)]. If [an] incapacitating event occurs not more often than once in every 10^6 hours (i.e. once in every 100 years approximately or 1% risk of event/annum), then the fatal multi-pilot aircraft accident rate due to cardiovascular cause should not occur more frequently than in 10^9 hours. Accident statistics over the past [30] years suggest that this target is being achieved. Once a professional airman has a 1% major risk of incapacitating event per annum, or greater, then he/she will be unfit for duty. This objective, known as "the 1% rule" bears clarification. For each fatal myocardial infarction which occurs, there [are to be expected] 1-3 non-fatal such events, likewise for each fatal stroke, there will be a non-fatal event rate which is factored round a cardiovascular mortality of 1% per annum. This also applies to other cardiovascular pathologies (i.e. valvular heart disease/arrhythmias)[, but is most successfully applied] to the ischaemic syndromes.

The JAA Class 2 requirements relate to private pilots. As most private flights are single-pilot operations, a fatal accident is likely to be the outcome of complete incapacitation from medical cause. Most fatal accidents involving private aircraft, however, are due to pilot error and until recently the rate [has approximated 1 : 10.000] flying hours. For Class 1 operations it has been suggested that only 1 in 10^2 single-pilot accidents should be attributable to medical cause. It would be appropriate to downgrade this to 1 in 25-50 for Class 2 operations, this lowered requirement having a resonance with the lower safety level of Class 2 operations as a whole. In this case the judgmental point becomes an anticipated event rate of one in 10^6 (i.e. 1 in $25 \times 4 \times 10^4$) hours, or 1% per annum. Thus the Class 2 target for unrestricted certification is necessarily more or less identical with the Class 1 'valid only as or with qualified co-pilot' requirement (Class 1 'OML'). This means that only minor modification is needed to the Class 1 OML standard to apply it to the Class 2 standard. []

Although there may be some doubt about the wisdom of a Class 2 limitation 'valid only with safety pilot and in aircraft with dual controls' (Class 2 'OSL') on the certificate to allow private pilots with a lower standard of fitness to continue to hold a licence, it is possible to identify certain areas where this might safely be permitted. []

Therefore, in the foregoing, 'Class 1' refers to the requirements permitting single-pilot commercial operation. [A multi-pilot (Class 1 'OML') limitation] deals with the requirements restricting an applicant to multi-pilot commercial operation only. Class 2 [] applies to the unrestricted certification of private pilots. Finally Class 2 'OSL' implies a restriction on the latter to fly with a type-rated safety pilot.

2 HYPERTENSION

2.1 Hypertension and overall vascular risk

Hypertension has been described as the most powerful and prevalent of all the coronary vascular risk factors and its impact on [health and aeromedical assessment] of professional flight crew is profound. Flight crew undergoing frequent medical examinations should be well placed for early intervention to minimise the effect of hypertension. Nevertheless, repeatedly moderate, and sometimes severe, hypertension is detected having apparently been missed or ignored by [AMEs]. The explanation probably lies in part in a lack of appreciation of the likely additional cost in future health terms of untreated hypertension, and in part to a desire to avoid unnecessary interference which might have licensing implications.

[Not taking into account the so-called “white-coat hypertension, most] hypertension in adults is “idiopathic” representing no doubt in part the genetic inheritance of the subject and his interaction with the environment. In Northern Europe, 15-25 % of middle aged males and females are above the World Health Organisation cut-off point (160/95mmHg). If the hypertension is particularly severe, or poorly controlled, then a cause should be sought although a correctable cause is rarely found.

In younger subjects, in their 20s and early 30s, however, there is a greater chance of finding an identifiable cause, which is quite likely to involve the [renal / adrenal axis]. Renovascular abnormalities when corrected may not render the subject normotensive, although the blood pressure is sometimes easier to control. Renal investigation may include [ultrasound] examination of the kidney and a [DMSA scan for differential function]. Any difference in function should provoke further investigation, particularly in [a] young subject. This may include [a Magnetic Resonance Angiogram (MRA) to define the vascular anatomy. Conn's Syndrome (hyperaldosteronaemia) needs to be considered in the presence of persisting hypokalaemia]. Pheochromocytoma is an extremely rare cause of hypertension and often not diagnosed during life.[]

Hypertensive subjects as a group do not have a normal prognosis, and this is worsened if other vascular risk factors are present. It has become increasingly recognised that high blood pressure may be associated with biochemical abnormalities such as insulin resistance and mixed lipid disorders (Reaven's syndrome, [Metabolic Syndrome]), risk to the cardiovascular system being multiplicative. The significance of an elevated blood pressure should, therefore, be expressed in terms which include acknowledgement of the presence or absence of other vascular risk factors which include smoking, family history and obesity as well as those given above. Untreated hypertension multiplies the risk of the following conditions: Stroke - sevenfold, congestive heart failure-fourfold, myocardial infarction-threefold, and occlusive vascular disease-twofold. [Decision making has been enhanced by [various] publications, (e.g. the Joint European Societies' Task Force Report on Cardiovascular Disease Prevention and in Clinical Practice tables published in the European Heart Journal.)

2.2 Definition

Treatment of hypertension has been shown to [target levels of a diastolic pressure of 85 mmHg, measured at the disappearance of the Korotkoff sounds (Phase V). [If the subject is diabetic the lower target of 80mmHg should be sought]. There is a difference in prognostic terms between 'casual' blood pressure recordings, such as may be made during a routine examination, and the 'basal' level which may be obtained as the mean of a number of observations, commonly on different occasions and sometimes after a period of rest. For [aeromedical assessment] purposes at least two readings of both systolic and diastolic pressure should be obtained. [More if the values obtained are elevated.] If the heart rate is increased [the observations] should be repeated after an interval. So called 'white-coat' hypertension, representing an exaggerated alarm reaction is likely to be common in the pilot group and needs careful consideration. [It can only be diagnosed with 24 hr ambulatory monitoring and should not be “best – guessed” as an excuse for complacent management.] Here the clinical signs of established hypertension should be absent.

The value of a full clinical assessment by a cardiologist needs to be emphasised. The presence or absence of loss of compliance in the peripheral arterial wall is an important clinical observation in hypertension. Furthermore, vascular change in the fundus oculi such as silver wiring of the retinal arterioles, an increase in the arterio-venous ratio, or arterio-venous nipping are important signs. The last named, if present, is a sign of significant hypertension and it is unlikely that the subject would be fit for aircrew duties without further review. Echocardiography is of value in determining an increase in the left ventricular muscle mass[,which is predictive of outcome independent of the level of hypertension. It is also associated with excess alcohol intake]. Electrocardiography is not such a sensitive technique but left ventricular voltage hypertrophy with systolic overload is an important predictor of adverse outcome- it carried a 36% mortality at five years in the Framingham Study.

Neither displacement of the apex beat nor a fourth heart sound should be present. High sympathetic drive may be causal if a tachycardia is present. Multiple observations of the pressure on different occasions, preferably made by the personal physician, are also helpful. But ambulatory blood pressure monitoring should always be employed in cases of doubt. The diagnosis of " white coat hypertension" is not acceptable without such evaluation. Exercise electrocardiography is not indicated routinely.

The levels of systemic pressure permitted for [aeromedical assessment are just meant for] that. They are not treatment targets which should be judged on clinical grounds. It should be the objective in the management of hypertension in flight crew, as in others, to secure smooth reduction of elevated pressure in the absence of unwanted effects. Ambulatory blood pressure recording may enhance []. Recording devices should be of proven standard.

2.3 Investigation

When the diagnosis of hypertension (160/95-WHO) is made, an identifiable cause is unlikely to be present in more than about 5% of all subjects and a correctable cause in a much smaller percentage. All, however, should undergo at least serum creatinine, urea and electrolyte, fasting cholesterol (total and HDL component), triglyceride, urate and glucose estimation. [An increased creatinine level will signal a probable reduction in renal function.] If the hypertension is unusually severe or difficult to control, or the patient is young (<40 years)[, then Magnetic Resonance renal angiography (MRA)] and []urinary catecholamine excretion measurement may be indicated. Plasma renin [and aldosterone levels should be measured in the erect and supine position.] [Abdominal ultrasound] (for aortic calibre and renal outline) [is also] appropriate.

2.4 Treatment

Non-pharmacological methods of treatment should be adopted initially to encourage involvement by the airman in health maintenance. Attention should be paid to the achievement of an optimum body weight. A reduction in alcohol consumption to no more than two units per day will be beneficial. Other techniques include restriction of sodium intake, enhanced potassium consumption, increased exercise and relaxation training, although the benefits [and probably the compliance of the applicant] are likely to be small.

Until recently the only treatment permitted by ICAO and most certificatory agencies included non-loop diuretics and beta-blocking agents. [Following recent trial evidence of less efficacy and an increased eventual risk of the development of insulin resistance neither are likely to be the treatment of first choice. Diuretics have immediate] drawbacks in metabolic terms – elevation of the plasma triglyceride, of plasma urate and impairment of glucose metabolism for example. Loop diuretics are to be avoided on account of their short duration of action. Unwanted effects such as headache, cramp, muscle aches and loss of potency also occur [and are not uncommon. Beta-blocking] agents also have minor adverse metabolic effects and tend to cause drowsiness and fatigue, even if hydrophilic. Propranolol was the first beta-blocking drug permitted in flight crew but is to be avoided as it has a higher side effect profile than some of the newer agents. This, in part, reflects variation between individuals in its metabolism. Atenolol [has been] the most widely used beta-blocking agent and can be given at a dose of not more than 50mg [per day]. It may be combined with a diuretic agent. Angiotensin converting enzyme inhibitors (ACEI), the [angiotensin

I receptor blockers (ARB) and the slow channel calcium blockers (CCB) are more suitable.] The use of centrally acting antihypertensive agents such as methyldopa, clonidine and reserpine, together with the ganglionic and post-ganglionic agents, such as bethanidine and guanethidine, [as well as selective alpha blocking agents such as prazosin] disqualify from any form of certification to fly.[]

Recently a consensus has developed which suggests that the angiotensin converting enzyme (ACE) inhibitors [(enalapril, lisinopril, ramipril, perindopril), angiotensin I receptor blockers (ARBs, sartans) (e.g. sartans (losartan, valsartan, candesartan), which block the angiotensin II receptor and have a very low side effect profile] and the slow channel [calcium-blockers (CCB) (amlodipine, nifedipine) are the products of choice, for use by flight crew subject to careful supervision]. These groups of products do not appear to cause central nervous system effects that are of significance and may be used under supervision either alone or combined with other agents, [including] non-loop diuretics. The possibility of a first dose effect requires consideration with any ACE inhibitor and the dosage may need to be reduced in the event of sodium depletion from whatever cause. This includes diarrhoea and feverish illness. The slow-channel calcium-blocking agents are associated with flushing and headache[, peripheral oedema and occasionally gum hypertrophy. Combination] with a beta-blocking agent agent [such as bisoprolol] may reduce these side effects. The longer acting products (i.e., amlodipine) are to be preferred to shorter acting ones (i.e. nifedipine). Verapamil and diltiazem may also be considered but not in concert with a beta-blocking agent. [The angiotensin I receptor blockers (ARB) have a very low side effect profile and are the drugs of first choice.]

During the institution of treatment and its regulation, an airman should be made temporarily unfit and a note made of any adverse effects of medication [and of its efficacy]. If the treatment has been instituted with a product with potential side-effects, such as a beta-blocking agent, the satisfactory completion of an appropriate 'base check' [may be] required. The airman should be restricted to multi-pilot operations (Class 1 'OML')) unless it can be demonstrated that his overall risk of cardiovascular event, taking into account his age, treated and untreated blood pressure levels and any other vascular risk factor presence, is normal or near normal in actuarial terms.

3 LIPID ABNORMALITIES

Inherited abnormalities of lipid metabolism are [common]. Certain examples, such as familial hypercholesterolaemia (Fredrickson Type IIa) occurs in about 2-3/1 000 of the population and have profound implications for the cardiovascular system. The cholesterol may be elevated to 10 mmol/L (385 mg%) or more and 50% of male patients suffering this disorder will have manifestations of coronary artery disease by the age of 50. Once identified such individuals need to be treated aggressively with [a statin (HMG CoA reductase inhibitor) (simvastatin, pravastatin, atorvastatin) if necessary with the addition of an] ion-exchange resins or [a fibrate. Ezetimibe is also a useful adjunct and may also be used if the product of first choice, a statin, cannot be tolerated.]

As with hypertension, even minor elevations of the plasma cholesterol have an effect on cardiovascular health and it is recommended that special attention be paid to diet and body weight when the level exceeds [5,5] mmol/L (215 mg%). Above [6,5]mmol/L (255 mg%) pharmacological intervention may be indicated if weight reduction and dietary manipulation have failed. [This particularly applies in the presence of hypertension or other risk factors, especially diabetes.] Minor elevation of triglyceride should yield to weight and/or alcohol reduction. More substantial elevations (> [8,7] mmol/L (>350 mg/dL)) will require specialist review [and intervention].

JAR-FCL 3.130 and 3.250 require routine investigation of the plasma lipids, if other risk factors are present. There is no requirement, as such, to review the individual fractions of high density and low density lipoprotein cholesterol, but a high density fraction [(HDL) < 1,0] mmol/L (< 40 mg %) may be associated with additional vascular risk on account of loss of the protective effect of [HDL. Certain risk tables (i.e. those of the Joint British Societies – JBS) include the HDL level in their tables of prediction.]

Treatment of a lipid disorder is not a bar to [a fit assessment] and no [limitation], per se, is required on the medical certificate unless the overall vascular risk is considered to be too great.

[Treatment is an absolute requirement, unless contra-indicated, in the presence of known coronary artery disease.]

[In Summary:] From the point of view of overall risk, a European in his 50's probably has a median risk of major coronary event of one every 3×10^6 flying hours but the presence of hypertension, lipid abnormality and/or smoking may increase this to one in every 2×10^5 hours. In spite of this, [belonging to] a high risk group does not necessarily extend to an individual in that group, but three fifths of major coronary events will occur within the top quintile of risk. Unfortunately, intervention to reduce risk factor presence is only likely to bring about at best a 30% reduction in risk when compared with age matched controls. The discovery of elevated plasma lipids should thus prompt careful review of the blood pressure and attention to other risk factors such as minor hypertension, smoking and glucose intolerance. This is particularly important in single-pilot operations. In this situation regular cardiological review with exercise electrocardiography is justified.

[4 SPECIFIC CARDIOLOGICAL PROBLEMS

4.1 Protocols of investigation]

Diseases of the circulation are an important and in many countries the single most important cause of death. In North West Europe the number of deaths from diseases of the circulation [has been declining but still represents some two fifths of all cause mortality. This does not altogether hold in Eastern Europe and in] certain countries in the Third World, however, increased living standards appear to be associated with an increased incidence of coronary artery events.

In addition to variation in the prevalence of coronary artery disease between countries, there is variation between regions within the same country but these are not however sufficiently large to have [] implications [on aeromedical assessment]. The recommendations with regard to [a fit assessment] following a cardiovascular event or intervention are based on available data, and the current practice by a number of ICAO and JAA signatory nations. [As investigation of the commonly encountered cardiological problems follows a well defined pathway, and as certain of the investigations are common to all, the indexed paragraphs below will be referred to in the subsequent text by as Required Investigation (RI) A, B, C, etc. This is to avoid inevitable repetition. Likewise Mandatory Guidance (MG) statements relating for example to reduction of vascular risk will also be suggested.]

[RI (A) Resting electrocardiography

Resting electrocardiography is required at defined intervals as laid down in the JAR Med. The expected standard is for the subject to be warm and comfortable at rest. Adhesive electrodes are to be preferred. A 12 lead 4 presentation is optimum, the recording system representing at least three leads simultaneously. Such systems usually make an analogue to digital conversion which facilitates electronic transmission for interpretation, if required. The older, single channel, systems, if used, should be optimally filtered and damped and satisfy the American Heart Association requirements. Interpretation should be by a specialist acceptable to the JAA. Computer assistance may be permitted by an individual AMS.

RI (B) Exercise Electrocardiography

Exercise Electrocardiography should be carried out to a standard treadmill protocol, preferably that of Bruce in which both the slope and its rate increase every three minutes. The 20 watt bicycle ergometric protocol equivalent may also be used, there being a 20 watt increase in load each minute. symptoms. A 12-lead recording system should be used with at least three leads being recorded simultaneously. Single lead bipolar or unipolar systems are not acceptable. Electrode preparation should include skin abrasion and alcohol cleaning. Silver chloride is to be preferred as the contact agent. Dedicated recording systems help overcome the problem of muscle induced artefact. All 12 leads should be recorded in the recumbent position at rest, following hyperventilation, in the standing position before commencement and for each minute of exercise and each of ten minutes of recovery. At least 9 minutes of the Bruce protocol should be completed. The reason for cessation should be symptom limitation, any

symptoms should be recorded, together with symptoms, if any. Interpretation by an accredited cardiologist is required and the recording should show no evidence suggestive of myocardial ischaemia. Medication with cardio-active drugs (beta-blocking agents, vaso-dilators) should ideally have been withdrawn 48 hours beforehand. Digoxin should preferably be discontinued 14 days beforehand.

RI (C) Stress Myocardial Perfusion Imaging (MPI)

MPI employs a radionuclide to evaluate myocardial perfusion. The greatest experience is with Thallium, which behaves as potassium in the exercising myocardium. Thallium MPI has the advantage that is a non-invasive means of predicting the outcome over a limited period (up to 4 years) but suffers from the disadvantage that the radiation dosage is three times that received during coronary angiography. It should be carried out in a recognised and experienced centre and may be used for aeromedical assessment in the coronary syndromes. It may be used in establishing fitness, for example following revascularisation, provided a recent, index coronary angiogram is available. Pharmacological stress, often using adenosine, is more useful than exercise stress and is mandatory in the investigation of left bundle branch block. Other radionuclides such as MIBI are also permissible. When radionuclide techniques are used to assess left ventricular ejection fraction it, should be >50%

RI (D.1) Doppler echocardiography

Two (and now three) dimensional Doppler echocardiography (RI.1) is an excellent non-invasive means of demonstrating cardiac chamber diameters, wall thickness and motion. The heart valves can also be assessed. Doppler techniques allow the deduction of pressure drops (i.e. the gradient) across a valve. Left ventricular fractional shortening may be employed to calculate the ejection fraction which is better derived by Simpson's rule. The cardiac dimensions should be within the normal range. The left ventricular ejection fraction should be > 50 % without significant abnormality of wall motion such as dyskinesia, hypokinesia or akinesia.

RI (D.2) Stress echocardiography

When echocardiographic techniques are used to assess the ejection fraction, it should be >50%. Stress echocardiography (RI D2) is a useful non-invasive technique for the assessment of reversible ischaemia. Pharmacological stress such as intravenous dobutamine should be used, rather than exercise. Stress induced wall motion abnormalities demand further investigation.

RI (E) Twenty four hour ambulatory electrocardiographic (Holter) monitoring

Twenty four hour ambulatory electrocardiographic (Holter) monitoring is of use in the detection of atrial and ventricular arrhythmias and conduction abnormalities. It is commonly used in aeromedical assessment to seek episodes, for example of paroxysmal atrial fibrillation. Other techniques, operated by the subject, i.e. CardioCall / CardioMemo, are applicable to less frequent rhythm disturbance. Complex ventricular rhythm disturbance and paroxysmal atrial / ventricular rhythm disturbance is likely to disqualify, or require further evaluation.

RI (F) Coronary angiography

Coronary angiography has long been the gold standard in the assessment of coronary artery disease. It is invasive and therefore has found less favour in the aeromedical assessment of an airman with known coronary disease. Furthermore increasing experience has permitted the use of stress MPI and exercise ECG as surrogates, always provided there is a recent (i.e. within 6 months) coronary angiogram, to which the findings can be related. There should be no delay > 6 months prior to assessment of fitness. Significant left main stem (> 30% stenosis) or triple vessel coronary artery disease is disqualifying. Single or two vessel involvement may be considered for Class 1 OML provided the coronary angiogram shows < 50% luminal narrowing in any major epicardial vessel (unless subtending an infarction) in the presence of a normal contrast ventriculogram. No more than 30% stenosis is permitted in the proximal left anterior/ left main coronary artery. Thus luminal obstruction >30% but < 50% elsewhere may be tolerable always provided there is no evidence of myocardial ischaemia on stress MPI/exercise ECG. However, more than two stenoses between 30 and 50 % within the vascular tree are not acceptable. The ejection fraction as measured by the contrast ventriculogram should be >50%. Following myocardial infarction It is important to establish, in so far as is possible, that the infarction has been 'completed' and that a tight stenosis, which may or may not represent recanalisation of a blocked vessel, is not subtending potentially ischaemic muscle. This is generally best demonstrated by stress MPI. Following

coronary artery surgery (CABG), if coronary angiography is carried out, there shall be no proximal disease in any ungrafted vessel >30% and no demonstrable impairment of the myocardium subtended by any such vessel. There shall be no obstruction in any graft or of its anastomosis >30% unless stress MPI confirms the absence of stress induced myocardial ischaemia.

RI (G) Electrophysiological study (EPS)

Electrophysiological study is invasive and indicated in the definition of tachy-arrhythmias and impaired atrio-ventricular conduction. It is also indicated as a prelude to therapeutic intervention, for example in the ablation of atrial flutter circuits. It is not commonly required.

RI (H) Magnetic Resonance Imaging & Angiography (MRI & MRA)

Magnetic Resonance Imaging & Angiography (MRI & MRA) is a non-invasive technique increasingly used in the elucidation of abnormalities of the myocardium such as the infiltrative myopathies and myocarditis. It can also demonstrate localise wall damage in the context of coronary artery disease.

MG (A) Reduction of vascular risk.

This is almost universally indicated and applies to treatment of hypertension, reduction in the plasma lipids, weight reduction, increase in exercise, reduction in alcohol intake and smoking cessation. It particularly applies in the coronary artery syndromes. Reduction of elevated levels of cholesterol with the statins has been demonstrated to have a beneficial effect on cardiovascular outcome. Targets for cholesterol reduction should be < 5.0 mmol/L (< 200 mg %), total, and < 3.0mmol/L (< 115 mg %), of the low density component (LDL). If this cannot be achieved then an overall 30% reduction should be sought. The statin dose should be titrated to the tolerable maximum, if possible. Adjuvant treatment with, for example ezetimibe, should be considered. Subjects with demonstrated coronary disease would be expected to be receiving low dose aspirin (75-150 mg) unless there is a specific contraindication.

MG (B) Follow up.

Special requirements for follow up by the AMC will include follow up medical examination by a cardiologist acceptable to the AMS and repetition of special investigations, i.e. exercise ECG. The periodicity will be determined by the AMS. This is likely to be at least annually.

MG (C) Limitations

A multi-pilot (Class 1 'OML') limitation may be required.]

[4.2] Coronary artery disease

The coronary syndromes are capricious in their presentation and potentially devastating in their outcome. In Northern Europe myocardial infarction will be the cause of death in between one quarter and one third of the [] population[. Twenty five per cent of males may die from this cause] before reaching age 65. One sixth of new cases of coronary heart disease will die suddenly without [previous clinical] symptoms []. A further two fifths each will present with myocardial infarction or angina pectoris. Coronary artery disease predicts coronary events and one third of subjects suffering a myocardial infarction will die within 28 days, half of the deaths occurring within the first 15 minutes after the onset of symptoms.

[Thus, demonstrated] coronary artery disease [] has to [be dealt with meticulously in aeromedical assessment]. Angiographic data are powerful predictors of future cardiac events in proven or suspected coronary artery disease and although long used as the so-called "gold standard" an assessment should be properly made with full clinical biochemical and exercise electrocardiographic/scintigraphic evaluation. []

[4.2.1] Electrocardiographic correlates of coronary artery disease

a *Minor repolarisation anomalies*

Minor repolarisation anomalies involving mainly the ST segments and T-waves are seen in 2-3% of asymptomatic males with flying status. Exercise ECG should be used to clarify such

anomalies, which have a low predictive value for coronary artery disease. [With increasing age the overall prevalence of such disease is greater. []

b *Exercise electrocardiography*

Exercise electrocardiography should not be used routinely. It is now accepted that the problem of [the] limited specificity of the technique makes the likelihood of a 'false positive' exercise recording several times [greater than] a 'true positive' one in the average middle-aged asymptomatic pilot. It may, however, [be used to elucidate minor resting electrocardiographic changes and when the presence of vascular risk factors (hypertension and/or hyperlipidaemia)] is such that the probability of cardiovascular event becomes excessive. Even so, a negative exercise recording may not permit a confident decision [for a fit assessment with multi-pilot (Class 1 'OML') limitation] in such circumstances. Furthermore, an abnormal response in hypertensive subjects may not necessarily indicate coronary artery disease. [Hypertension is one cause of a "false positive" appearance. The walking time of the exercise ECG (which should be symptom-limited) is predictive of outcome notwithstanding the appearance of the ECG.]

[4.2.2] Minor coronary disease

It is likely that significant coronary artery disease will [appear] as angina pectoris or myocardial infarction (see below). Minor coronary artery disease [appears] in a number of ways, sometimes following angiography for atypical chest pain, sometimes following minor and often irrelevant electrocardiographic findings.

For [aeromedical assessment] purposes subjects with asymptomatic minor coronary artery disease are acceptable for multi-pilot operation provided that [there is compliance with RI (B) (or RI (C)), and RI (D)]. There must also be compliance with MG (A, B, C)]

This level of assessment applies also to Class 2. [At revalidation / renewal Class 2 applicants having completed (a) above only may be assessed as fit with Class 2 'OSL'.] More significant disease is acceptable for Class 2 'OSL' only if symptom-limited exercise ECG / [stress MPI] / stress echocardiography fails to suggest myocardial ischaemia. Evidence of exercise induced myocardial ischaemia disqualifies from all classes of certification to fly.

[4.2.3] Angina pectoris

Angina pectoris, as a potential cause of subtle incapacitation, [is disqualifying], irrespective of whether it is abolished or not by medication. This is independent of whether the symptoms are due to obstructive coronary artery disease (which will in all probability be disbaring in its own right) or to coronary arterial spasm giving rise to variant (Prinzmetal) angina. Other causes of angina pectoris (i.e., aortic stenosis, hypertrophic (or dilated) cardiomyopathy) also disqualify.

[4.2.4] Chest pain of doubtful cause

Chest pain of uncertain cause is uncommon in professional flight crew but requires full investigation including symptom-limited exercise electrocardiography and/or [stress MPI] / stress echocardiography. Coronary arteriography is useful in [cases of uncertainty]. If the coronary arterial tree and left ventricular performance are within normal limits then the prognosis should be as good as that of the airman's uninvestigated peers. [A fit assessment] requires a judgement on the severity of the symptoms and their likely effect. The possibility of other cardiac (i.e. mitral leaflet prolapse) or non-cardiac explanation for such symptoms should be sought.

4.2.5 Myocardial infarction

The prognosis following myocardial infarction improves exponentially from the point of onset of symptoms. The intermediate and longer term outcome correlate powerfully with residual left ventricular function and with coronary anatomy. The prediction of coronary events from the appearance of the coronary angiogram is not straightforward. Much has been learnt in recent years about the composition of atheromatous plaques, their pathophysiological behaviour and their anatomy. Loss of stability appears to be associated with the thinning of the fibrous tissue covering the core of the plaque. This may be associated with rupture and clot formation leading to an unstable ischaemic syndrome or myocardial infarction. Contrary to what was initially believed, it cannot be assumed that the more severe stenoses carry a worse outlook as not infrequently it is the less severe stenoses which undergo plaque rupture and subsequent occlusion of the vessel with thrombus.

The epidemiological data, however, have all suggested that provided there is no lesion [$> 30\%$] in any major epicardial artery, the 5 year prognosis in terms of coronary event is sufficiently good [for Class 1 for a fit assessment after a period of temporary disqualification for at least six months following the index event. Asymptomatic] subjects may be considered for [a fit assessment with multi-pilot (Class 1 'OML') limitation] not sooner than six months following the event, provided that [there is compliance with RI (B) (or RI (C)), RI (D), RI (E) and RI (F). There must also be compliance with MG (A, B, C)]

This level of assessment applies also to Class 2. Should post-event coronary angiography not be available, [a safety pilot (Class 2 'OSL') limitation may be required,] provided that symptom-limited exercise ECG / [stress MPI] / stress echocardiography fails to suggest myocardial ischaemia. Evidence of exercise induced myocardial ischaemia disqualifies [for] all classes [].

4.2.6 Coronary artery bypass grafting (CABG)

The intermediate and long term prognosis following coronary artery bypass grafting has been reported widely. There is a procedure-related mortality of [0,5]-2% with a small risk of peri-operative myocardial infarction or cerebrovascular event. First year graft occlusion occurs at a rate of about 10% falling to 1–3% per annum subsequently. [This should be modified by attention to vascular risk factors.] As time goes by, obstructive coronary disease progresses in the native circulation and after 10 years 50% of saphenous bypass grafts will have obstructed. [Internal mammary artery grafts have a better survival although the efficacy of the presently favoured radial artery grafts it is yet to be proven. The left internal mammary artery grafted into the left anterior descending coronary artery, or its first diagonal branch, appears particularly durable with a reported 10-year survival $> 90\%$. Nevertheless, up to 50% of patients undergoing coronary artery bypass grafting for angina pectoris are likely to experience a recurrence of their symptoms after six or seven years.] Efforts towards secondary prevention to reduce [vascular] risk [factors are both indicated and] required. []

Asymptomatic subjects may be considered for [fit assessment] not sooner than six months [following] surgery, provided that [there is compliance with RI (B) (or RI (C)), RI (D), RI (E) and RI (F). There must also be compliance with MG (A, B, C)]

This level of assessment applies also to Class 2. Should post-intervention coronary angiography not be available, [a safety pilot (Class 2 'OSL') limitation may be required,] provided symptom-limited exercise ECG/scintigraphy / stress echocardiography fails to suggest myocardial ischaemia. Evidence of exercise induced myocardial ischaemia disqualifies [for] all classes [].

4.8 Percutaneous transluminal coronary angioplasty (PTCA)

A [certain number] of flight crew with coronary artery disease requiring revascularisation are suitable for angioplasty/stenting. This includes individuals who have developed a stenosis in a coronary arterial bypass graft. If the patient has multi-vessel disease, the risks of intervention and recurrence are higher. [Early experience with "plain" balloon angioplasty suggested a re-stenosis rate of] up to 20% of patients in the first 6 months. [Improved technique and the widespread adoption of intravascular stenting has improved on this significantly, with further gains being made by drug eluting stents. Nevertheless the MACE (major adverse cardiac event) rates in all still exceed the 1% cut off point and point and only the best risk subjects can be considered following coronary artery stenting. Early re-stenosis is associated] with the recurrence of symptoms. Thereafter the restenosis rate is lower, but still appreciable - 38% overall at 30 months in one [early] study. [This has now fallen to some 8% in the first year with bare metal stenting, and about half that with drug eluting stents.]

A number of international trials have examined whether angioplasty or coronary artery bypass grafting is the procedure of [choice] in the management of certain categories of coronary artery disease, whilst others are examining the significant prognostic gains demonstrated by lipid lowering strategies, notably with statins. [Coronary artery bypass grafting has been demonstrated to prolonged survival with certain correlates of disease but it proved difficult to demonstrate a survival benefit following angioplasty. It is good, however in the management of symptoms.]

Asymptomatic subjects may be considered for [a fit assessment] following [] angioplasty with or without stenting, [not sooner than] six months following intervention, provided that [there is compliance with RI (B) (or RI (C)), RI (D), RI (E) and RI (F). There must also be compliance with MG (A, B, C). Five yearly coronary angiography should be considered after the index intervention, but may not be necessary, if the exercise ECG / stress MPI shows no change on evaluation and is acceptable to the AMS. Particular attention should be paid, if multi-lesion coronary angioplasty / stenting in the same vessel or multi-vessel coronary angioplasty / stenting was performed. Graft angioplasty and angioplasty in diabetic subjects has a poor prognosis and is likely to lead to an unfit assessment.

This level of assessment applies also to Class 2. Should post-event coronary angiography not be available, [a safety pilot (Class 2 'OSL') limitation may be required,] provided symptom-limited exercise ECG/scintigraphy / stress echocardiography fails to suggest myocardial ischaemia. Evidence of exercise induced myocardial ischaemia disqualifies [for] all classes [].

5 AORTIC ANEURYSM

The prognosis in aortic aneurysm is related to the diameter of the affected segment. About half of all in the abdomen >[6,0] cms rupture within one year while one sixth rupture over a similar period if the diameter is <[6,0] cms. Data are fewer for thoracic aortic aneurysm but about two thirds, only, survive five years, rupture occurring in one third of those dying over this period. Surgical correction may stabilise the situation but does not correct remote pathology.

The diagnosis of aortic aneurysm in any part of the thoracic aorta, irrespective of cause, whether before or after surgical repair, [is disqualifying. Applicants with unoperated infra-renal aneurysms may be assessed as fit by the AMS with a multi-pilot (Class 1 'OML') or safety pilot (Class 2 'OSL') limitation. A follow-up will be determined - as appropriate - by the AMS].

Following satisfactory repair of an abdominal aortic aneurysm, a normotensive applicant with a satisfactory exercise electrocardiographic response [and sufficient cardiovascular assessment may be assessed as fit with a multi-pilot (Class 1 'OML') or safety pilot (Class 2 'OSL') limitation], with annual review by the AMS, the review to include [ultrasound] examination of the abdominal aorta.

6 MARFAN'S SYNDROME & RELATED DISORDERS

Marfan's syndrome is usually transmitted via an autosomal dominant gene with variable expression. In about 15% of subjects it appears to be due to a mutant gene. Its prevalence is approximately [1,5]/100 000 of the population which is adjacent to that of the somewhat similar Ehlers-Danlos syndrome. In view of the risk of progressive aortic and/or mitral regurgitation and of post-operative aortic rupture it is incompatible with both Class 1 and Class 1 'OML' status. Applicants with a forme fruste showing no evidence of aortic aneurysm formation on MRI scanning, or of no more than minor aortic or mitral regurgitation on 2D Doppler echocardiography, all other echocardiographic measurements being within the normal range may be considered for Class 1 'OML' subject to annual cardiological follow up.

This level of assessment also applies to Class 2. Applicants unable to meet the above requirements may be considered for Class 2 'OSL' provided the diameter of the ascending aorta remains < [4,5] cms and that of the abdominal aorta < [5,0] cms. Mild aortic/mitral regurgitation may be acceptable in this context.

7 PERIPHERAL ARTERIAL DISEASE

Peripheral arterial disease is powerfully predictive of a wider spread arteriopathy involving the coronary and cerebral arteries. Once the diagnosis has been made cardiological assessment is required, including exercise ECG [(if possible) / stress MPI] / stress echocardiography. [Exercise ECG] may be of limited sensitivity, if [its] end point is lower extremity claudicant pain. In that case further investigation including [pharmacological stress MPI] / coronary angiography will be warranted. A careful search should also be made for carotid artery bruits. [Duplex carotid ultrasound examination and / or MRA] should be carried out on the carotid circulation (see also section III). Cranial artery disease is disqualifying [for] all classes [If the investigations are within the normal range a fit assessment with a multi-pilot (Class 1 'OML') limitation] may be considered[. This level of assessment also applies to Class 2.

[]

8 VALVULAR HEART DISEASE

Chronic rheumatic heart disease is of declining importance in Europe and problems such as bicuspid aortic valve and mitral leaflet prolapse are becoming much more commonly diagnosed, being seen in 1% and 5–8% of the population respectively.

8.1 Flow (innocent) murmurs

Systolic ejection murmurs in the young and slim are very common and should be reviewed by a cardiologist. They are normally early and brief and are not associated with an ejection sound or early diastolic murmur. Usually a single cardiological consultation will establish the innocence of an unidentified murmur, but 2D Doppler echocardiography will be required in cases of doubt.

8.2 Aortic valve disease

a Bicuspid aortic valve

This is a common congenital abnormality and may be associated with [disease] of the aortic root. It affects up to 1% of the adult population in Europe. In view of the risk of progression

to aortic stenosis or regurgitation or both, cardiological review should be carried out [regularly, often annually.] In addition to the risk of progression to aortic stenosis or regurgitation, there is a risk of endocarditis. An enhanced risk of this insidious condition is not a reason for denial of [a fit assessment] but subjects with a bicuspid aortic valve [have a risk of endocarditis and] need to pay attention to dental hygiene[, although the indication for prophylactic antibiotics is less secure than formerly]. Provided there is no known sensitivity, usually 3g amoxycillin is taken orally one hour beforehand. The same applies to urinary tract manipulation (see 8.5). It is uncommon for significant valvular abnormality to be present before the fifth decade.

Provided no other abnormality (2D Doppler flow rate <[2,0] m/sec) is present [a fit assessment without limitation may be considered]. If the aortic root is > 4,0 [, a multi-pilot (Class 1 'OML') limitation] and annual review by a cardiologist acceptable to the AMS [should be required]. An aortic root diameter >[4,5] cm is disqualifying [for] all classes.

This level of assessment also applies to Class 2. [More significant] degrees of dilatation of the aortic root in the presence of a bicuspid valve may [require a safety pilot (Class 2 'OSL') limitation].

b *Aortic stenosis*

[Aortic stenosis requires AMS review. A fit assessment requires an intact left ventricular function and depends on the mean pressure gradient and requires good signals at echocardiography.

Applicants with a minor aortic stenosis (mean pressure gradient of up to 20 mm Hg) may be assessed as fit.

Applicants with a mild aortic stenosis (mean pressure gradient above 20 and of up to 40 mm Hg) may be assessed as with with a multi-pilot (Class 1 'OML') limitation. Applicants with a more severe aortic stenosis (mean pressure gradient of up to 50 mm Hg) may be accepted on discretion of the AMS]. The applicant should be capable of exercising to Bruce stage IV without symptoms. The risk of embolism from platelet aggregation on the closure line of the valve cusps, and of endocarditis make [the multi-pilot (Class 1 'OML') limitation in other than minor aortic stenosis] necessary. Significant deterioration of a bicuspid aortic valve usually does not occur before the fifth decade of life when either stenosis or regurgitation may become increasingly important. No significant left ventricular hypertrophy [(free wall and septal thickness > 1,1 cm)] nor dilatation [(left ventricular diastolic diameter > 5,6 cm in dominant stenosis, > 6,0 cm in dominant regurgitation) should be present]. A history of transient ischaemic attack (TIA) shall disqualify [for] all classes [. Recurrent] review by a cardiologist []with 2D Doppler echocardiography is required, [the periodicity will be determined by the AMS.]

This level of assessment also applies to Class 2. In the absence of a history of peripheral embolism, applicants []without other abnormality of the resting electrocardiogram or echocardiogram, may be considered for Class 2 [without] 'OSL'.

c *Aortic regurgitation*

Aortic regurgitation is well tolerated and even moderate regurgitation may be present for very many years. Minor regurgitation in the absence of aortic root disease may be compatible with [a fit assessment,] but requires regular review by a cardiologist []with 2D Doppler echocardiography. The applicant should be capable of exercise to Bruce stage IV without symptoms. Co-existent dilatation of the aortic root (>[4,5] cm) [is disqualifying]. Evidence of volume overloading of the left ventricle (left ventricular end diastolic dilatation

>[6,0] cm) disqualifies although minor increase in the left ventricular end diastolic diameter may [be acceptable] with Class 1 'OML'.]

This level of assessment also applies to Class 2. A more significant increase in the left ventricular end diastolic diameter without an increase in the left ventricular end systolic diameter [> 4,1 cm] may be consistent with a Class 2 'OSL' [].

8.3 Mitral valve disease

a Rheumatic mitral stenosis

Rheumatic mitral stenosis and/or regurgitation, once diagnosed, [is disqualifying] in view of the risk of abrupt onset of atrial fibrillation and of cerebral embolism. [Minor degrees of mitral leaflet tethering without enlargement of the left atrium may be assessed as fit with a multi-pilot (Class 1 'OML') limitation.] The onset of atrial fibrillation may be at a fast rate, which in the presence of mitral stenosis, can provoke syncope and may be associated with pulmonary odema.

This level of assessment also applies to Class 2. Applicants with mild mitral stenosis (valve area >[2,0] cm²) in sinus rhythm may be considered for Class 2 'OSL'.

b Mitral regurgitation/leaflet prolapse

Mitral regurgitation has numerous causes, both congenital and acquired. Not uncommonly it is due to prolapse of a leaflet of the mitral valve, and - much less commonly in Europe - [due] to chronic rheumatic involvement. Mitral leaflet prolapse may be associated with atypical chest pain and atrial and ventricular rhythm disturbances. If frequent atrial or ventricular rhythm disturbances (>2% of normal complexes) are detected on routine [ECG], 24-hour ambulatory ECG and echocardiography are indicated together with exercise ECG []. There is a very small risk of cerebral embolus, chordal rupture and sudden cardiac death. Patients with an isolated mid-systolic click need no [multi-pilot (Class 1 'OML') limitation,] but the presence of mitral regurgitation secondary to mitral leaflet prolapse requires [a] multi-pilot [] (Class 1 'OML') [limitation]. Significant mitral regurgitation as evidenced by left ventricular end diastolic dilatation of the heart [>6,0] cm and/or systolic dimension [>4,1] cm or left atrial internal diameter [>4,5] cm [is disqualifying]. Any reduction of left ventricular function should be closely scrutinised and [may be disqualifying]. The embolic stroke risk has been reported as increasing after 45 years of age, sharply in the presence of atrial fibrillation. The co-existence of mitral regurgitation and atrial fibrillation is in general terms an indication for treatment with warfarin, which [is disqualifying]. A history of transient ischaemic attack (TIA) [is] likewise [disqualifying]. Annual review by a cardiologist []including echocardiography is required.

Other causes of mitral regurgitation (i.e. rheumatic or degenerative) are normally disqualifying. [A fit assessment with a multi-pilot] (Class 1 'OML') [limitation] may be considered in the absence of other abnormality only, if the 2D Doppler echocardiogram demonstrates normal left ventricular dimensions and normal myocardial performance is confirmed by symptom-limited exercise electrocardiography to Bruce stage IV.

[This level of assessment also applies to Class 2. More than minor degrees of non-rheumatic mitral regurgitation should [require a safety pilot (Class 2 'OSL') limitation]. Significant mitral regurgitation and/or a history of transient ischaemic attack (TIA) [is disqualifying].

8.4 Valvular surgery

a Mechanical valves

Mechanical valves, such as the Starr Edwards ball, and the Bjork-Shiley tilting disc prostheses, in any position [are disqualifying, because] of the risk of embolic incident. The performance of the St Jude Medical pyrolytic carbon valve may be haemodynamically superior to the first two, but is also disqualifying, [because of] the requirement for continuous anticoagulant treatment.

This level of assessment also applies to Class 2.

b Tissue valves

[]The xenograft valves, such as the Hancock and the Carpentier-Edwards prosthesis have a >1% per annum risk of embolism and endocarditis. The unmounted homograft valve in the aortic position has the lowest risk of such complications. All tissue valves deteriorate with age and this occurs more sharply after five years. Such valves may be less durable in younger subjects. The []unmounted homograft aortic valve in the aortic position.[is the most favourable.in terms of aeromedical assessment. Candidates who have had a porcine xenograft such as the Carpentier Edwards, or similar, inserted] into the aortic position may also be considered. [The results following aortic valvotomy are not sufficiently reliable for a fit assessment. Mitral leaflet repair in the presence of prolapse is a successful procedure and compatible with a fit assessment provided the requirements above and below can be satisfied. The] poorer prognosis and a higher thromboembolic risk []associated with mitral valve replacement [should be disqualifying].

Asymptomatic subjects, who have undergone valve replacement / repair with a tissue valve, may be considered for [a fit assessment] provided that [there is compliance with RI (B) (or RI (C)), RI (D) and RI (E) and 8.4 b, above. There must also be compliance with MG (A, B, C).]

This level of assessment also applies to Class 2. Applicants failing to comply with the above standards, who, for example, have minor degrees of impairment of left ventricular function on 2D Doppler echocardiography may be considered for Class 2 'OSL'.

8.5 Antibiotic prophylaxis

Subjects with congenital or valvular abnormalities of the heart [have a risk of endocarditis. For prevention they] require antibiotic cover for both dental and urinary tract manipulation in line with current recommendations[, although these have recently been re-considered. At special risk are subjects] with prosthetic [heart] valves or a past history of endocarditis[, also subjects in whom there has been a surgically constructed conduit]. The current recommendation [for routine prophylaxis] is that 3 gms of amoxycillin be taken one hour before such procedure provided the patient is not penicillin sensitive. In that case erythromycin may be used at a dose of [1,5 g] followed by [0,5 g] six hours later. If there is a history of endocarditis an intravenous regime which includes gentamycin is currently recommended assuming there is no known drug sensitivity. Current guidelines should be followed.

9 VENOUS THROMBOEMBOLISM AND ANTICOAGULATION

9.1 Venous thrombosis

Isolated deep venous thrombosis with pulmonary thromboembolism is rare in fit patients of flight crew age. It has been described, however, following prolonged journeys by air but causative factors may include recent surgery, trauma, pregnancy, occult neoplasm, clotting abnormalities and previous deep venous thrombosis.

The diagnosis of deep venous thrombosis/pulmonary embolism needs to be secure. [Doppler ultrasound, phlebography], ventilation and perfusion (V/Q) scanning and pulmonary angiography may be required. [If] the diagnosis [has been established], treatment with anticoagulants is indicated. [This treatment is temporarily disqualifying until the anticoagulation has been discontinued] (see paragraph 5.1, Chapter Haematology). []If previous thromboembolism is suspected, it is necessary to ensure that there is no concomitant pulmonary hypertension (>30 mmHg systolic)[. Right heart catheterisation is only justified if the tricuspid regurgitant velocity suggests pulmonary systolic hypertension.]

[After fit assessment a] follow up [and a multi-pilot (Class 1 'OML') limitation may be required] for the first two years [on discretion of the AMS]. Anticoagulation with warfarin or coumarin like substances [is disqualifying].

This level of assessment also applies to Class 2.

9.2 Use of aspirin

Aspirin is normally prescribed on a regular basis in the management of the coronary syndromes before and after intervention. It also may provide [limited] protection against [coronary artery disease and] the risk of cerebral embolism in rhythm disturbances and valvular heart disease. It is also given in the presence of a muscle bridge in the myocardium.

Aspirin, 75-300mg, is a permitted substance provided there is no otherwise disqualifying condition. Its use should be regarded as 'usual care' and not be pivotal in reaching a [fit assessment], for example, to reduce the risk of thromboembolism.

10 MYOCARDITIS

There are a number of different causes of myocarditis which include infection, often with the Coxsackie A & B groups of viruses, bacteria and their toxins, protozoa and fungi. Certain drugs (i.e., the anthracyclines), organic (i.e., halogenated hydrocarbons) and inorganic compounds (i.e., carbon monoxide) may damage the myocardium, as may certain allergic reactions.

The most likely cause in flight crew will be a virus, which runs a limited time course, often of weeks. The diagnosis is often missed although rhythm or conduction disturbance with evidence of impaired left and/or right ventricular performance should encourage its consideration. In the case of previous anthracycline administration i.e. for malignant disease, the impact on the myocardium may be significantly delayed and a risk of ventricular arrhythmia/sudden cardiac death remains indefinitely.

[Asymptomatic subjects may be considered for a fit assessment] no sooner than six months following complete recovery from the illness, provided that [there is compliance with RI (B), RI (D) and RI (E). There must also be compliance with MG (A, B, C). There should be no history of systemic embolus. In the majority of cases a multi -pilot (Class 1 'OML') limitation will be required for some years, probably indefinitely following anthracycline administration. An uncertain number of patients suffering a virus myocarditis progress, over a period of months or years, to dilated cardiomyopathy (see below).

This level of assessment also applies to Class 2 and Class 2 'OSL'.

11 PERICARDITIS

The causes of pericarditis include infection, neoplasia, myocardial infarction, collagen vascular disease, metabolic abnormality and hypersensitivity to certain pharmaceutical agents. [A fit

assessment depends on] the underlying cause of the condition and whether or not its course is self limiting.

11.1 **Acute benign aseptic pericarditis**

Acute benign aseptic pericarditis is a febrile illness often presenting in young adults and characterised by chest pain, diffuse electrocardiographic change and sometimes breathlessness. It is a generally benign condition which may recur within the first few months after recovery.

During acute illness an airman should be [assessed as] temporarily unfit [. A fit assessment may be considered] three to six months following full recovery, provided that [there is compliance with RI (B), RI (D) and RI (E). RI (F) may be indicated if the diagnosis of coronary artery disease cannot be satisfactorily resolve. There must also be compliance with MG (A, B, C). A fit assessment requires a multi-pilot (Class 1 'OML') limitation] for at least two years. Review by a cardiologist [with resting ECG and echocardiography may be required. The periodicity (usually 6-monthly) and an initial supervision (usually at least two years) is up to the AMS].

This level of assessment also applies to Class 2 and Class 2 'OSL'.

11.2 **Constrictive pericarditis**

Constrictive pericarditis is a rare form of pericarditis in Europe, often with insidious onset. Pericardectomy is normally disqualifying. Following surgical removal of the pericardium [a fit assessment with a multi-pilot (Class 1 'OML') limitation] may be considered provided the patient is in sinus rhythm and the requirement of 11.1 above can be fulfilled. [Review] by a cardiologist [] is required. [The periodicity (usually annually) is up to the AMS.]

12 **CARDIOMYOPATHY**

Cardiomyopathy is a disorder of heart muscle, which is not secondary to hypertension, valvular or coronary disease or other identifiable cause. Its various forms are characterised by []systolic and/or diastolic [dysfunction]. It may be subdivided into hypertrophic, dilated and obliterative/restrictive forms.

12.1 **Dilated Cardiomyopathy**

This form of cardiomyopathy is associated with dilatation of either the right and/or the left ventricle. It is characterised by reduced cardiac output[, perhaps] with symptoms of fatigue and breathlessness. In the more severe forms, sudden cardiac death occurs in up to 50% of patients. It may be secondary to a viral illness, alcohol abuse, or be idiopathic or congenital, or be secondary to the conditions noted under myocarditis (paragraph 10) above. Complications include atrial and ventricular rhythm disturbances, cerebral embolism and sudden cardiac death. If limited to the right ventricle it may present as arrhythmogenic right ventricular [cardiomyopathy (ARVC)] with associated risk of sudden cardiac death[. Some subjects with dilated myopathy run a very prolonged course with stable, but reduced ventricular function, whilst others inexorably decline - in spite of optimal treatment, which will include an ACEI or a sartan. ACE inhibitors have transformed the management of the condition, but only those with minor, stable impairment of the left ventricle may be considered for a fit assessment. Established dilated cardiomyopathy involving the left and/or the right ventricle is disqualifying.]

The small percentage of patients who appear to make a complete [or near complete] recovery may be considered for [multi-pilot (Class 1 'OML') limitation] not less than six months after recovery has been deemed to be complete, provided that [there is compliance with RI (B), RI (D)

and RI (E). RI (F) may be indicated if the diagnosis of coronary artery disease cannot be satisfactorily resolved. There must also be compliance with MG (A, B, C).]

This level of assessment also applies to Class 2. Applicants with minor degrees of left ventricular impairment, stable for at least two years, may be considered for Class 2 'OSL', without further investigation.

12.2 Hypertrophic cardiomyopathy

Hypertrophic cardiomyopathy [is present when there is (often asymmetric) left ventricular hypertrophy is the absence of hypertension or outflow tract obstruction. It is associated with diastolic dyscompliance and has a prevalence in the population of the order of 1 : 500. To date 19 genes] have been identified with associated abnormalities of contractile protein function. In general terms [a fit assessment may be considered] in adulthood, but not in children or young adults, provided there is no family history of sudden [cardiac] death [(SCD), gross (>2.5cm) hypertrophy of the inter-ventricular septum], vasomotor instability on exercise or occult or overt ventricular tachyarrhythmia []. Increase in the left ventricular muscle mass may contribute to breathlessness due to loss of [myocardial] compliance [and tachy-arrhythmias, such as atrial fibrillation, should they occur, are poorly tolerated for the same reason], The resting ECG may be [more or less] normal or more commonly demonstrates septal vectors, [These are] characterised by significant Q-waves with a widely discordant QRST angle. Septal vectors are also seen in the chest leads.

Difficulties may arise, where there is minor isolated asymmetric hypertrophy (ASH) of the interventricular septum without other clinical, or diagnosis feature, on the resting ECG. If this is [not associated] with other echocardiographic features of hypertrophic myopathy (i.e., reduction in left ventricular cavity size [with apical obliteration], systolic anterior motion of the mitral valve and evidence of diastolic dysfunction), a family history of sudden cardiac death, or evidence of autonomic nervous system dysfunction, the situation is likely to be benign but requires supervision by a cardiologist [and a multi-pilot (Class 1 'OML') limitation].

[Because of the excess potential risk of rhythm disturbance, syncope, cerebral embolism and sudden cardiac death, such conditions are most likely disqualifying, once the diagnosis of hypertrophic cardiomyopathy has been established]. Applicants in whom features of hypertrophic cardiomyopathy are detected may be considered for [fit assessment with a multi-pilot (Class 1 'OML') limitation] provided that [there is compliance with RI (B), RI (D) and RI (E). There must also be compliance with MG (A, B, C). The presence of sustained or non-sustained ventricular tachycardia, unexplained dizziness or syncope, or significant increase in the intraventricular septum, (i.e. >2.5 cms) disqualifies from all forms of certification. A family history of early sudden cardiac death needs to be very carefully reviewed.]

The presence of sustained or non-sustained ventricular tachycardia, unexplained dizziness or syncope, or significant increase in the intraventricular septum, (i.e. >2.5 cms) [is disqualifying]. [Applicants with a] family history of early sudden cardiac death needs to be very carefully reviewed.]

This level of assessment also applies to Class 2. Failure to meet these requirements in full may still be consistent with Class 2 'OSL'.

12.3 Obliterative and restrictive cardiomyopathies

The obliterative cardiomyopathies may be associated with eosinophilic heart disease[.They] have a poor prognosis due to an excess risk of pulmonary and systemic embolism. [The] established condition, or the presence of $1 \times 10^9/L$ circulating degranulated neutrophils [, are disqualifying].

The infiltrative (restrictive) cardiomyopathies such as amyloidosis, sarcoidosis and idiopathic fibrosis have a high incidence of arrhythmia, the possibility of sudden cardiac death, and may progress to heart failure. Sarcoidosis has a variable incidence across Europe and there is further variation within certain countries. Commonly the condition is picked up on routine chest x-ray, on account of co-existent erythema nodosum or fever and uveitis. Usually the bilateral hilar lymphadenopathy disappears within two years but systematic involvement occurs to an unknown extent and the condition may be diagnosed by scalene node biopsy. Myocardial biopsy may be indicated. Evaluation of the plasma angiotensin converting enzyme (ACE) [level may indicate] active sarcoidosis, if [it is] elevated. Evaluation of late potentials on the resting ECG may be considered. Some 5% of those with systemic involvement also have involvement of the heart. In such patients examination of the heart with MRI is required.

Myocardial involvement with sarcoidosis is associated with complete atrioventricular block and Morgagni-Adams-Stokes attacks. Ventricular rhythm disturbances are frequent and a significant number suffer sudden cardiac death. Others develop congestive cardiac failure and as a result sarcoidosis of the heart [is disqualifying].

Symptom-free individuals including those with sarcoidosis with radiographic signs only of sarcoidosis involving the hilar nodes may be [assessed as fit with a multi-pilot (Class 1 'OML') limitation], provided that [that there is compliance with RI (B), RI (D) and RI (E). RI (F) may be indicated if the diagnosis of coronary artery disease cannot be satisfactorily resolved. The appearances of the myocardium as assessed by MRI (RI (H)) shall show no evidence of structural abnormality or reduction of function. There must also be compliance with MG (A, B, C)]

This level of assessment also applies to Class 2. Any [failure to comply with these requirements is disqualifying.]

13 RHYTHM AND CONDUCTION DISTURBANCES

13.1 Rhythm disturbances

[In aeromedical assessment rhythm] disturbances give rise to problems [whether paroxysmal or sustained]. Some individuals when encountering their first such rhythm disturbance - be it atrial fibrillation, atrial flutter[, atrioventricular (nodal) re-entrant tachycardia (AVRT / AVNRT)] - find the experience at least alarming. Such disturbances remain a potential causes of subtle incapacitation and retain a capacity for complete incapacitation by means of significant hypotension or embolic stroke. Some patients experiencing paroxysmal atrial fibrillation are unaware of the attacks, [whereas others experience significant symptoms. Likewise some,] who develop chronic atrial fibrillation [may be aware or unaware of] symptoms. These differences in the symptomatology observed by different individuals, or in the same individual in different attacks, need to be considered when attempting to maintain certification.

a *Atrial and ventricular premature beats*

Both atrial and ventricular premature beats are common findings in normal individuals. Atrial premature beats are usually harmless unless particularly frequent, in which case [, if of left atrial origin they may be premonitory of atrial fibrillation.] Holter monitoring should be carried out to seek [both for evidence of this and] the possibility of sino-atrial disease [in the older individual].

Ventricular premature beats are also usually harmless if infrequent and unifocal, and present in an otherwise normal heart. Evidence of multiformity, couplets and ventricular tachycardia if non-sustained (<5 seconds at a rate of >120 beats/min) may still be associated with a good prognosis in the normal heart[.] This has not been universally accepted and for this reason ventricular premature beats occurring in >2% of the total QRS count require further investigation, particularly if multifocal, or if couplets or salvos of ventricular tachycardia are present. Ventricular parasystole should be similarly considered. [A fit assessment] may be considered, provided that [there is compliance with RI (B), RI (D)

and RI (E) and 24-hour ambulatory ECG demonstrates no significant rhythm disturbance (the premature or aberrant atrial or ventricular beat count should be <2% of the total QRS count with no complex forms.)]

This level of assessment does not apply to Class 2. Class 2 'OSL' may be appropriate for private pilots failing to achieve the above criteria in full.

b *Atrial fibrillation*

[Atrial fibrillation may be associated with an underlying disease (e.g. structural heart disease, hypertension or hyperthyroidism) or without underlying condition (lone atrial fibrillation). It] may present as a single isolated event (for example, complicating a defined physical illness), in a paroxysmal form in which attacks may be separated sometimes by very long intervals of time, [in the persistent form in which sinus rhythm is only restored by cardioversion, or it may be permanent]. For [aeromedical assessment], paroxysmal atrial fibrillation will be defined as more than one attack with no time limit. [It may] be associated with [] valvular or hypertensive heart disease, myocardial ischaemia, or [a] primary myocardial [abnormality]. The possibility of alcohol abuse and thyrotoxicosis [] need to be considered [and excluded]. An airman with any such concomitant diagnosis is likely to be [assessed as unfit]. 'Lone' atrial fibrillation may be present when there is no other demonstrable cause [nor structural] cardiac abnormality. A pilot with paroxysmal or established atrial fibrillation [bears an excess risk of thrombo-embolism, which increases with age. In general terms, in the absence of risk factors – hypertension, diabetes and structural heart disease - the use of warfarin is not indicated to protect against the risk of thromboembolic stroke until age 65 years. The management of atrial fibrillation includes the attempt to suppress attacks (i.e. of paroxysmal disturbance of rhythm) or to control the heart rate when the rhythm disturbance is established. Permissible medication at present includes sotalol, other] beta-blocking agents (bisoprolol, atenolol), verapamil, or digitalis products in adequate dose. The Class 1 agents (i.e. quinidine, flecainide, propafenone) are not permitted, nor are Class 3 agents (i.e. amiodarone, disopyramide) on account of side effects. [Sotalol (with amiodarone some discussion is going on) may be acceptable to the AMS.] Cardiological supervision acceptable to the AMS is required as well as demonstration of freedom from unwanted effects. The latter is usually best carried out in a flight simulator.

Assuming no other disqualifying conditions are present, an airman may be considered for [a fit assessment with a multi-pilot (Class 1 'OML') limitation, provided that [that there is compliance with RI (A)) RI (B), RI (D) and RI (E) and]

- [i] If atrial fibrillation is present, the rate shall be controlled (i.e. resting rate <90 beats/min, on exercise [<] 220 beats/min) and any QRST abnormality should be attributable to medication or heart rate only;
- [ii] [The left atrial internal diameter shall not exceed 4.5 cm;]
- [iii] 48 hours of ambulatory ECG on 3 separate occasions separated by an interval of 4 weeks each should demonstrate the absence of atrial fibrillation (having presented as a single attack, or in paroxysmal form) and of significant pauses (>[2,5] sec) during the daytime. In the presence of established atrial fibrillation, the shortest RR interval shall not exceed 300 ms and the longest 3.5 sec. The longest pause on recapture of sinus rhythm shall not exceed 2.5 sec. Ventricular arrhythmia should not exceed an aberrant beat count >2% of the total QRS count with no complex forms. If atrial fibrillation is provoked by exercise, this should be managed as the paroxysmal form;
- [iv] Following] a single attack of atrial fibrillation with a defined cause, an applicant who has satisfactorily completed the above investigations may be [as fit with a multi-pilot (Class 1 'OML') limitation], subject to a review [] by a cardiologist [], the periodicity to be determined by the AMS (usually every 6 months). [A] Class 1 [medical certificate

without an OML limitation] may be considered after an interval of not less than two years provided that there are no further symptoms suggestive of atrial fibrillation, nor of a recorded episode;

- [v Following] a second or further attack of paroxysmal atrial fibrillation, and following satisfactory completion of the above, the applicant may be considered for [a fit assessment] provided he/she is under cardiological supervision acceptable to the AMS and receiving appropriate medication, if indicated (see above). If the attacks are completely suppressed, [a fit assessment with a multi-pilot (Class 1 'OML') limitation] may be considered. Repeated 24-hour ambulatory ECG should be carried out initially and no less frequently subsequently than twice a year. If suppression of the attacks is incomplete, or if/when atrial fibrillation becomes established, an AMS decision based on individual assessment of symptoms during an attack, rate experience and other relevant data [is] required;
- [vi] [Provided] the above requirements can be satisfied in full, established atrial fibrillation is consistent with [a fit assessment with a multi-pilot (Class 1 'OML') limitation] subject to [regular] review [(usually every 6 months)] by a cardiologist [] acceptable to the AMS with 24-hour ambulatory ECG and echocardiography.

Other paroxysmal disturbances such as atrial flutter and paroxysmal atrial tachycardia are usually at a rate which, unsuppressed, give rise to significant symptoms and are [disqualifying. An atrial flutter circuit, if successfully ablated may be assessed as fit with a multi-pilot (Class 1 'OML') limitation] no sooner than 6 months following intervention. [If a bi-directional isthmus block can be demonstrated with EPS (Electrophysiological Study), the OML limitation may be removed.]

c *Sinus node arrest and sinoatrial block*

Sinoatrial disorders are infrequent in flight crew but [rather] similar disturbances are sometimes seen in those in good athletic training with high vagal tone.

Pauses >[2,5] seconds are probably abnormal, although [they] may be provoked by vagal effects including exaggerated sinus [arrhythmia]. Sinus node dysfunction usually progresses slowly and the outlook is good over many years. [Early evidence] of []sinoatrial node dysfunction may be [shown] by a reduced heart rate response to atropine or exercise. Sinus node recovery time on electrophysiological testing is prolonged in about half of those investigated. Salvos of fast atrial rhythm disturbance may also be present.

It should be assumed that a subject in whom the diagnosis of sinoatrial disease has been made will eventually become symptomatic. [The presence of symptoms is disqualifying.] Symptomatic pauses require endocardial pace-making. Those with asymptomatic pauses brought to light by routine resting ECG may be considered for [a fit assessment], provided that [there is compliance with RI (B), RI (D) and RI (E) and]

- [i The] 24-hour ambulatory ECG demonstrates no significant conduction disturbance, nor complex, nor sustained rhythm disturbance, nor evidence of myocardial ischaemia, [pauses should not be >2,5] s);
- [ii An] electrophysiological study, if carried out, shall show a normal sinus node recovery time and normal conduction velocities. [The presence of symptoms is disqualifying;]

This level of assessment also applies to Class 2. Applicants who are free of symptoms but do not satisfy the above requirements may be considered for Class 2 'OSL'

[]

d *Paroxysmal narrow complex tachycardias (Atrioventricular [nodal] re-entrant tachycardia and atrioventricular [re-entrant] tachycardia (pre-excitation))*

The most common causes of 'paroxysmal supraventricular tachycardia' include atrioventricular nodal reentry (AVNRT) [(50% of all)], and atrioventricular re-entry or 'pre-excitation' [(30% of all)]. Less common are other forms of narrow complex tachycardia including sino-atrial nodal reentry, [junctional re-entry,] atrial tachycardia and other incessant supraventricular rhythms. All suffer the disadvantage that the fast heart rates involved are at best distracting and at worst potentially incapacitating. Radiofrequency ablation is []used for ablation of identifiable bypass pathways (i.e. the Kent bundle) and it may be [considered for a fit assessment]. Rhythm disturbances involving nodal reentry may be [managed with atrio-ventricular slow pathway modification and a fit assessment may be possible. The risk of ablation in both cases is associated with a 1% chance of complete atrio-ventricular block].

e *Ventricular pre-excitation*

A number of different examples of ventricular pre-excitation due to the presence of intra- or extranodal pathways have been described. These include the Wolff-Parkinson-White pattern (Kent bundle), [Lown]-Ganong-Levine (James bundle) and paraspecific [Mahaim] forms. [The characteristic] electrocardiographic [anomaly - the Δ (Delta) - wave is] seen in approximately [0,25] % of asymptomatic individuals with a risk of about 2% of significant tachyarrhythmia [in a non-hospital population].

[Atrioventricular] reentrant tachycardia (AVRT) or atrioventricular nodal reentrant tachycardia (AVNRT) []develop [initially] in the first two or three decades of life and less commonly []thereafter. Atrioventricular [re-entrant] tachycardias can both give rise to hypotension and syncope, particularly if atrial fibrillation develops and conduction occurs at a rapid rate via the accessory pathway. Subjects in whom a delta wave is intermittently present due to intermittent refractoriness of the bypass pathway are likely to be 'safe' and have a longer effective refractory (ERF) period of the bypass tract.

The discovery of a pattern of pre-excitation on the resting ECG may be [considered for a fit assessment], provided that [there is compliance with RI (B), RI (D) and RI (E), and

- i [There is no history of ongoing paroxysmal rhythm disturbance;
- ii A fit assessment requires an electrophysiological study demonstrating an HV interval < 70 ms, no inducible atrio-ventricular tachycardia, and, in the presence of a persisting Δ - wave, an antegrade effective refractory period of >300 ms and an accessory pathway conduction time >300ms RI (C) may indicated if the exercise induced ECG changes (likely to be due to repolarisation anomaly secondary to the bypass pathway) are of concern. Following pathway ablation, there is additional requirement for a follow up RI (G) to confirm no inducible tachycardia. If a pre - ablation Δ - wave was abolished, an adenosine test may be sufficient;];

Modification of a slow conducting pathway in nodo re-entrant tachycardia, or of an atrial flutter circuit, when demonstrated electrophysiologically to have been complete, may be consistent with a multi-pilot (Class 1 (OML) limitation for 12 months before a fit assessment is made, provided that there is compliance with RI (B), RI (D) and RI (E). The presence of atrioventricular re-entrant tachycardia or paroxysmal atrial fibrillation in the presence of an accessory pathway is disqualifying.

This level of assessment also applies to Class 2. Applicants not completely fulfilling the above, who nevertheless have no history of a sustained tachycardia may be considered for Class 2 'OSL'.

[]

13.2 Conduction disturbances

a *Atrioventricular block*

First degree [atrio-ventricular] block is [common] in fit young men and the PR interval may [be > 200 ms] in the presence of a bradycardia. In the absence of a bundle branch disturbance the situation is most often benign. Occasionally very long PR intervals are seen, up to [400 ms], which shorten on exercise and with atropine and are likely to represent an exaggerated vagal phenomenon. Subjects who demonstrate shortening of the PR-interval to <200 ms with exercise / atropine, may be [assessed as fit].

The co-existent presence of a bundle branch disturbance suggests distal conducting tissue disease, particularly if right or left bundle branch block is present with left or right axis deviation. This requires [compliance with RI (B), RI (D) and RI (E)].

Asymptomatic Mobitz Type I (Wenkebach) atrioventricular block occurs in normal individuals during sleep but the periodicity should be short. The presence of a narrow QRS complex usually indicates that the block is junctional and it is sometimes associated with prolongation of the PR interval. This may not be the case in older age groups and at least two studies have suggested that narrow complex Mobitz Type I block may progress to complete atrioventricular block in young people. [A fit assessment] may be considered, provided that [there is compliance with RI (B), RI (D) and RI (E) Short periodicity Mobitz type 1 AV block may occur at night in young subjects.]

- i An electrophysiological study, if carried out, [should show] normal conduction velocities within the normal range;

This level of assessment also applies to Class 2 and Class 2 'OSL'.

Evidence of distal conducting tissue disease on electrophysiological study [or the] presence of Mobitz Type II, 2:1 and 3:1 atrioventricular block [or] complete congenital atrioventricular block (a rare condition, which may become symptomatic during early adult life) is disqualifying.

b *Right bundle branch block [(RBBB)]*

Incomplete right bundle branch block is seen in 2–3% of routine flight crew electrocardiograms and appears to carry a normal prognosis in asymptomatic subjects. No special requirements are needed.

Complete right bundle branch block has a prevalence of about [0,2]% in flight crew. When isolated, established and unassociated with other abnormality of the myocardium or coronary circulation, there appears to be no significant risk of development of further degrees of block or of syncope. Recently acquired right bundle branch block usually also has a benign prognosis provided significant coronary artery disease is not present.

On first presentation of complete right bundle branch block [a fit assessment] may be considered [for initial applicants below age 40 years and for initial applicants over age 40 if a period of stability of normally 12 months can be demonstrated, provided that the requirements under 13.2 (b) (i) to (vi) are fulfilled. For revalidation / renewal a fit assessment may be considered, provided that there is compliance with RI (B), RI (D) and RI (E). This restriction may be lifted thereafter subject to there being compliance with RI (B), RI (D) and RI (E)]

- i [A multi-pilot (Class 1 'OML') limitation is required for 12 months];
- [ii] Coronary angiography is [indicated] should there be any doubt about the result of non-invasive investigations;
- [ii] The] co-existent presence of first degree heart block and anterior or posterior hemiblock [requires an] electrophysiological study.

This level of assessment also applies to Class 2 and Class 2 'OSL'.

c *Left bundle branch block [(LBBB)]*

Left bundle branch block is an uncommon problem in otherwise healthy flight crew. In at least one quarter it will be due to co-existent coronary artery disease and this needs to be excluded at least by exercise [/ pharmacological stress MPI] / []echocardiography and/or by coronary angiography on first appearance. In the recently acquired form, the risk of sudden cardiac death in patients [>] age 45 years is ten times that of the peer group[.] Rate related left bundle branch block should be treated in the same manner. [A fit assessment with a multi-pilot (Class 1 ('OML') limitation may be considered, provided there is compliance with RI (B) (including an assessment of overall physical fitness), RI (D) and RI (D). RI (C) or RI (F) are required to exclude significant coronary artery disease. An EPS study is occasionally indicated. A fit assessment may be considered after 3 years provided the above can be satisfied, at the discretion of the AMS].

This level of assessment also applies to Class 2. Applicants not fulfil all the above requirements may be considered for Class 2 'OSL'.

d *Left anterior and left posterior hemiblock*

Left anterior hemiblock has a 1–2% prevalence in normal individuals[, increasing with age]. When isolated and stable it appears to carry no appreciable risk of progression to higher degrees of block. Recently acquired left anterior hemiblock raises the possibility of myocardial ischaemia [or acquired conduction tissue disease] and requires at least [RI (B)]. Stable incomplete left bundle branch aberration (complex [width]< 120ms) in the absence of any other abnormality appears to carry no greater risk than the pre-existing left anterior hemiblock. If recently required the protocol applied to the left bundle branch is required. Occasional progression to complete left bundle branch block may be seen (see paragraph 13.2 c).

Left posterior hemiblock has a prevalence in healthy flight crew of [0,1] %. There are no data on risk of progression and in an otherwise asymptomatic individual no special action is needed. Recently acquired left posterior hemiblock [requires RI (B)] and review by a cardiologist acceptable to the AMS.

14 CONGENITAL HEART DISEASE

Most forms of congenital heart disease are incompatible with flying status and only those that are of sufficiently low risk before or after corrective surgery are detailed here. All require regular cardiological review and appropriate, usually non-invasive investigation.

14.1 Atrial septal defect

Atrial septal defects account for over a quarter of all individuals with congenital heart disease. An ostium primum defect carries a risk of progressive mitral regurgitation and conduction disorder. [A fit assessment with a multi-pilot (Class 1 'OML') limitation] may be [considered] provided mitral regurgitation is demonstrated by 2D Doppler echocardiography to be minimal or absent and 24-hour ambulatory ECG shows no significant rhythm or conduction disturbance. This applies both before and after surgery. Indefinite review by a cardiologist []is required in view of the risk of late arrhythmia.

- a** Ostium primum defects are consistent with Class 1 'OML,' if small, i.e., the pulmonary systemic flow ratio <[1,5] : 1, or [surgically corrected]. The pulmonary pressures should be normal.

- b An uncorrected small secundum defect with no other abnormality is consistent with a [fit assessment] provided the right ventricular [and pulmonary artery] pressures are normal. The pulmonary systemic flow ratio should be $<[1,5]: 1$. In view of the risk of late [atrial] arrhythmias, [a fit assessment] following surgical correction may [require a multi-pilot (Class 1 'OML') limitation]. Indefinite review by a cardiologist acceptable to the AMS is required at intervals, before and after operative correction, in view of the risk of late arrhythmia.

14.2 Sinus venosus defects

Subjects with sinus venosus defects may be considered for [a fit assessment with a multi-pilot (Class 1 'OML') limitation,] if the defect is too small to require surgical repair, 24-hour ambulatory ECG does not reveal rhythm or conduction disturbances more important than an aberrant beat count $<2\%$ of the total QRS count, with no complex forms, and no significant conduction disturbance. Following surgery the increased risk of arrhythmia [is disqualifying,] except where repeated ambulatory monitoring has [shown no] significant rhythm disturbance. [A fit assessment with a multi-pilot (Class 1 'OML') limitation requires that there is compliance with RI (B and RI (C).] Annual review by a cardiologist []with 2D Doppler echocardiography and 24-hour ambulatory ECG is required.

14.3 Ventricular septal defect

Ventricular septal defect accounts for almost a third of all congenital heart disease. Subjects, who have a normal cardiac configuration on chest x-ray, a pulmonary/systemic flow ratio $<[1,5]$ and no evidence of pulmonary hypertension, [may be assessed as fit] (Class 1). There is a small risk of arrhythmia following surgical closure although the risk of endocarditis is largely removed. Occasional cardiological review is required.

14.4 Pulmonary stenosis

Isolated pulmonary valvular stenosis accounts for one tenth of individuals with congenital heart disease. Subvalvular (infundibular) and supra-valvular stenoses are much rarer. Subvalvular stenoses in the anatomically normal heart with an intact ventricular septum may occur in the form of a fibromuscular ring or as concentric thickening of the myocardium. The valve also may be involved and stenosed. Supra-valvular stenosis may affect the pulmonary trunk, the pulmonary arteries or there may be multiple stenoses. [Therefore, supra-valvular stenosis is most likely disqualifying,] but corrected infundibular stenosis may be [acceptable]. Provided the pressure difference is $>30\text{mmHg}$ peak to peak and the situation is stable, then the outlook is good. [Applicants with a] minor degree of pulmonary stenosis [may be assessed as fit,] provided there is no evidence of right ventricular hypertrophy on 2D Doppler echocardiography. [Applicants with a] drop $>20\text{ mmHg}$ but $<30\text{ mmHg}$ [may be assessed as fit with a multi-pilot (Class 1 'OML') limitation] with annual review by a cardiologist []to confirm the stability of the situation. 2D Doppler echocardiographic assessment is [sufficient], if the signals are good.

14.5 Patent ductus arteriosus

Patent ductus arteriosus is a common [anomaly] representing perhaps 10% of all congenital abnormalities of the heart. It is often associated with other anomalies [, it] may be associated with a bicuspid aortic valve. Following closure no special risks [exist,] provided the shunt was not large and pulmonary hypertension is not present. [Applicants with closed defects may be assessed as fit. Those with] a small unclosed defect [may be assessed as fit with a multi-pilot (Class 1 'OML')] limitation.

14.6 Coarctation of the aorta

Late correction [of a coarctation of the aorta] (i.e., $>\text{age } 12\text{ years}$) appears to be associated with a higher risk of sudden cardiac death and stroke. If the condition is corrected $<\text{age } 12\text{ years}$ and the subject is normotensive, both at rest and on exercise, then [a fit assessment] may be appropriate. Late surgical correction requires [a fit assessment with a multi-pilot (Class 1 'OML') limitation] with indefinite supervision of the blood pressure. 30% of patients with coarctation also have a bicuspid

aortic valve. Late surgical correction is also associated with an increased risk of dissection of the aorta and ruptured berry aneurysm (see paragraph 8.2).

These levels of assessment also apply to Class 2 and Class 2 'OSL'.

14.7 QT Prolongation

[Congenital prolongation of the QT interval on the ECG] is occasionally detected in aircrew although it is probably more commonly missed. [Associated with deafness it may be transmitted as an autosomal recessive characteristic (Jervell-Lange-Nielsen Syndrome)] and in the absence of deafness as an autosomal dominant characteristic (Roman-Ward Syndrome). It is associated with an increase of disturbed consciousness due to ventricular tachycardia (Torsade de Pointes) and sudden cardiac death. The QT interval varies and may be normal in 25% of individuals. There are three phenotypes – LQTC 1,2,3 with varying QT morphologies and a variable risk of event. The longer the QTc (the corrected QT interval, derived by dividing the QT interval by the RR interval⁻²), the worse the prognosis, especially when QTc >500 ms. Certain drugs may prolong the QTc. When [associated with symptoms] these syndromes are [disqualifying].

Less obvious changes in the QT interval in an asymptomatic individual (arbitrarily >440ms < 480 ms) are encountered in the absence of medication [(which might provoke such features)]. Under these circumstances, a full evaluation [is required] with particular attention to [a history of possible disturbed consciousness / tachycardia, family history, any pharmacological therapy, and detailed analysis of the resting ECG. The Holter ECG should also be analysed for occult QTc prolongation, especially at night. The echocardiogram should be normal. A fit assessment with a multi-pilot (Class 1 'OML') limitation may be considered.]

15 IMPLANTABLE DEVICES & AVIATION

15.1 Endocardial pacemaker

Permanent endocardial pacemakers are rarely required in personnel of flight crew age. A failure rate between [0,12 - 1,44] % per annum is to be expected, which is within the overall permitted annual target event rate. The possibility of electrical interference has also been investigated in aircraft, although mainly in unipolar systems [(in these systems a risk of electrical interference may exist, which disqualifies applicants with an unipolar system; bipolar systems are much less affected). In case of pacemaker failure there must be an intrinsic escape rate sufficient to support the cardiac. Pacemaker dependency is disqualifying. Pacemaker dependency is defined by a heart rate < 30 / min with the pacemaker system inactivated (achieved by a magneto held close to the pacemaker aggregate).] Applicants may be [assessed as fit with a multi-pilot (Class 1 'OML') limitation at revalidation / renewal] three months following an insertion, provided that [there is compliance with RI (B), RI (D) and RI (E). and MG (B) and]

- a there is no other disqualifying condition;
- b a bipolar lead system has been used;
- c the applicant is not pacemaker dependent;
- [d 6-monthly] follow up by a cardiologist []with a pace-maker check and 24-hour ambulatory ECG [are] carried out as appropriate;

This level of assessment also applies to Class 2. Applicants failing to fulfil all of the above may be considered for Class 2 'OSL'.

Anti-tachycardia pace-makers and automatic implantable defibrillating systems are [disqualifying].

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CHAPTER 3 - THE RESPIRATORY SYSTEM

1 INTRODUCTION

The importance of the respiratory system in an aviation context rests with its ability to provide adequate levels of tissue oxygenation during flight. Due consideration has to be given to the fact that both pressurised and unpressurised aircraft may be flown and that a pilot has to be capable of performing efficiently during prolonged and difficult flights including those following pressurisation failure.

In assessing respiratory fitness, the inter-dependence of the cardiovascular and respiratory systems cannot be over-emphasised. A functional deficiency in either system will have a very significant effect on tissue oxygenation.

In Europe, respiratory disorders and infections represent very common causes of short and long term morbidity. However we have to consider that present statistics suggest that in the near future at least 20% of younger applicants will have a history of this problem and it will certainly become the largest respiratory condition to require consultant evaluation. Such respiratory conditions may cause acute incapacitation and/or loss of functional efficiency. The effect of treatment and/or prophylaxis may also cause such incapacitation.

In assessing an applicant's fitness, especially at initial medical examination, those individuals with histories and with physical findings indicating a potential for the development of significant respiratory problems require careful evaluation.

However, it should be noted that respiratory disease (following effective early screening) does not represent a significant cause of denial of medical certificate in the established pilot community.

It is beyond the scope of this chapter to provide a detailed discussion of the well-documented health hazards of smoking. The ill effects relative to the pulmonary and cardiovascular systems (e.g. chronic bronchitis, chronic obstructive lung disease, bronchial malignancy, and coronary artery disease) are not the only considerations from the standpoint of air safety, however. Decreased altitude tolerance secondary to the displacement of oxyhaemoglobin by methaemoglobin, increased fatigue, conjunctival irritation, and decreased night vision have also been demonstrated as a result of smoking.

1.1 Radiography

A Chest x-ray of the heart and lungs taken in the P.A. (Postero-Anterior) plane is [neither] a requirement for the initial assessment of Class 1 applicants any more nor is there a mandatory requirement for repeat x-rays[, but - as for Class 2 applicants - Chest X-ray may be required for clinical or epidemiological reasons at initial, revalidation or renewal examinations]

Any abnormality in the lung fields, the thoracic skeletal system or of the cardiovascular image, requires full evaluation before the assessment can be completed.[]

1.2 Pulmonary function testing

The assessment of respiratory fitness must be specifically directed to the early detection of the most common patho-physiological markers of pulmonary disease, namely:

- a Restrictive impairment
- b Obstructive impairment

Quantitative measurements of pulmonary function which might give an indication of such an impairment are required at initial examination [and on clinical indication] for Class 1 applicants [and on clinical indication] for Class 2 applicants. []

[Spirometric examination is required for pulmonary function testing. The Peak Flow Meter is no adequate tool for pulmonary function testing, except for assessing the control of asthma therapy].

A spirometer (e.g. Vitalograph) measures lung volumes and air flow dynamics and the minimum required measurements are Vital Capacity (VC), Forced Vital Capacity (FVC), Forced Expiratory Volume (in the first second (FEV1) and the Peak Expiratory Flow Rate (PEFR) [as well as the FEV1 / FVC ratio]. At least three acceptable forced expiratory volume manoeuvres are required and the results should be within 7 per cent of the highest. The values obtained can be compared to predicted values for age, sex, height and ethnic groups.

The spirometer used should produce a graphical record of either time versus volume or flow versus volume, in the form of a permanent record. The apparatus should also have a thermometer or temperature probe and must be calibrated regularly. All volumes recorded should be corrected to body temperature and pressure, saturated with water vapour (BTPS). Modern spirometers are programmed to perform such correction.

Significant changes in volumes or flow patterns, particularly changes in the FEV1/FVC ratio should lead to further investigation (and always when less than 70% at initial examination). Where indicated the diagnostic efficiency of these function tests can be heightened by measuring the response of lung function to both severe exercise and the administration of a metered dose of a broncho-dilator. It should be noted that it is the absolute change in FEV1 following a broncho-dilator which is important, not the change in FEV1 as a percentage of the vital capacity [(FEV1/FVC ratio)]. An increase in PEFR or FEV1, of 15% or more is very suggestive of an underlying asthmatic tendency. Such findings at the outset of a flying career require further informed assessment by a pulmonary physician. It should be noted that a tall, fit man could have an actual FEV1/FVC ratio considerably below that predicted and care must be exercised in making judgements on fitness on such ratios.

A peak flowmeter (e.g. Wright) is a rotating vane instrument that records the peak flow which can be sustained over 100 ms. during a short, sharp exhalation (a maximum puff). The peak flow measured is compared to predicted values for age, sex and height. If measurement is found to be less than 80% of predicted normal value, then further evaluation by a pulmonary physician is required. [The Peak Flow Meter is no adequate tool for pulmonary function testing, except in patients with asthma for assessing the current severity of disease and the effect of asthma therapy].

2 CHRONIC OBSTRUCTIVE AIRWAY DISEASE AND ASSESSMENT GUIDELINES

[Chronic obstructive airways disease (COAD, COPD or COLD) is defined by a chronic pulmonary disease with a progredient airway obstruction, which is not totally reversible after applying bronchodilators or glucocorticoids]. All applicants with chronic obstructive airways disease [due to] Chronic Bronchitis and/or Emphysema require careful and individual evaluation and assessment. In general though, all applicants for initial Class 1 and Class 2 certificates with an established history of COAD requiring continuous medication shall be assessed as unfit.

Class 1 and Class 2 certificate holders whose disease is mild, who have only very minor impairment of lung function, are symptomless, require no medication, and have no radiological evidence of bullae, may usually be assessed as fit. Increased medical scrutiny may be required. Intercurrent infections require a temporarily unfit assessment for appropriate treatment. Smoking cessation cannot be over emphasised.

3 ASTHMA AND ASSESSMENT GUIDELINES

Asthma is defined as a disorder characterised by bronchial hyperreagibility, variable] obstruction [and chronic inflammation] of the intrapulmonary airways, such obstruction varying widely in short periods of time. It has a wide clinical spectrum varying from a single short-lived episode requiring no medication to that of a constant disabling condition. Its course and severity are unpredictable and sudden incapacitation is an uncommon but potential hazard for all diagnosed asthmatics. The prognosis of childhood asthma is now known to be less good than was generally believed with, in all, nearly three quarters of childhood asthmatics expecting to suffer bronchospasm during adult life. The disorder has important aeromedical implications.

Known trigger factors which might precipitate an attack are a viral respiratory infection, hyperventilation, cold, dust, smoke or fumes and other stressors such as operational delays and frustration, difficult flight conditions and circadian rhythm disturbances.

[The use of oral methylxanthines is not compatible with certification for any class due to the high incidence of side effects including CNS irritability.]

Initial applicants who give a history of recent acute attacks of asthma shall be assessed as unfit for both Class 1 and Class 2.

3.1 Assessment guidelines Class 1

Initial applicants for Class 1 certification with a history of pre-existent asthma may be assessed as fit [by the AMS] provided that the applicant demonstrates:

[]

- a acceptable pulmonary function tests (FEV1/FVC ratio >75% and normal home peak flow monitoring);
- b treatment limited to [medication compatible to flight safety (inhaled corticosteroid or inhaled beta agonist or any combination of two, or inhaled cromoglycate, but no systemic steroids)];
- c absence of bronchospasm on clinical examination;
- d absence of bronchospasm associated with mild respiratory infection;
- e Acceptable personal and family history with regard to asthma (with regard to age of onset, frequency of severity of attacks, hospital admissions, loss of schooling and requirement for medication) and other atopic states;
- f a comprehensive report of all of the above will be forwarded to the AMS.

Class 1 certificate holders who develop bronchospasm require detailed evaluation. Those whose symptoms are easily controlled by inhaled chromoglycate and/or inhaled corticosteroid may be assessed as fit for Class 1, [with or without a multi-pilot (Class 1 'OML') limitation] and reviewed as indicated by a respiratory physician.

3.2 Assessment guidelines Class 2

Initial applicants for Class 2 certification with a history of pre-existent asthma may be assessed as fit by the AME in consultation with the AMS provided that the applicant demonstrates:

[]

- a acceptable pulmonary function tests (FEV1/FVC ratio >75% and normal home peak flow monitoring);

- b treatment limited to [medication compatible to flight safety (inhaled corticosteroid or inhaled beta agonist or any combination of two, or inhaled cromoglycate, but no systemic steroids)];
- c Absence of bronchospasm on clinical examination;
- d bronchospasm associated with mild respiratory infections easily controlled;
- e Acceptable personal and family history with regard to asthma (with regard to age of onset, frequency of severity of attacks, hospital admissions, loss of schooling and requirement for medication) and other atopic states;
- f A comprehensive report of all of the above will be forwarded to the AMS.

Class 2 certificate holders who develop bronchospasm require detailed evaluation. Those whose symptoms are easily controlled by inhaled preparations (cromoglycate, corticosteroid, beta agonist) may be assessed as fit for Class 2 [with or without a safety pilot (Class 2 'OSL') limitation] and review by a respiratory physician as indicated.

All applicants who have been assessed as fit should be advised that any change in their physical status, particularly acute attacks of asthma, [may influence their aeromedical fitness].

4 ACTIVE INFLAMMATORY DISEASE

4.1 Assessment guidelines

Active inflammatory disease of the respiratory system of any nature shall result in a temporarily unfit assessment until the condition has fully resolved without sequelae and no further medication is required. Depending upon the nature of the infection or inflammation, pulmonary function tests and/or review by a respiratory physician may be required before [a fit assessment] or a return to flying is permitted.

This assessment applies to both Class 1 and Class 2 certificates.

4.2 Pulmonary tuberculosis

Initial applicants for or holders of a Class 1 certificate with a history of previous pulmonary tuberculosis may be assessed as fit provided that:

- a A recognised course of medication has been completed.
- b Chest radiography shows no significant lung damage.
- c Normal pulmonary function testing is demonstrated.

Applicants for Class 1 []with active disease or undergoing any treatment shall be assessed as 'temporarily unfit' for a minimum period of six months. Following completion of therapy, assessment of fitness shall be performed as detailed in a, b, c above.

Applicants with substantial lung damage may have bronchiectasis, be susceptible to recurrent episodes of chest infection and therefore require careful evaluation. Applicants with persistent cavities also require careful evaluation, but as these cavities will probably have a bronchial communication, the risk of significant problems is not great. However, large cavities are likely to be associated with considerable degrees of lung damage and applicants will be unlikely to be assessed as fit.

5 SARCOIDOSIS AND ASSESSMENT GUIDELINES

Sarcoidosis is a disease of unknown aetiology characterised by granulomatous lesions which can affect multiple organ systems. It can cause pulmonary manifestations, skin lesions, uveitis, hepatic cirrhosis, renal calculi, hypersplenism, cardiac arrhythmias and valvular defects. Full evaluation of pulmonary, cardiovascular, neurological, ophthalmic and renal systems may be indicated to exclude or determine the extent of systemic involvement. The main hazard of sarcoidosis in aviation is the involvement of [systems, especially] the central nervous system or the heart. Indeed, cardiac sarcoidosis has an ominous reputation with a high incidence of sudden death (which may be the presenting feature). The [most common] form appears to affect the respiratory system alone. It is often symptomless and is detected on routine chest x-ray as bilateral hilar lymphadenopathy. This type has a good prognosis with at least 80% of those affected showing complete and sustained resolution of all features of the disease within two to five years. The incidence of cardiac involvement is unknown, but likely to be rare. With the present difficulties of diagnosing cardiac sarcoid, it is likely to remain unknown and hence a very cautious approach must be maintained towards those applicants who develop sarcoidosis.

5.1 Assessment guidelines for initial applicants

Applicants with a diagnosis of active sarcoidosis shall be assessed as unfit.

Initial applicants [] with a history of multi-system sarcoidosis shall be assessed as unfit.

Initial applicants with a history of sarcoidosis confined to hilar lymphadenopathy may be assessed as fit provided that:

- a A full clinical evaluation is normal. Tests must include a chest x-ray, resting and exercise ECG, 24-hour ambulatory ECG monitoring, and if needed myocardial scintigraphy or perfusion scanning.
- b Normal pulmonary function tests are demonstrated.
- c There is no evidence of other organ or parenchymal involvement.
- d No medication is prescribed.

5.2 Assessment guidelines for revalidation/renewal of a medical certificate

Certificate holders who develop sarcoidosis confined to hilar lymphadenopathy may be assessed as fit provided that:

- a Disease is deemed to be inactive.
- b Full clinical evaluation as detailed above in 5.1 a is normal.
- c Normal pulmonary function tests are demonstrated.
- d There is no evidence of other organ or parenchymal involvement.
- e No medication is prescribed.
- f [Fit assessment with multi-pilot (Class 1 'OML') or saety pilot (Class 2 "OSL") limitation].

These investigations should be repeated annually and provided regression has occurred [fit assessment without limitation] may be permitted after two years observation. Surveillance should continue annually.

Certificate holders deemed recovered from multi-system sarcoidosis with no detectable cardiac involvement may be considered for [fit assessment with multi-pilot- (Class 1 'OML') limitation] by the AMS provided that all the criteria listed above in a, b, c are met. Annual screening as in a, b, c

is essential and indefinite restriction to multi-pilot duties is mandatory due to late potential cardiac involvement.

Applicants with known cardiac sarcoid shall be [assessed as unfit].

This assessment also applies to Class 2.

6 SPONTANEOUS OR IDIOPATHIC PNEUMOTHORAX

A spontaneous pneumothorax occurs when there is escape of air from the lung into the pleural space with [subsequent] partial or complete collapse of the lung. An episode may be asymptomatic but the presentation is often that of sudden severe chest pain and dyspnoea. Such an occurrence in flight, though rare, could result in sudden incapacitation. Any reduction in ambient pressure in flight will cause an increase in size of the pneumothorax and may lead to a tension pneumothorax as may the development of a flap valve.

Another major problem with spontaneous pneumothorax in an aviation context is the recurrence rate; about 30% following an initial episode, 50% following a second and 80% following a third. There is also a risk of a contralateral pneumothorax of about 10%. Most recurrences usually occur within twelve months of the original episode and with continuous smoking.

Spontaneous pneumothoraces occur most commonly in two groups. Firstly, the young, healthy individual with no underlying lung pathology, the leak of air into the pleural space arising from the rupture of a sub-pleural bleb. Secondly, as a complication of another lung disease usually with established chronic airway obstruction and bullous lung disease.

6.1 [Assessment guidelines for initial applicants]

Applicants for initial certification with a history of a single spontaneous pneumothorax may be assessed as fit provided that:

- [a One year has elapsed since full recovery after adequate treatment.]
- [b Full respiratory evaluation is normal.
- [c No bullae are discovered on chest radiography, CT scans, or other medical imaging technique.]
- [d The bullae have been treated by surgery and no smoking status has been confirmed.]

[6.2 Assessment guidelines for revalidation/renewal of a medical certificate]

Certificate holders who develop a spontaneous pneumothorax must be assessed as temporarily unfit until full resolution has occurred. They maybe assessed as fit for certification provided that:

- a Full re-expansion of the lung has taken place.
- b A minimum of six weeks has elapsed since the occurrence.
- c Full respiratory evaluation is normal.
- d [No bullae are discovered on chest radiography, CT scan, or other medical imaging technique.]
- e [Multi-pilot (Class 1 'OML') of safety pilot (Class 2 'OSL')] for one year from the original occurrence.

Following a second pneumothorax, [a fit assessment] must be denied in view of the recurrence rate. [A fit assessment at revalidation / renewal] may only be considered by the AMS following satisfactory surgical treatment (thoracotomy, oversewing of apical blebs and parietal pleurectomy) and full convalescence, usually three months. 'Medical' pleurodesis is followed by a high recurrence rate and is no longer an acceptable form of treatment.

6.3 Bullae

Bullae are thin walled air spaces > 1 cm in diameter, composed of connective tissue, occurring within the substance of the [lung]. If large they [can compress the surrounding lung tissue [and impair the pulmonary function]]. They may occur simply in the young individual (usually tall, thin male) with no underlying lung disease and these tend to be stable or only slowly increasing in size. More commonly they occur in association with chronic airways obstruction and emphysema. Because of their possible non-communication with the airways, there is a high risk of rupture with decompression, producing an air embolus or a spontaneous pneumothorax. The presence of bullae would render an applicant unfit for certification. Surgical resection of a solitary bulla would allow certification providing pulmonary function tests were normal. A bulla in association with underlying emphysema would normally result in an "unfit" assessment.

6.4 Traumatic pneumothorax

A traumatic pneumothorax occurs as a result of accident or injury and does not present the same problem. [Fit assessment] may be considered on complete recovery from the incident and full absorption of the pneumothorax.

7 THORACIC SURGERY AND ASSESSMENT GUIDELINES

Any major thoracic surgical procedure requires a minimum period of three months post operation before [a fit assessment] may be considered by the AMS. This period may need to be increased in accordance with the underlying pathology which necessitated [the] surgical [procedure]. [Fit assessment] following treatment from lung cancer is dealt with in the Oncology chapter.

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CHAPTER 4 - THE DIGESTIVE SYSTEM

1 INTRODUCTION

Abdominal disorders can be acute or chronic and vary greatly in severity. In most cases applicants with any acute presentation or exacerbation of a chronic condition will be assessed as temporarily unfit until satisfactorily recovered. The most commonly reported cause of in-flight air crew incapacitation is acute gastrointestinal upset, however, even symptoms which are rather less severe can distract or may disable a pilot at critical stages in flight. Even [if] conditions appear to be in remission, it is essential to remember the volumetric changes of intra-abdominal gases due to altitude and that these may [result in] further symptoms. Because of such risks it is often necessary to confirm recovery or healing by additional [assessment] of an apparently asymptomatic and recovered individual.

2 OESOPHAGUS

The oesophagus is the first part of the alimentary tract. Any expanding gases associated with decreased ambient pressure at altitude can equalise through the mouth and are unlikely to cause discomfort. [However, any obstruction] or discomfort associated with food transit [], will require a temporarily unfit assessment until fully investigated. Associated conditions are:

- a Peptic oesophagitis/Oesophageal hiatus hernia with reflux oesophagitis are both associated with gastric or acid irritation of the oesophageal tissue, which usually present as pain. Symptoms and/or treatment require a temporarily unfit assessment until satisfactorily recovered. Minor prophylactic treatment may be considered.
- b Oesophageal stricture may result from long term inflammation and cause regurgitation. It is disqualifying unless successfully treated.
- c Oesophageal varices are associated with advanced cirrhosis of the liver [and risk of upper gastrointestinal haemorrhage] and are disqualifying.
- d Sliding hiatus hernia requires individual evaluation but if particularly mobile will require surgical treatment before any fit assessment can be made.

3 STOMACH

As the second stage of the alimentary canal, the stomach has sphincters above and below. This makes it subject to barometric pressure change, particularly if motility is affected by inflammatory reaction. [Several pathomechanisms] can lead to inflammation and/or ulceration of the gastric mucosa. Gastric discomfort which persists despite occasional treatment with simple antacids, requires investigation.

Any gastritis or definite ulceration requiring treatment, [requires] a temporarily unfit assessment until recovery has been demonstrated. [Confirmation] of healing must be shown and only minimal dosage of prophylactic treatment [is] acceptable [for a fit assessment by the AMS]. If surgical treatment of a bleeding or perforated ulcer is required, the individual must be asymptomatic three months later with demonstrated healing before [fit assessment]. Recurrent peptic ulceration may require detailed evaluation before [a fit assessment] can be considered. Any malignancy demonstrated will be assessed according to the notes regarding oncology and malignant conditions. Post-surgical conditions such as 'dumping syndrome' will be disqualifying until satisfactorily controlled.

4 DUODENUM

The third stage of the alimentary canal with entry of the bile duct and pancreatic duct can also be subject to inflammation and/or ulceration. Peptic duodenal disorders are treated in a similar fashion to the gastric [ulcer] outlined above. All demonstrated disease must be shown to have healed before returning to flying. All medication must be minimal and approved by the AMS before returning to flying.

Recent research has associated the organism *Helicobacter pylori* with peptic ulceration. In such cases specific treatment may clear the condition for an extended period.

For any abdominal surgery see JAR FCL []3 Appendix 3 para 3 before considering [fit assessment].

2, 3 and 4 – these assessments apply to Class 1 and Class 2
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5 SMALL INTESTINE

This is the longest part of the intestine and is again subject to barometric pressure changes. However, the intrinsic elasticity of the normal small bowel allows any expanded gas to pass without symptoms:

- a Gastro-intestinal upsets. Acute gastro-intestinal upsets may be infective or reactive to certain foods and may pass with minor symptomatic treatment. Flying should not be undertaken until the [applicant] has recovered.
- b Crohn's disease. [Due to the unpredictable nature of Crohn's disease acute and chronic phases are] of concern[]. [Applicants] with a confirmed history of Crohn's disease are unfit. [A fit assessment may be considered by the AMS provided that the disease is in established remission and stabilised, there are no signs of complication (adhesion/obstruction) and that systemic steroids are not required for control]. Close follow-up []and supervision by the AMS [will be required].
- c Coeliac disease (non-tropical sprue), tropical sprue and galactose intolerance. Dietary intolerance conditions, such as listed above, should be assessed individually by the AMS. Although such individuals may be well controlled by dietary means any initial applicants should be considered against the difficulty of maintaining such control, given the [irregular] lifestyle of air crew.

6 LARGE INTESTINE (COLON)

The primary function of this region of intestine is fluid and mineral absorption. In aviation, chronic discomfort may be caused by expansion of gases causing colic and may [result in] diarrhoea, haemorrhage or even perforation [if associated with an underlying pathology like diverticulitis].

Conditions which give rise to chronic []symptoms [of the colon] are disqualifying. Individual cases should be assessed by the AMS to ensure full recovery before [a fit assessment] can be considered. []Conditions of note are:

- a Irritable bowel syndrome. This may be incompatible with [a fit assessment]. Individuals with symptoms controlled by diet or acceptable medication may be [assessed as fit].
- b Diverticular disease. This may be a single episode of diverticulitis, chronic inflammation, or associated with haemorrhage. Each case should be considered individually by the AMS. [Applicants with single] episodes or isolated areas which have been treated surgically may

be [assessed as fit] if the applicant is fully recovered and taking only acceptable medication.

- c Ulcerative colitis. This inflammatory condition of unknown aetiology can be acute or chronic with multiple symptomatology that could incapacitate a pilot.

Any history or clinical diagnosis of ulcerative colitis [results in an unfit assessment. A fit assessment may be considered by the AMS provided that the disease is in established remission and stabilised and that systemic steroids are not required for control] A single acute episode if satisfactorily recovered for more than a year without symptoms or medication may be [assessed as] fit.

[At revalidation / renewal a fit assessment] may be considered after three months without symptoms and with minimal use of []medication[, systemic steroids are not acceptable].

Applicants who have had surgical resection should be assessed individually at least three months following surgery and be subject to regular follow-up.

6 a, 6 b and 6 c – these assessments apply to Class 1 and Class 2 – particular consideration must be given to Class 1 initial applicants

- d Crohn's disease of the colon. See Crohn's disease of the small intestine.
- e All infective diseases. Applicants with any infective disease of the colon require a temporarily unfit assessment while being treated and must be free of all disease processes and symptoms before [a fit assessment].

6 d, 6 e – these assessments apply to Class 1 and Class 2

7 ANUS AND RECTUM

The terminal part of the alimentary tract retains the faecal mass. Aviation problems relating to this part of the bowel are caused by pain or haemorrhage and as follows:

- a Haemorrhoids. Haemorrhoids may be acutely uncomfortable and can cause bleeding. Any acute haemorrhoidal inflammation requires a temporarily unfit assessment until it is asymptomatic. If surgery is required, a temporarily unfit assessment will be necessary to ascertain full recovery.
- b Anal fissure or perianal abscess. These conditions require a temporarily unfit assessment while inflamed or undergoing treatment.

7 a, 7 b – these assessments apply to Class 1 and Class 2

8 PANCREAS

The pancreas' function in producing digestive enzymes may give rise to aeromedical concern if inflamed or obstructed:

- a Pancreatitis. Pancreatitis caused by obstruction may be resolved surgically and so could be considered for [a fit assessment by the AMS], [provided that] the damage was minimal and the individual is asymptomatic after an acceptable recovery period.
- b Recurrent or chronic pancreatitis. Recurrent pancreatitis, which is idiopathic, drug or alcohol induced, is disqualifying due to its unpredictable and incapacitating nature.

- c Pancreatic abscess or pseudo cyst. Conditions such as pancreatic abscess or pancreatic pseudo cyst may be considered individually [for fit assessment] if a satisfactory recovery is noted.

9 LIVER

Hepatic conditions may be acute, chronic, infective, toxic or obstructive. Applicants with any acute inflammation for whatever reason, [require a] temporarily unfit [assessment] and may be [considered for a fit assessment] when asymptomatic, non-infectious and with normal liver function

- a Hepatitis. Hepatitis associated with drug or alcohol abuse will require this condition to be treated before [a fit assessment] can be considered [(see Chapter 8 Sexually transmitted diseases and other infections, paragraph 5 and Chapter 18, Tropical Medicine, paragraphs 4.2.5 and 4.2.6)].
- b Chronic Hepatitis. Chronic hepatitis must be assessed individually but if associated with cirrhosis and reduced liver function, should be disqualifying.
- c Gilbert's disease. Gilbert's disease (congenital unconjugated hyperbilirubinaemia) is acceptable for certification as may be minor liver function test abnormalities which are not supported by a clinical history.
- d Liver transplant. Liver transplantation is usually a late resort and [therefore] likely to be associated with [chronic hepatitis and subsequent] secondary conditions such as oesophageal varices. If however, transplant function is normal, immunosuppressive medication minimal and there is no increased risk from secondary conditions, [a fit assessment] (Class 2) and [fit assessment] for multi-pilot operations (Class 1 'OML') [at revalidation / renewal] may be considered by the AMS.

9 – these assessments apply to Class 1 and Class 2

10 GALL BLADDER AND BILIARY TRACT

Biliary secretions are collected in the gall bladder and [once released into the duodenum] assist in the digestion of fat. Aeromedical concerns arise in association with calculus formation which can cause sudden []incapacitation [due to gall colics]:

- a Biliary calculi. A single, large, asymptomatic gall stone which has been discovered by chance may be acceptable. However, multiple gall stones, whether symptomatic or asymptomatic, are potential causes of incapacitation and require treatment. Individual cases [may] be considered by the AMS [for Class 1 with multi-pilot (Class 1 'OML') limitation at revalidation / renewal or for Class 2 with safety pilot (Class 2 'OSL') limitation].

Gallstones small enough to enter the bile duct are potentially incapacitating and require specialist assessment. While awaiting assessment or treatment a [fit assessment by the AMS with multi-pilot (Class 1 'OML') or safety pilot (Class 2 'OSL')] limitation may be appropriate[].

- b Cholecystectomy. Cholecystectomy, whether performed via intra-abdominal or laparoscopic surgical procedures, requires adequate recovery appropriate to the procedure before [a fit assessment after individual review by the AMS] can be considered.[]

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[11] ABDOMINAL SURGERY

After abdominal surgery the effects of expansion of intrainntestinal air (more than two liters) due to the reduced ambient pressure within the pressure cabin have to be taken into consideration. This can have an effect on the gastrointestinal passage, especially with possible postoperative adhesions, and the sutures. Abdominal surgery is disqualifying for a minimum period of three months. However, the AMS may consider an earlier fit assessment in case of complete recovery, asymptomatic applicant and only minimal risk of recurrence or secondary complications (e.g. microinvasive surgery, appendectomy)].

[12] TUMOURS OF THE GASTROINTESTINAL TRACT

[Malignant tumours of the oesophagus, stomach, small intestine, colon and rectum may be] disqualifying. An applicant who is considered to be fully recovered may be assessed against the criteria outlined in the malignancy and oncology section of these guidance notes. The primary criteria are whether recurrence at the primary site or via secondary, distal tumours will be incapacitating. All cases should be assessed by the AMS with full reports including histology, from the treating physician. [In any case abdominal surgery is disqualifying for a minimum period of three months (see above).]

[13] HERNIAE

Herniae require assessment against the possibility of barometric pressure changes and subsequent strangulation giving rise to incapacitating symptoms. Hernial sites are inguinal, femoral, umbilical and incisional. [Herniae with a risk of] strangulation are disqualifying until repaired. [Fit assessment] may be considered after full recovery, which would normally be 30-days following surgery.

12 – this assessment applies to Class 1 and Class 2

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CHAPTER 5 - METABOLIC, NUTRITIONAL AND ENDOCRINE SYSTEMS

1 INTRODUCTION

Metabolic disorders are common and may develop rapidly into an [incapacitation]. Nutritional and [endocrine] disorders are less common and more likely to be slow in development and onset. They may finally become incapacitating [. However] adequate treatment and review should allow safe continuation of flying duties.

2 ENDOCRINE DISORDERS

Although these disorders are not a common aeromedical problem they are frequently insidious in onset and ultimately may endanger flight safety. The effects of modern treatments and the availability of replacement therapy have modified [aeromedical assessment].

3 THYROID DISORDERS

Disease of the thyroid gland can cause [] important disturbances in function [and/or goiter].

Diffuse [goiters] with no endocrine imbalance have only a cosmetic or rarely a mechanical need for treatment. Nodular [goiters], more common in women over 50, can produce both [mechanical] symptoms and hyperthyroidism, but exclusion of malignancy is the most difficult problem and that may require [extensive expert] investigation.

3.1 Hyperthyroidism

This condition usually occurs in connection with diffuse [goiter] (Graves Disease) and has an [auto-]immunological basis. [Antibodies] against the TSH receptor [] stimulate the autonomous over-production of thyroid hormone [and glandular growth]. Toxic nodular [goiter] or toxic adenoma also over produces thyroid hormone, but not on an auto immune basis.

a *Symptoms*

Sweating, palpitations, nervousness, irritability, insomnia, tremor, hyperactive bowels, weight loss (with appetite apparently normal), exophthalmus, smooth diffuse non-tender [goiter], tachycardia (possibly atrial fibrillation and high output heart failure). In certain cases exophthalmos may be severe with paresis of eye muscles. There may be personality changes.

b *Diagnosis*

Clinically the florid case is unmistakable. Confirmation may be obtained by:

- i determination of TSH level [(decreased)];
- ii determination of total serum T4/free T4 [(increased)]; [and/or]
- iii determination of serum T3/free T3 levels [(increased)].

c *Treatment*

Propyl thiouracil, [methimazole] or carbimazole, will control symptoms but the effect is slow, taking some [two] to [four] months. Propranolol may be used for quicker control of symptoms. Anti thyroid drugs should be continued for [9 - 12] months and then withdrawn but only [50% - 70 %] of patients so treated may remain euthyroid .

Partial [or near total] thyroidectomy is practised much less frequently now and is reserved mostly for [therapy resistant] cases [or in patients] with large and/or nodular [goiters].

Radioiodine administration, is an effective treatment and no evidence of adverse mutagenetic effects on the gland has become apparent, even after many years. However, hypothyroidism is a common sequel and the percentage showing reduced or absent thyroid function grows year by year. Lifelong follow-up and appropriate substitution therapy is mandatory.

d [Aeromedical assessment]

A hyperthyroid pilot is unfit for flying and must remain so until a stable euthyroid state has been attained. [A fit assessment] may be considered by the AMS in any category when they are euthyroid. The individual must be annually reviewed (to include TSH estimation) to guard against recurrence or the development of hypothyroidism. The continued use of anti thyroid drugs, if well tolerated, is consistent with [aeromedical fitness]. Where eye involvement has occurred, the pilot must be [examined and] cleared by an ophthalmologist as well prior to returning to flying.

3.2 Hypothyroidism

The failure of the thyroid gland to produce sufficient thyroid hormone quantities may be due to decreased hypothalamic production of thyroid releasing hormone (TRH) or insufficient pituitary production of thyroid-stimulating hormone (TSH). However, much more frequently the condition is caused by inflammation or destruction of the thyroid gland, and may be a sequel of surgery or radio iodine treatment of the hyperthyroid state. The destruction of the gland through an auto immune mechanism may lead to apparent spontaneous cessation of function which may be an extremely chronic process.

a Symptoms

[Tiredness, weight gain, constipation, thickening and drying of the skin, hoarseness, bradycardia, apathy, slow speech.] These may slowly develop into a frank myxoedema with heart failure and in rare cases into the myxoedematous coma.

b Diagnosis

TSH is increased (in primary thyroid failure); T4/free T4 is decreased.

c Treatment

Hypothyroidism is perhaps the most satisfactory condition to treat, adequate substitution therapy makes the individual normal in every way. Treatment will usually be L-thyroxine [0,1–0,15] mg daily (with caution exercised in increasing to this dosage in cases with cardiac involvement). Treatment should be continued until TSH has dropped to a normal range and the patient is clinically euthyroid, and then continued [life-long with annual TSH measurement].

d [Aeromedical assessment]

Florid hypothyroidism requires a temporarily unfit assessment. The candidate may be considered for [fit assessment] while euthyroid and taking [their] prescribed medication. Annual endocrinological [control examinations are] required by the AMS. Some hypothyroid patients cease taking medication, because they feel entirely well, recurrence of the [disease] may not be obvious and the typical apathy may lessen the chance of recognition. [Therefore, annual] review essential.

4 PITUITARY DISORDERS

4.1 Diseases of the anterior pituitary

a Over-production of adrenocorticotrophic hormone (ACTH)

An over-production of ACTH, usually by a basophil micro adenoma of the pituitary gland, can cause Cushings Disease by over-stimulating the adrenal cortex to produce an excess of adrenal hormones.

- i Features. Obesity, hypertension, myopathy, diabetic tendency, osteoporosis, plethoric facies (moon face), easy bruising, poor wound healing, striae, change in appearance.
 - ii Diagnosis. Urinary free cortisol and serum cortisol are increased. Serum potassium is decreased. Dexamethasone administration will not suppress the over-production of ACTH.
 - iii Treatment. Transphenoidal removal of the microadenoma.
 - iv [Aeromedical assessment]. Applicants with acute Cushing's Syndrome are unfit for flying and must be assessed [as] temporarily unfit until a normal hormone balance is restored, by whatever means. After adequate surgery it may take six months or more for the symptoms and signs to subside and for the adrenal to resume normal production of cortisol. [Fit assessment] by the AMS is dependent on satisfactory reports from, and supervision by, an endocrinologist.
- b *Over-production of prolactin*
- [Over-production of prolactin, usually] from an macro- or microadenoma of the pituitary, is now recognised as the most common hormonal abnormality [or] pituitary neoplasia. The adenoma may be large enough to distort the sella turcica and cause pressure signs on adjacent structures, especially compression of the optic chiasm [with subsequent defects of the visual field].
- i Symptoms. Galactorrhoea, amenorrhoea or irregular cycles in females; impotency and loss of libido in men. Headache and visual field defect in cases with macroadenoma.
 - ii Diagnosis. The adenoma is diagnosed by MRI or CT of the pituitary gland. Serum prolactin (PRL) is elevated and usually a level above 100 ng/ml is a diagnostic parameter for [an] adenoma [secreting prolactin].
 - iii Treatment. Many tumours respond to dopamine agonists such as bromocriptine and this treatment should be continued, if tolerated, on a long-term basis. On cessation of therapy, the hormonal overproduction will most likely recur. Cases which do not respond or those with local pressure symptoms, may require surgical intervention.
 - iv [Aeromedical assessment]. An applicant with macroadenoma and associated pressure signs is unfit.
- Many individuals on long term medication without side effects or following successful surgery may be considered [for fit assessment] by the AMS. [Current evidence indicates that] treatment [has to be continued] lifelong []. Annual review must include ophthalmic and endocrinological examination.
- c *Growth hormone [(GH)]*
- Hyper-secretion of GH by a pituitary adenoma produces acromegaly in the adult.
- i Features. Increase in bone size and soft tissues of hands, feet, supraorbital ridges, sinuses, mandible. Skin thick and coarse; tongue, lips and ears may be enlarged. Any adult with significant changes in appearance or size of extremities requires investigation. MRI or CT imaging may be used for a pituitary tumour. The biochemical diagnosis is based on elevated serum glucose levels which cannot be suppressed, an oral glucose tolerance test (OGTT), and an increased insulin like growth factor I (IGF I) level.
 - ii Treatment. In the majority of cases, surgery is the [] treatment [of choice]. Irradiation and/or [] treatment [with somatostatin analogs] may also be required.
 - iii [Aeromedical assessment]. Any pilot with a GH secreting tumour producing symptoms is unfit (also see [Chapter 17] Oncology with regard to assessment).
- After operation or irradiation of the tumour, an individual must be very carefully reviewed over an extended period to determine whether he or she is fully recovered. Anyone with gross physical changes, most of which do not regress, is unlikely to be assessed fit [for] Class 1 or 2. Specialist ophthalmological and endocrinological review

will be required before consideration by the AMS. Annual review is necessary [for those] assessed as fit.

4.2 **Disease of the posterior pituitary**

a *Diabetes insipidus (DI)/ failure to secrete ADH*

A condition marked by polyuria (partial or complete failure of vasopressin [(ADH)] secretion by the posterior pituitary).

- i *Diagnosis.* Fluid deprivation tests are diagnostic. If dehydration raises the serum osmolality to 295 mOsm/kg but the urine remains [diluted], the diagnosis is diabetes insipidus.
- ii *Treatment.* Desmopressin (DDAVP), is effective and convenient. The dose must be individualised.
- iii [Aeromedical assessment]. Each case must be considered individually by the AMS with full specialist reports. An individual, who is well controlled, using vasopressin or desmopressin, may be considered for [fit assessment for] initial Class 2 applicants and Class 1 and 2 [applicants at revalidation / renewal] with regular specialist [follow-up].

5 **DISEASES OF THE SUPRARENAL GLAND**

5.1 **Hypoadrenalism (Addison's disease)**

a *[Aetiology] and pathogenesis*

The adrenal cortex fails to produce hormones or adequate quantities of hormones. Most cases are due to an autoimmune process which eventually destroys the adrenal cortex. In the past destruction of the gland by tuberculosis was a frequent cause.

b *Features*

The patient may complain of weakness, anorexia and weight loss. The onset is usually gradual, though a sudden onset may be precipitated by unrelated diseases, classically acute infections. Hyper-pigmentation may be seen. The blood pressure will be low in crisis. Hypovolaemia is present . Serum potassium is elevated and serum sodium depressed in crisis. The ECG may show changes related to the raised serum potassium.

c *Diagnosis*

Low plasma cortisol and decreased urinary cortisol excretion which do not rise after administration of ACTH. Elevated serum ACTH level.

d *Treatment*

Using cortisol and cortisone in low doses. Additional medication is needed for infection or stress. An individual receiving adequate substitution therapy has no immediate risk of incapacitation. However, any minor infection or stress can quickly induce a [crisis and incapacitation].

e [Aeromedical assessment]

Fully stabilised cases may be considered by the AMS for [a fit assessment at revalidation / renewal]. A multi-pilot limitation (Class 1 'OML') or safety pilot limitation (Class 2 'OSL') may be required. Regular specialist review will be required.

6 **DIABETES MELLITUS**

This carbohydrate metabolic disorder [,characterised by absolute or relative lack of insulin] is associated with many complications which may produce sudden incapacitation or grossly reduced performance and thus cause a serious risk to air safety.

6.1 Diagnostic criteria

Typical symptoms are weight loss, polyuria and polydipsia. The findings of 2% glycosuria and an elevated blood sugar are diagnostic. However, the difficulty arises when mild glycosuria and subsequent abnormal blood glucose levels are found in a symptomless applicant during routine medical examinations. An abnormal blood glucose requires glucose tolerance testing. 75 gram glucose loading in a minimum of 250 ml of water is given to a fasting subject who has eaten a normal diet containing 250 gram of carbohydrate for the previous few days. Fasting whole blood glucose levels and those two hours after glucose loading are [tested]. [The]WHO agreed levels [in venous full blood] are outlined below [(please find the levels in capillary full blood in brackets)].

	Fasting		2 hours post	
Normal []	< 6,1 mmol/l < 110 mg/100ml	(< 6,1 mmol/l)(< 110 mg/100ml)	< 7,8 mmol/l < 140 mg/100ml	(< 7,8 mmol/l) (< 140 mg/100ml)
Impaired glucose tolerance	< 6.7 mmol/l < 120 mg/100ml	(6,1 - 6,7 mmol/l) (< 120 mg/100ml)	<6,7- 10,0mmol/l <120-180mg/100ml	(7,8 - 11,1mmol/l) (140-200mg/100ml)
Diabetes mellitus	≥ 6,7 mmol/l ≥ 120 mg/100ml	(≥ 6,7 mmol/l) (≥ 120 mg/100ml)	≥ 10,0 mmol/l ≥ 180 mg/100ml	(≥ 11,1 mmol/l) (≥ 200 mg/100ml)

These results are valid for venous whole blood glucose [(please find the levels in capillary full blood in brackets)]. Differing laboratories and methods using capillary blood or plasma glucose may require minor changes to these figures. Diagnosis should not rely on one abnormal OGTT result and all borderline tests should be repeated.

6.2 Classification

The accepted modern classification is:

Type 1 Insulin Dependent (IDDM)	Genetically associated with T-cell dependent auto immune disease and HLA factors. Very low or absent endogenous insulin. Liable to keto-acidosis. Onset typically under 30.
Type 2 Non-insulin dependent (NIDDM)	Related to obesity and [family history of NIDDM]. Endogenous insulin always present and often hyperinsulinaemic with insulin resistance. Rarely if ever ketotic. Onset 40+. There is a non-obese sub-group which have different aetiology and [hereditary family factors].

6.3 Complications

Macro-angiopathic vascular damage is the common background for the coronary, cerebral and peripheral arterial disease which can constitute a major aeromedical risk and may be related to the hyperlipidaemic effects of diabetes.

Estimates of the risk of Type 2 diabetes vary, but it is clearly significant and increases with the duration of the condition. Microangiopathy is associated with progressive retinal and renal damage. Neuropathy is probably related to the long term effects of the metabolic abnormality and can involve motor, sensory and autonomic functions. Cataract is common in older patients. All complications tend to be found in long term diabetes, especially those which are poorly controlled, but can also appear early in the disease – retinopathy in particular can be an initial finding.

6.4 Management

- a Type 1: it should be noted that an apparent remission of insulin requirement invariably ends in relapse and the applicant should not be [assessed as fit] during such a remission or 'honeymoon period'.
- b Type 2 requires:
 - i optimum weight
 - ii dietary control and/or oral hypoglycaemic drugs (insulin in occasional resistant cases is disqualifying)
 - iii satisfactory control of blood glucose levels, lipids, blood pressure, and any other risk factors.

6.5 Treatment [of Type 2 diabetes mellitus (NIDDM)]

Reduction of carbohydrate and total calorie intake in the obese may be sufficient in many cases to reduce blood glucose levels [to an acceptable level]. Other dietary modifications may include an increase in dietary fibre and a reduction in animal fat. Glucose levels are now usually assessed by home monitoring with meters or sticks. Routine urine testing is unreliable for treatment management because of the wide variation in renal threshold for glucose, especially in old people. Glycosylated haemoglobin (HbA1) or serum fructosamine estimations are of good value as indicators of average blood glucose over periods of weeks .

The ideal result of dietary management would include:

- | | |
|-----------------------------------|------------------------------------|
| - Blood glucose control | appropriate to diabetes management |
| - HbA1 | within normal range |
| - Body mass index | less than 25 |
| - Regular exercise and no smoking | |
| - Lipid control | appropriate to diabetes management |

Type 2 diabetics may need oral hypoglycaemic drugs to supplement dietary treatment. This is especially likely in the non-obese sub-group. Quar-gum may be used as a dietary adjunct.

In selected cases, the use of oral **[antidiabetic]** drugs may be acceptable:

Medication	Class 1 'OML'	Class 2
Biguanides	Yes [(OML)]	Yes
Alpha-glucosidase Inhibitors	Yes [(OML), if used as single therapy or in combination with biguanides and / or glitazones]	Yes, if used as single therapy [or in combination with biguanides and / or glitazones]
Sulphonylureas	Not acceptable	Yes, with 'OSL'
Thiazolidinedione [(Glitazones)]		
Rosiglitazone	[Yes (OML)]	Yes, [without limitation],
Pioglitazone	[Yes (OML)]	Yes, [without limitation],
[Glinides]		
Repaglinide / Nateglinide	Not acceptable	[Yes, with 'OSL']

6.6 Long term monitoring of Type 2 diabetes [(NIDDM)]

- a. The monitoring process should consist of:
 - i careful examination to exclude common complications of diabetes;
 - ii assessment of the degree of control;
 - iii regular weight measurements;
 - iv blood glucose measurements;
 - v urine test results (limited value).
- b. Air crew should undergo careful review of the following in addition to the periodic medical examination:
 - i regular [ophthalmological examination with] ophthalmoscopy after pupillary dilation to check for retinopathy and [and slit lamp examination of the] lens [for] vitreous opacities;
 - ii [neurological] examination for evidence of neuropathy;
 - iii periodic blood tests including biochemistry, [HbA1], renal function, liver function and plasma proteins, plus fasting blood lipids and cholesterol;
 - iv cardiological review with consideration of exercise electrocardiography;
 - v periodic urinary tests for detecting early renal damage (microalbuminuria).

6.7 [Aeromedical assessment]

Type 1 diabetics requiring exogenous insulin are unfit to fly. The intrinsic risks of the disease itself are further increased by that of hypoglycaemia. No present injection regime or insulin infusion pumps are sufficiently efficient to act as an artificial pancreas. Nevertheless, progress in such developments as islet transplantation may require consideration in the future.

Type 2 diabetics fully controlled on diet alone may be [assessed as] fit [for] Class 1 and Class 2 [without limitations], subject to detailed follow-up at periodic medical examinations or at least annually. Those requiring [treatment with] biguanide [glitazones, the combination of glitazones with biguanides] or alpha-glucosidase inhibitors in addition may be acceptable [with a multi-pilot (Class 1 'OML') limitation for Class 1 applicants] and [without limitation for] Class 2 [applicants,] but the follow-up would need to be more stringent, namely 6 monthly. The use of sulphonylureas, [Repaglinide or Nateglinide] is unacceptable except for Class 2 [with a safety pilot (Class 2 'OSL') limitation].

This Assessment applies to Class 1 and Class 2.

Impaired glucose tolerance often represents a pre-diabetic state that may convert to the full condition at a rate of around 4% per year. Cases may need dietary treatment and will require prolonged and detailed follow-up in order to [preserve aeromedical fitness in the long run].

[The international aeromedical literature presents examples of assessing pilots with Type 2 diabetes (NIDDM) and being insulin dependent as fit under strict regimes and strict selection, either Class 2 or even Class 1 or military pilots. European experts discuss whether protocols may be useful in the future to gain scientific evidence in this field in Europe as well.]

New types of medicine like the incretins offer promising features like no significant risk of hypoglycaemia and may be useful in an aero-medical setting in the future.

7 GOUT

Gout is a term representing a heterogeneous group of disease which in their full development are manifested by:

- a an increase in the serum [] concentration [of uric acid (hyperuricaemia)];
- b recurrent attacks of a characteristic acute arthritis in which crystals of monosodium urate monohydrates are demonstrable in leukocytes of synovial fluid;
- c aggregated deposits of monosodium urate monohydrate (tophi) chiefly in and around the joints of the extremities and sometimes leading to severe crippling and deformity;
- d renal disease involving interstitial tissues and blood vessels;
- e uric acid nephrolithiasis (renal stones). These may occur singly or in combination.

The full natural history of gout comprises four stages.

7.1 Asymptomatic hyperuricaemia

This is especially common in overweight and hypertensive men who may be taking diuretics. Only a minority will progress to clinical gout. However, it carries a small risk of urate stone or nephropathy, potentially preventable by prophylactic treatment with allopurinol. In practice the inconvenience and other disadvantages of indefinite drug treatment outweigh any benefits. Low purine diets are rarely practicable but general health measures such as weight reduction, alcohol restriction, and a review of need for diuretic treatment should be attempted.

7.2 Acute gouty arthritis

Acute gout, often recurrent, usually of the metatarso-phalangeal joint of a great toe, is not uncommon in air crew. Familial or constitutional factors are more important than obesity or alcohol, but combinations of predisposing and precipitating factors are usual. Acute gout and its immediate drug treatment should preclude flying duties which may be resumed 24-hours after [termination] of treatment. The inconvenience of this restriction often leads to maintenance treatment with allopurinol, which may precipitate acute gout early in the course of treatment so prophylactic treatment with an anti-inflammatory drug, such as indometacin, is usually prescribed simultaneously for the first few weeks of treatment. Allopurinol may disturb liver functions and rarely causes more serious side-effects, usually early in treatment. In practice it is generally well tolerated, normalising the serum uric acid, preventing attacks of gout and development of complications. This treatment can, and usually should, be continued indefinitely with periodic follow up.

7.3 Intercritical period

The initial, acute attack of gout may last only a day or two up to several weeks, but characteristically subsides spontaneously. [Usually, there are no sequelae] and resolution is complete. An asymptomatic phase termed 'the inter critical period' then commences. The patient is totally free of symptoms during this stage, a feature that is diagnostically important. While approximately 7 [%] never have [another] attack, approximately 60 [%] experience a recurrence within 1 year. However, the inter critical period may last up to 10 years and is terminated by successive attacks, each of which may last longer and resolve less completely than its predecessors. Later attacks tend to be polyarticular, more severe, more prolonged and associated with fever. In this stage gout may be difficult to differentiate from other types of polyarticular arthritis such as rheumatoid arthritis. Rarely patients progress directly from the initial acute attack to chronic polyarticular disease with no remissions.

7.4 Tophic and chronic gouty arthritis

Effective therapy alters the natural history of the disease. Since the advent of effective anti-hyperuricemic therapy only a minority of patients develop visible tophi, permanent joint changes or chronic symptoms. Tophi, if present, will occur in the helix or antihelix of the ear, along the forearm, as enlargement of the Achilles tendon or at other pressure points. This stage of the disease is [only rarely preventing aeromedical fitness].

7.5 [Aeromedical assessment]

- a Asymptomatic hyperuricaemia is not disqualifying.
- b Acute gout and the associated treatment require [a] temporarily unfit [assessment] until 24 hours after cessation of treatment.
- c Tophic and chronic gouty arthritis should be assessed individually, depending upon the strength, range of movement, pain and medication used.
- d The possibility of nephrolithiasis at any stage must be considered.

This Assessment applies to Class 1 and Class 2.

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CHAPTER 6 - HAEMATOLOGY

1 INTRODUCTION

Blood transports the oxygen required for, and carbon dioxide produced by the cellular metabolic processes. Any condition reducing these functions affects the individual while the reduced oxygen tension associated with altitude exacerbates any effects. Although the pressurisation of [the aircraft cabin] reduces the [latter] effects the airman [might be faced with low ambient pressure by the emergency of a loss of pressurisation and] must also be able to respond normally to [this] emergency[].

2 ANAEMIA

[Testing the haemoglobin is required for every examination for Class 1 applicants and for initial examination and when clinically indicated for Class 2 applicants. Applicants with abnormal haemoglobin require a haematocrit test. Haematocrit below 32 % requires an unfit assessment, and further tests as clinically indicated.] Final assessment [depends] on the diagnosis and response to treatment. [Only a temporary unfit assessment is required if the primary cause can be satisfactorily treated (e.g. iron or Vitamin B 12 deficiency) and the haematocrit has stabilised at greater than 32 %. In case of thalassaemia minor or haemoglobinopathies with full functional capability, but without history of crises a fit assessment by the AMS may be considered.]

2.1 Iron deficiency

If the cause can be identified and is not disqualifying, treatment must lead to a haematocrit greater than 32% [before a fit assessment] can be considered.

2.2 Vitamin B12 and folic acid deficiency

After establishing the aetiology and restoring reserves of vitamin B12 or folic acid, a [fit assessment may be considered] subject to [a] follow-up [of at least 6 months].

2.3 Sideroblastic anaemia

Only carriers of the familial type can be [assessed as fit if] the haematocrit is greater than 32%.

2.4 Haemolytic anaemia

[In case of acquired haemolytic anaemia] the underlying conditions must be evaluated and treated [sufficiently]. Congenital haemolytic anaemia that is not due to a haemoglobinopathy and with haematocrit above 32%, may be considered for [a fit assessment].

Applicants with hereditary spherocytic anaemia can be assessed as fit with a haematocrit above 32% or after successful splenectomy.

Applicants with chronic auto immune haemolytic anaemia are unfit. Decompensation is unpredictable and severe [and may result in sudden incapacitation].

Other rare conditions, or those of obscure aetiology, should be evaluated on an individual basis. These include paroxysmal nocturnal haemoglobinuria, disorders of red cell synthesis or red cell destruction.

3 POLYCYTHAEMIA

For applicants with a haematocrit greater than 55% further investigation is needed to establish the aetiology. After successful treatment resulting in a haematocrit below 55%, [a fit assessment] may be considered by the AMS. Annual review is required.

Polycythaemia vera is normally disqualifying, subject to AMS discretion, due to its [potential] thromboembolic complications and rapid and unpredictable progression.

4 HAEMOGLOBINOPATHIES AND THALASSAEMIAS

4.1 [Sickle cell trait]

[The red blood cells containing HbS may sickle under low oxygen tension and obstruct blood vessels. This is most likely in individuals, who are homozygous for the disorder (Sickle cell disease, Hb SS). However, even though a lot of applicants with sickle cell trait (Hb AS) have been certified world-wide in the past decades there is no scientific evidence for any complications due to the sickle cell trait occurring in-flight or in altitude chambers. A fit assessment] should be denied when sickling can be demonstrated at reduced oxygen tension [or if there is a history of a sickling crisis.]

[HbSS. If the haematocrit is within the acceptable range and the candidate has no symptoms or history of vaso-occlusive disease, a certificate may be issued.]

[Hb AS. In the absence of conditions such as splenic infarction, Haemoglobin S trait (Hb AS) is acceptable.]

[4.2 Haemoglobin C

In Haemoglobin C disease (HbCC) the applicant is homozygous for the abnormal HbC. It shows mild anaemia and is associated with , arthralgia, abdominal pain and jaundice. A fit assessment should be denied. In Haemoglobin C trait (Hb AC) the applicant is heterozygous for the abnormal HbC and - except target cells in the thin blood film - there are no haemolysis, anemia or other symptoms. Applicants can be considered for fit assessment.]

[4.3 Haemoglobin SC

The disorder shows an abnormal Hb S and an abnormal Hb C. It shows a variety of symptoms and] is associated with a high incidence of retinal haemorrhage and splenic infarction. [A fit assessment] should be denied.

[4.4 Thalassaemia

[Thalassaemia can be subdivided in heterozygous (Thalassaemia minor) and homozygous (Thalassaemia maior) forms, and alpha and beta Thalassaemia (depending on which globin chain of the haemoglobin is deficient). Applicants with Thalassaemia minor can be considered for a fit assessment.]

Applicants with S/B or S/Bo thalassaemia should be denied certification.

Simple, uncomplicated Beta-thalassaemia trait is acceptable.

[]

5 BLEEDING AND THROMBOTIC DISORDERS

5.1 Coagulation disorders

Applicants with an inherited coagulation disorder or any history of factor replacement or serious bleeding episodes [must be] considered unfit.

a *Haemophilia*

Applicants with Factor VIII deficiency are unfit. The AMS may consider [a fit assessment] for Class 2, if there is no history of significant bleeding episodes.

b *Von Willebrand's disease*

Applicants with von Willebrand's disease should be [assessed as unfit]. Individuals without therapy or without a history of significant bleeding episodes may be [assessed as] fit by the AMS.

c *Deep vein thrombosis*

A history of deep vein thrombosis requires full investigation for underlying conditions. The individual has to be [assessed as] temporarily unfit.

d *Pulmonary embolism*

Applicants with a history of pulmonary [embolism], not associated with chronic deep venous thrombosis, [have to be assessed as] temporarily unfit until a period of at least 6 months after anticoagulant therapy has been discontinued and not less than 1 year after the actual pulmonary embolism.

e *Recurrent pulmonary [embolism]*

Applicants with more than one episode of pulmonary [embolism] documented by radio-isotopic or angiographic methods are unfit, even if the candidate is asymptomatic. If associated with recurrent injury or special circumstances, [a fit assessment may be considered] at the discretion of the AMS.

f *Arterial emboli*

[Even a] single episode [requires an unfit assessment] because of the high risk of emboli in the brain.

g *Anticoagulant medication*

The use of anticoagulant drugs, such as heparin, coumarin and warfarin, is disqualifying. Following therapy, [a fit assessment] may be considered by the AMS. The use of low dose of low molecular weight heparine may be considered acceptable by the AMS. The use of antiplatelet agents such as acetylsalicylic acid, dipyramidole or sulphinpyrazone alone for their prophylactic anti-platelet effect is not disqualifying. Ongoing treatment with anticoagulants in an otherwise fit individual, may be acceptable [for Class 2 applicants with a] safety pilot (Class 2 'OSL') [limitation] by the AMS. [(For cardiovascular] requirements also []see JAR-FCL 3.150(c), JAR-FCL 3.270(c), paragraph [10] Appendix 1 to Subparts B and C and Manual Chapter Aviation Cardiology paragraph 9).

h *Haemorrhagic platelet abnormalities*

A decreased circulating platelet count due to any cause may result in debilitating haemorrhagic episodes. Haemorrhage can also occur when platelet counts are normal but platelet function is abnormal. [An individual assessment by the AMS is required.]

5.2 Thrombotic disorders

Applicants with idiopathic thrombocytopenic purpura (ITP), previously treated by splenectomy and with stable platelet counts for six months [may be considered for a fit assessment by the AMS] after therapy has been discontinued []. Platelet counts should be repeated at six monthly intervals. Applicants, who have had thrombocytopenia due to abnormal destruction or consumption, as with disseminated intravascular coagulation (DIC), vasculitis or thrombotic thrombocytopenic purpura (TTP), should be [assessed as unfit] permanently.

Persons with thrombocytopenia below 75 000/mm³ should be [assessed as unfit]. Some temporary episodes of [thrombocytopenia] can occur in persons with underlying iron deficiency anaemia or other temporary disorders such as recovery from alcoholic bone marrow suppression. [Such conditions require only a temporary unfit assessment until the thrombocyte counts have normalised again, notwithstanding the necessity of further assessment in case alcohol abuse should be suspected (see Chapter 11 Aviation Psychiatry, Subchapter 18.1 Mental and behavioural disorders due to use of alcohol).

[After] a temporary, secondary thrombocytosis that has been resolved and platelet counts have been consistently normal, the AMS may consider [a fit assessment]. Applicants with “essential” thrombocytosis without apparent explanation, who continue to have platelet counts above 750 000/mm³, should be assessed by the AMS.

6 HAEMATOLOGIC NEOPLASIA

Applicants with a haematologic neoplasia should be denied [a fit assessment]. Individuals with histories of haematologic neoplasia not requiring continuous therapy may be assessed as fit. Adequate follow-up and re-assessment is necessary because of [the] risk of relapse or progression.

Individuals receiving chemotherapy or glucocorticoids should be assessed as unfit.

6.1 Leukaemia

a *Acute lymphocytic leukaemia*

Applicants with the diagnosis of acute lymphocytic leukaemia as an adult shall [be assessed as unfit]. Applicants with a medical history of acute lymphocytic leukaemia in childhood may be [assessed as fit,] if they are in complete remission and without treatment for at least ten years.

If the individual has had cranial radiation, particular attention should be paid to examination of the neurologic system and mental status.

b *Acute myelogenous leukaemia*

Acute myelogenous leukaemia (AML) or acute nonlymphocytic leukaemia is a very serious disorder and long-term survival is uncommon. Treatment is effective, yet the relapse rate is high and remission lasts only about 15 months on average. An applicant with a history of AML may be considered [a fit assessment] by the AMS.

c *Pre leukaemia or myelodysplastic syndromes*

The preleukaemic or myelodysplastic syndromes are a group of haematopoietic disorders that frequently evolve to acute myelogenous leukaemia. They are characterised by hypercellular bone marrow and various degrees of peripheral blood cytopenias. Persons with these conditions are prone to infection and bleeding. Because of the relatively poor

prognosis and high risk of sudden incapacitation, individuals with these disorders should not be [assessed as fit].

d *Chronic myelogenous leukaemia and myeloproliferative syndromes*

Applicants with a confirmed diagnosis of either Ph chromosome-positive or negative chronic myelogenous leukaemia (CML) should be [assessed as unfit] permanently.

e *Chronic lymphocytic leukaemia*

A common staging system for chronic lymphocytic leukaemia (CLL) is as follows:

Stage 0	– bone marrow and blood lymphocytosis only
Stage I	– lymphocytosis with enlarged nodes
Stage II	– lymphocytosis with enlarged spleen or liver, or both
Stage III	– lymphocytosis with anaemia
Stage IV	– lymphocytosis with thrombocytopenia

Individuals with disease in Stage II through IV should not be [assessed as fit]. In these stages of the disease cytotoxic therapy is often necessary and the cytopenias present a serious risk of sudden incapacitation. Persons with Stage 0 or Stage I disease may be [assessed as fit] by the AMS, provided there is no haemolytic anaemia and no requirement for chemotherapy or corticosteroids. Re-examination at intervals of three months should be required with documentation by the treating physician.

f *Hairy cell leukaemia*

Individuals who are stable after splenectomy, or without treatment [may] be assessed as fit by the AMS.

6.2 Lymphomas

a *Hodgkin's disease*

Applicants with active Hodgkin's disease or individuals undergoing therapy should not be [assessed as fit]. Persons with Stage I and II-A who have had no evidence of disease for two years after completion of treatment may be [assessed as fit].

Persons with Stage II-B through IV-B should be free of disease and therapy for at least five years before [they may be considered for a fit assessment] and they should be [re-assessed] every six months for ten years. After ten years there should be annual [re-assessments].

b *Non Hodgkin's lymphoma*

Well differentiated and poorly differentiated lymphocytic lymphoma, mixed lymphocytic lymphoma and histiocytic lymphoma of either the nodular or diffuse type, are usually disqualifying. Persons with B-cell, diffuse histiocytic lymphoma, particularly in the early stages, may be cured by radiation therapy and/or chemotherapy. If they are free of disease without therapy for at least three years they may be [assessed as fit] with [re-assessment] every three months for three years and then every six months. Persons with T-cell, diffuse histiocytic lymphoma, including immunoblastic lymphoma and T-cell lymphoblastic sarcoma, should not be [assessed as fit] because of the high degree of malignancy of these disorders and their unpredictability. Cases of Burkitt's lymphoma are usually disqualifying, but may be [assessed as fit] at the discretion of the AMS.

c *Plasma cell dyscrasia*

Applicants with multiple myeloma, Waldenstrom's macroglobulinaemia or multiple plasmocytomas should not be [assessed as fit]. These disorders are not curable, require frequent [toxic] therapy[], and are associated with side effects such as neurologic impairment that may lead to sudden incapacitation.

Applicants with a single plasmocytoma may be cured and, if they are free of disease [for] more than three years after therapy has been discontinued, they may be considered for [a fit assessment] with frequent follow-up.

Applicants with benign monoclonal spike gammopathy with a monoclonal spike comprising less than 2 gram/dl of protein, with less than 5% plasma cells in the bone marrow and with no haematopaietic compromise [or] osteolytic lesions, may be [assessed as fit] by the AMS. The major risk of monoclonal gammopathy is progression to multiple myeloma and an increase in serum viscosity leading to neurologic impairment.

Applicants with amyloidosis associated with plasma cell [abnormalities] should not be [assessed as fit] because of the high incidence of organ infiltration and the risk of sudden impairment.

Applicants with gamma or alpha heavy chain disease should not be [assessed as fit]. The median survival is approximately 12 months for gamma heavy chain disease and the alpha chain disease is often associated with abdominal lymphoma.

Applicants with cold agglutinin disease should not be [assessed as fit] because of the risk of sudden haemolysis.

Applicants with cryoglobulinaemia associated with myeloma and persons with the mixed cryoglobulinaemia syndrome should not be [assessed as fit] because of the risk of sudden vascular incidents and neurologic dysfunction.

7 SPLENOMEGALY

Significant enlargement of the spleen is disqualifying due to the increased risk of sudden rupture. The AMS may consider [a fit assessment, if] the enlargement is minimal, stable and no associated pathology is demonstrable. In all cases splenomegaly requires investigation of the cause of the enlargement.

[8 BONE MARROW TRANSPLANTATION

Cases of bone marrow transplantation may be assessed as fit at the discretion of the AMS.]

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CHAPTER 7 - THE URINARY SYSTEM

1 INTRODUCTION

The kidneys, ureters, bladder and urethra collectively form the urinary system and are not normally affected by flying. Abnormalities of the urinary tract are usually associated with infection, inflammation and obstruction, all of which can cause pain which may be severe enough to be incapacitating.

Any abnormality of the urinary tract requires investigation prior to the issue of an initial certificate. However, re-certification may be considered if the individual is asymptomatic.

2 URINE

The urine [shall] be analysed at each examination and should be clear of blood, protein and sugar. A trace finding of protein is probably of little significance if present in isolation but should be recorded for comparison at future examinations. A trace of blood likewise, is usually benign, but if it persists should always warrant further investigation. The presence of significant haematuria or proteinuria requires full assessment before a decision can be made on fitness to fly and a temporarily unfit assessment may be necessary until the results of investigation are known.

3 URINARY INFECTION

Infection is the most common urinary tract condition. It may be acute, chronic, incapacitating or asymptomatic. It is disqualifying until properly investigated, diagnosed and treated.

3.1 Acute infection

This may be associated with anorexia, pyrexia, dysuria, polyuria, renal pain, headache and nausea. The pilot should be assessed as temporarily unfit until [being] asymptomatic and the urine [being] clear. Extended treatment may be required, however, flying may be possible if the medication is without side effects.

3.2 Chronic infection

Recurrent and chronic infection will cause [an unfit assessment] at initial examination. After full renal assessment and demonstrated recovery, [fit assessment] may be considered. Chronic infection is often associated with anatomic abnormalities which may be surgically corrected. A demonstrated recovery over a sufficient period of time should allow [a fit assessment].

3.3 Renal tuberculosis

This deserves mention as a chronic infection which will require extended treatment. A temporarily unfit assessment is required until the urine is clear and the treatment is stabilised and has no apparent side effects.

4 UROPATHIES

[Structural and functional changes of the urinary tract obstructing the flow of urine may result in renal dysfunction (uropathy or obstructive nephropathy)]. Chronic urinary obstruction from many causes may lead to uropathy. However, relief of obstruction is associated with an excellent renal prognosis and, therefore, following surgical relief unrestricted certification may be considered by the AMS. Following nephrectomy an individual may be considered fit subject to a satisfactory assessment [and function] of the remaining kidney.

3, 4 – These assessments apply to Class 1 and Class 2

5 CHRONIC RENAL DISEASE

Individuals with minor urinary abnormalities such as microscopic haematuria or mild proteinuria may be suffering from an underlying glomerular nephritis, typically IgA disease. In the majority of cases, this will have a benign course and there is no requirement to restrict or deny [a fit assessment]. Features suggestive of progression of disease are the development of hypertension, heavy proteinuria and a rising serum creatinine. With normal or well controlled blood pressure, these subjects are not at risk of incapacitation until creatinine clearance levels fall below 20 mls/min. Below these levels, [a fit assessment may only be considered by] the AMS and in exceptional circumstances. Each individual will require careful follow-up and assessment. The requirement for dialysis will normally preclude [a fit assessment].

6 RENAL TRANSPLANT

An individual with a good response to transplantation may be considered for [fit assessment at revalidation / renewal] if renal function is normal, there is no hypertension and the immunosuppressive regime is acceptable. A period of one year post operative temporarily unfit assessment is necessary to ensure stability. In view of the greatly increased cardiovascular risks following transplantation, a full cardiovascular profile to include an exercise stress test should be performed prior to consideration by the AMS[]. After a period of stability [fit assessment] with OML/OSL limitation may be possible with periodic AMS review.

6 – This assessment applies to Class 1 and Class 2

7 CALCULI OF THE RENAL TRACT

Urinary calculi (stones) may be found at all points within the urinary tract. Symptoms are produced by obstruction and associated spasm of the smooth muscles in the tract wall. Calculi vary in size, consistency, composition, shape and texture as do the dimensions of the renal tract. Any movement [of the stone(s)] is therefore unpredictable in terms of the abruptness of onset and severity of pain. The varying G-forces to which an individual is exposed during flight are particularly likely to dislodge renal calculi, and so any radiopaque lesion of the parenchyma [or shadowing lesions in the ultrasound] will require urological investigation.

[7.1] Asymptomatic stone(s)

The existence of calculi may be completely unknown to the applicant because of being asymptomatic and could be accidentally demonstrated during instrumental check-up performed for other reasons. In such cases, the AMS may consider [a fit assessment] with a multi-pilot [](Class 1 'OML') or safety pilot limitation (Class 2 'OSL') for one year. After this period of documented

freedom from symptoms [a fit assessment without such a limitation] may be considered by the AMS both for Class 1 and Class 2. A regular follow-up with [ultrasound] is required for every visit and it should demonstrate no volume increase of calculi and no movement of calculi from their original position.]

[7.2] Residual stone(s)

A residual stone, or stones, may often be asymptomatic. If in the collecting system, they remain a hazard and should be cleared before the individual can be assessed as fit to fly. If the stone is parenchymal or in a calyceal cyst, then the hazard is [minimal] and the applicant may be considered fit for multi-pilot operations (Class 1 'OML'), safety pilot (Class 2 'OSL') or [without limitation for] Class 2 by the AMS.

[7.3] Recurrent renal colic

Recurrent renal colic when associated with calculi must be investigated. If a comprehensive urological examination indicates a condition susceptible to treatment and subsequent review over an extended period after treatment shows no change, the individual may be assessed as fit. [Fit assessment] of individuals may be considered at an earlier stage for Class 2 than Class 1. Urological follow-up with [adequate techniques] shall be required by the AMS.

[7.4] Modes of treatment

These include direct surgical approach, percutaneous nephrolithotomy (PN) and extracorporeal shock wave lithotripsy (ESWL). Each method has advantages and disadvantages. However, each case must be fully recovered from the procedure with all signs of calculi having been cleared before [a fit assessment] can be approved by the AMS. Follow-up is important in all cases.

<p>7 – These assessments apply to Class 1 and Class 2</p>
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8 CONGENITAL RENAL TRACT ABNORMALITIES

8.1 Polycystic kidneys

Polycystic kidneys are frequently asymptomatic and the individual may be unaware of his condition in the absence of a recognised family history. If the individual is aware of his condition, even if asymptomatic, then the potential for acute colic, infection, development of hypertension and renal failure, and the association with berry aneurysm and subarachnoid haemorrhage precludes [a fit assessment for] initial Class 1 [applicants]. If symptomatic, [a fit assessment for Class 1 revalidation / renewal] may be considered by the AMS with careful follow-up and assessment. Minor degrees of asymptomatic polycystic kidney may be considered by the AMS, for initial and renewal Class [fit assessment] following investigation and follow-up.

8.2 Medullary sponge kidney

Medullary sponge kidney may vary in severity and present with renal colic, haematuria or intercurrent infection. Each case must be assessed individually, however, the probability of recurrent calculus formation with the associated risk of renal colic makes it unlikely that single crew operation would be acceptable. Each case requires [assessment] by the AMS.

9 GENITOURINARY MALIGNANCY

Such cases if fully treated may be assessed under the criteria noted in the oncological chapter and can be returned to flying in many cases.

10 OTHER URINARY TRACT SURGERY

Most surgery is carried out in order to correct abnormalities which have reduced renal function. The assessment will depend upon a return to normality and will require specialist assessment by the AMS.

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CHAPTER 8 - SEXUALLY TRANSMITTED DISEASES AND OTHER INFECTIONS

1 INTRODUCTION

The assessment of fitness for aviation duties should be guided by criteria of recovery and satisfactory control. Guidance on recommended methods of treatment are published and periodically up-dated by the World Health Organisation.

2 SYPHILIS

An applicant who has a history of syphilis may be assessed as fit provided that adequate treatment has been completed.

3 HIV POSITIVITY AND ACQUIRED IMMUNODEFICIENCY SYNDROME (AIDS)

[The HIV infection is caused by the Human Immunodeficiency Virus (HIV), a so-called retrovirus. HIV serological testing of individuals for aeromedical fit assessment purposes is required only when indicated on clinical grounds.]

[]

For some years the position adopted by most authorities has been that a holder of a pilot licence who has tested positive for HIV but otherwise is totally asymptomatic, is not disqualified from flight duties provided regular follow-up is carried out. However, there is a growing concern that HIV positive individuals will develop neuropsychiatric symptoms including dementia, subtle cognitive or other psychological changes associated with HIV encephalopathy or opportunistic Central Nervous System (CNS) infections. In general, the present position is that medical fitness status of licence holders who are biologically infected but in good health and completely asymptomatic, should be maintained.

However the neuropsychological status of asymptomatic HIV seropositive individuals is still a controversial issue in clinical aviation medicine. Even if there is no evidence reported for an increase of clinically significant neuropsychological abnormalities in HIV seropositive persons compared with HIV seronegative controls, it has been argued that the specific flight environment of an air crew flying with somewhat reduced oxygen tension and arterial [pO₂] would favour the appearance of CNS symptoms in HIV seropositive pilots. Individuals with early opportunistic infections such as pneumonia might be asymptomatic on the ground but be incapable of performing flight duties at certain cabin altitudes.

An individual with a history of HIV seropositivity shall undergo the evaluation of T₄ (CD₄-helper) and T₈ (CD₈-suppressor) lymphocytic ratio with a frequency of at least every three months. [Fit assessment with multi-pilot (Class 1 OML) or safety pilot limitation (Class 2 OSL)] may be considered by the AMS if the ratio is above 1 or if the count of the T₄ is above 300/ml of blood.

Milder forms of the disease caused by the HIV virus such as AIDS Related Complex (ARC) and Lymphadenopathy Syndrome (LAS) are disqualifying. Persons with LAS without evidence of previous opportunistic infections may be [assessed as fit] by the AMS with frequent follow-up.

This aeromedical disposition however, might be changed if and when more information is gained about the tendency of the disease to develop pertinent symptoms. An airman who is HIV seropositive with symptoms is [to be assessed as unfit].

[AIDS is an absolute bar to flight duties because of the high risk of opportunistic infections, which can appear suddenly and cause acute incapacitation. The virus responsible for AIDS is called Human Immunodeficiency Virus (HIV). The criteria for the diagnosis of AIDS include

immunodeficiency with non-specific known cause, with a positive serologic or virologic test for HIV, a history of opportunistic infections and Kaposi's sarcoma.]

4 IMPAIRMENT OF THE IMMUNE SYSTEM (IMMUNE DEFICIENCY DISEASES)

Immune deficiency syndromes, whether congenital, spontaneously acquired, or iatrogenic, are characterised by unusual susceptibility to infection, and sometimes, to autoimmune disease and lymphoreticular malignancies. All cases must be assessed in conjunction with the AMS.

5 INFECTIOUS HEPATITIS

Jaundice, as a result of inflammation of the liver, may be caused by infections or toxic agents.

Active infectious hepatitis is incompatible with flying. [Fit assessment] may be considered by the AME in conjunction with the AMS after full clinical recovery and normal liver function tests.

For assessment see also paragraph 9 in the Chapter on Digestive System, and paragraphs [4.2.5 and 4.2.6] in the Chapter on Tropical Medicine.

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CHAPTER 9 - THE REPRODUCTIVE SYSTEM

1 INTRODUCTION

In the male abnormalities are usually associated with obstruction, infection and/or malignancy.

In the female the situation is rather more complex as a result of the menstrual cycle and pregnancy where a wide range of 'normality' occurs and which can incapacitate under certain circumstances.

2 MALE REPRODUCTIVE SYSTEM

2.1 Infection

Urethritis, prostatitis, epididymitis may be associated with acutely incapacitating or distracting discomfort. Purulent discharge and/or painful swelling will lead to medical consultation, diagnosis and treatment. The pilot must be assessed as temporarily unfit until symptoms have fully cleared and only medication acceptable to the AMS is being used.

2.2 Prostatic hypertrophy

Usually occurs over age 50 and affects micturition. A consultant opinion may be required when symptomatic, and is required after surgery or other treatment. The individual must be fully asymptomatic before returning to flying.

2.3 Testicular and prostatic malignancy

See oncological chapter for recommendations.

3 FEMALE REPRODUCTIVE SYSTEM

3.1 Menstrual disorders

Dysmenorrhoea or pre-menstrual syndrome requiring medication should be reviewed to ensure that there are no side effects. The use of oral contraceptives is acceptable, however, an initial trial should take place while the individual is not flying to ensure that side effects are minimal.

3.2 Gynaecological conditions

A variety of such conditions may have sufficient clinical symptoms to require specialist opinion. Any symptoms or conditions requiring such an opinion should be discussed with the AME and/or AMS before continuing to ensure that the condition and/or treatment is compatible with flying.

3.3 Gynaecological surgery

Major gynaecological surgery is disqualifying for a minimum of three months. The AMS may consider earlier recertification if the holder is completely asymptomatic and there is only a minimal risk of secondary complication or recurrence.

3.4 Breast pathology

Minor degrees of fibroadenosis causing discomfort is normally transient, however, if severe enough to cause restriction of movement while wearing a restraining harness while at the controls, a further opinion should be sought. (Carcinoma of the breast is considered in the oncological section.)

These assessments apply to Class 1 and Class 2

4 PREGNANCY

Pregnancy is a normal physiological process, however, major anatomical and hormonal disturbances are associated with it which increase the risk of incapacitation accordingly. [30-40%] of pregnant women bleed or have cramping pains some time during the first twenty weeks of pregnancy. [20%] spontaneously abort; the majority of these take place within the first trimester. Under these circumstances it is important that the supervising physician can confirm pregnancy and apparent normality before the pilot continues flying. The AMS shall provide written advice to the applicant and the supervising physician regarding potentially significant complications of pregnancy (see paragraph 4.1 below). Continuous antenatal care is vital to the early detection of abnormalities and so monthly assessments are required to maintain [aeromedical fitness] up to twenty six weeks. Beyond this point the incidence of gastro-intestinal disturbance associated with hormonal and anatomical displacement is such that even multi-pilot (Class 1 'OML') or safety pilot (Class 2 'OSL') operation may be compromised, and so a temporarily unfit assessment is appropriate.

The AMS may approve [fit assessment] of pregnant air crew for multi-pilot (Class 1 'OML'), single-pilot [(Class 2 'OSL')] operations during the first 26 weeks of gestation following review of the obstetric evaluation. Monthly obstetric reports are required.

4.1 Pregnancy and flying – information sheet

Pregnancy is a normal physiological process, however, major anatomical and hormonal disturbances are associated with it which increase the risk of incapacitation accordingly. The pregnant pilot must also consider the cumulative effects of pressure changes and radiation exposure upon the developing foetus although these are not of immediate flight safety concern.

As flying is a demanding task, changes which only normally cause inconvenience can have significant safety implications in a pilot. A pilot shall consider herself disqualified and should contact a specialist in aviation medicine if she feels unwell or if any of the following occur during the period when flying is permitted (up to 26 weeks).

- a Faintness, dizziness or vertigo.
- b Nausea or vomiting.
- c Anaemia (haemoglobin 10 g/dl or less).
- d Glycosuria or proteinuria (sugar or protein in urine).
- e Urinary tract infection.
- f Any kind of vaginal bleeding (including 'spotting').
- g Abdominal pain.
- h High blood pressure.

Two copies of this information sheet are enclosed. It may be helpful for you to give one to your supervising physician or midwife for inclusion in your notes. Further advice is available from (details of AMS for each Member State to be included here).

4.2 **Re-examination after pregnancy**

Following confinement or termination of pregnancy, the individual may be considered for [revalidation or renewal] after examination has been carried out to confirm involution has taken place (normally four to six weeks after confinement or termination).

5 MAJOR SURGERY OF THE REPRODUCTIVE SYSTEM

5.1 **Male**

Orchidectomy or other major testicular surgery must be assessed against the normal surgical criteria for aviation, even apparently minor surgical procedures, such as ligation of the vas deferens (vasectomy) may produce complications that require extensive grounding. Each case requires aeromedical assessment prior to continuing flying.

5.2 **Female**

Gynaecological procedures may vary greatly in extent, however, virtually all are potentially incapacitating and some require extensive periods of recovery (hysterectomy).

5.3 **Medical conclusion**

It is not possible to lay down specific guidelines for each procedure, however, accredited medical conclusion i.e. applicant's physician plus Aeromedical specialist under supervision of the AMS, should be able to agree suitable recovery periods. These must be based upon the aviation requirement of full physical strength and resistance to fatigue throughout all phases of flight and possible emergency conditions.

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CHAPTER 10 - THE MUSCULOSKELETAL SYSTEM

1 INTRODUCTION

The physical and functional musculoskeletal demands on pilots have changed considerably with the development of modern aircraft; where previously muscular strength was a necessity, the most important ability today is fine motor skills. The musculoskeletal requirements for air crew flying commercial aircraft and that for private pilots are the same (see JAR-FCL 3.200 and 3.320), but should be applied with due regard to the different demands of different categories of aircraft.

The general guidelines of fitness to be adopted when assessing the musculoskeletal system of an applicant are described in this chapter. These include the assessment of:

- a Any abnormality of the bones, joints, muscles and tendons, congenital or acquired, which is likely to interfere with the safe exercise of the privileges of the applicable licence.
- b Sufficient sitting height, leg and arm length and muscular strength.
- c Satisfactory functional use of the whole musculoskeletal system including all four limbs.
- d Significant sequelae from disease, injury or congenital abnormality with or without surgery.

The use of drugs [used for] the treatment of musculoskeletal disorders must be assessed in accordance with JAR-FCL 3.115 [(for further guidance see Chapter 19 Medication and Flying)].

The assessment of the musculoskeletal system will be discussed systematically, starting with the general inspection and examination of the whole body and continuing from the lower extremity upwards. The spine will be discussed separately.

2 BONES, JOINTS, MUSCLES AND TENDONS

A careful inspection should reveal any significant abnormality or deformity of the bony skeleton. X-ray examination, as required, will show the detailed structure and possible signs of disease or trauma. The inspection also shows major deformity of the muscles and tendons.

2.1 Lower extremity

a *Ankle and foot*

A good range and painless movement of the ankle and subtalar joints are essential for the safe management and control of aircraft. There are many conditions, e.g. [sequelae of] trauma or infection, that could impair []this function. Painful foot or ankle injuries caused by sporting activities are common problems. [They may require a temporary or long-term unfit assessment.] The [assessment of] the applicant's fitness to manoeuvre the aircraft will often require a medical flight test, either in a simulator or in the aircraft.

b *Knee*

The knee joint should be stable and there should be a minimum, painless, range of movement from 0 to 90°. The knee joint is probably most prone to injury. The development of the arthroscopic surgery has brought great improvements in diagnosis and treatment of common knee problems, e.g. a torn meniscus or []ligament or a loose intra-articular body. Recovery after arthroscopic surgery is also remarkably quick, enabling rapid return to flight duty only one to two weeks after operation.

c *Hip*

Osteoarthritis [or degenerative joint disease (in continental Europe often referred to as “osteoarthrosis)] is the most common hip disorder affecting older pilots. A minimum painless range of at least 90° of flexion from the extended position in the hip joint is required. Occasionally an applicant will present with signs of congenital hip dislocation (not treated adequately in the postnatal period) or of Legg-Perthes disease (slipped upper femoral epiphysis). These cases should be diagnosed and assessed according to the functional abnormality. Any orthopaedic surgical operation of the hip area will need post-operational physiotherapy, therefore a minimum period of three months [of temporary] unfitness will be required.

2.2 **Upper extremity**

a *Shoulder*

A good range of shoulder movement is essential for operating controls located in overhead panels and side consoles. Traumatic dislocations or fractures of the shoulder or the acromioclavicular joint are common sequelae of traffic accident and contact sports. These injuries are usually easily diagnosed and following proper conservative or surgical treatment the recovery is complete. Physiotherapy is often required to attain full mobility [and to regain full strength]. Habitual shoulder dislocation should be treated surgically because a painful dislocation while operating aircraft controls, especially in the overhead panel, could lead to inflight incapacitation.

b *Elbow*

The elbow is also prone to injury. A certain amount of restriction at the elbow joint may be acceptable because some impairment can be compensated for by the shoulder movement. Most elbow problems are caused by acute trauma. The restoration of adequate function should be possible with surgery and physiotherapy. Epicondylitis (tennis elbow) is caused by extended repetitive stress in the insertion point of forearm muscles. This can become chronic and should be properly treated from the beginning.

c *Hand and wrist*

The assessment of the functional capacity of the hand and fingers should be made with a good knowledge of the complex aircraft control manipulations required for safe flying. There should be no major impairment of the three basic types of functions of the hand:

- i to grasp cylindrical objects;
- ii to pinch by tip, pulp or by lateral pressure;
- iii to hook.

Complete intact sensibility and good finger and thumb movements on both sides are also essential for operation of computer displays and keyboards.

A person with an amputated thumb should also be evaluated by a medical flight test, otherwise a single finger amputation is usually of no concern.

2.3 **Static physical disability**

Many physically disabled pilots are able to compensate for their disability without a reduction in flight safety by a change in flying technique, a limb prosthesis, or the judicious use of assistance when on the ground. Whilst it is difficult to predict every possible problem a disabled individual may encounter when flying, or when undertaking flying-related tasks, there are some general principles which can be applied.

The pre-flight check must be accomplished adequately. A paraplegic pilot may not, for example, be able to visually inspect the fuel contents. In these circumstances, an assistant may aid the process. The assistant must be properly instructed as to how to carry out such a task. The applicant must also be able to exit the aircraft, without assistance. In the event of an emergency []he/she [must be capable to leave the aircraft him/herself without assistance and to assist passengers in evacuating the aircraft]. If this is not possible without assistance, the applicant may still be accepted as fit to fly solo, but with the limitation that passenger carrying is not permitted.

All controls must be operated safely using aircraft modifications and/or limb prostheses as necessary. Aircraft modifications must be checked for airworthiness by the relevant department [of the Authority] but prostheses do not normally need an engineering check, unless complete reliance on them is necessary. For example, a single upper limb prosthesis can be used to operate controls, but [in case of] malfunction in the air, a pilot could land a light aircraft using one arm only. In the situation of a double arm prosthesis, then the artificial limbs need to be assessed from the engineering viewpoint to ensure that they are reliable. Consideration needs to be given to pre-flight checking of such artificial aids.

Applicants may need [] a safety pilot [(Class 2 'OSL') limitation] in the initial training stages, depending on their disability and they will need to successfully pass a medical flight test before being permitted to fly solo. This should be undertaken by an experienced examiner and preferably one who has experience in assessing disabled pilots. The attendance of a medical officer at the medical flight test can be helpful. It may be necessary to apply operational limitations different from the normal aircraft limitations e.g. a more restrictive cross-wind limit, depending on the aircraft modification or prosthesis.

Flying instructors of disabled pilots should, ideally, be qualified in the use of any hand controls (in particular) or any other device which enables a disabled pilot to overcome his handicap. If this is not possible, then it is desirable that a small number of instructors gain experience in this area and become familiar with the different techniques required.

3 SPINE

[The spine consists of a column of vertebral bodies with inter vertebral discs capable of taking heavy loads.] A careful examination [of the entire spine] by inspection, palpation and x-ray ([only] when required) should be included in every assessment [examination].

Any deformity should be evaluated to identify the underlying cause, e.g. a congenital malformation, trauma, sequelae of disease or a neoplasm.

In the case of helicopter pilots, extra care must be taken due to the adverse effects of vibration and the [postural effects] of the flight controls. It may be necessary to X-ray the spine in order to evaluate congenital or acquired abnormalities which may be incompatible with helicopter flying.

3.1 Thoracolumbar spine

Any deformity of a vertebral body caused by spondylolysis or trauma (fracture) or the deformity of the [vertebral] column (scoliosis, [Scheuermann's disease] or spondylolisthesis) may interfere with the muscular balance leading to muscle spasm and pain. A leg length discrepancy or more than 15–20 mm is a common cause for muscular imbalance and [secondary] scoliosis.

The compression of a nerve root by a [prolapse of an] inter vertebral disc may also cause severe sciatic pain.

All cases of backache among aircrew should be carefully evaluated for possible anatomical origin.

Low back pain is very common in all occupations and in all age groups[, especially in sedentary occupations]. The connection between occupational stress and low back pain is not obvious, neither is the connection between clinical low back pain and abnormal x-ray findings.

3.2 **Cervical spine**

The cervical spine is anatomically different from the lumbosacral spine in that it may be subjected to far greater strain as the result of its mobility rather than from weight bearing. Whiplash injury is common in minor traffic accidents, causing painful soft tissue pain.

Degenerative changes at C4-C7 levels are commonly found in people younger than 40 years, care must be taken in considering these as a cause for brachialgia, muscle weakness and impairment of hand functions.

4 **OTHER CONSIDERATIONS**

4.1 **Sitting Height, Leg [and] Arm Lengths, Muscular Strength**

The sitting height, arm and leg length of an [initial] applicant should be evaluated bearing in mind the ergonomic requirements of the cockpit. The applicant must be able to reach readily and operate effectively all controls during both normal and emergency conditions. Special attention should be given to the applicant's ability to read all instruments including the HUD display and at the same time to reach the extreme positions of both rudder pedals and the hand controls. Because of different cockpit designs great variations in ergonomic requirements exist. A medical flight test is often indicated.

Muscular forces needed to operate aircraft controls vary greatly. Most switches and knobs can be moved with one finger and modern aircraft, using electric or hydraulic actuators, demand minimal hand or foot movement and muscular power. In older aircraft with wire-controlled ailerons, elevator and rudder muscular forces needed during normal flight are also moderate, but emergency procedures resulting in asymmetric flight may require considerable muscular strength. Any deficiency in muscular power of the applicant must be assessed taking into consideration the type of aircraft to be flown. A medical flight test is often indicated.

4.2 **Injuries and incapacitation**

Musculoskeletal injuries are common. They occur most often during leisure or sports activities or in traffic accidents. Muscle spasms due to distension of the muscle fibres cause temporary discomfort and heal rapidly.

A distortion of a major joint will result in [temporary unfitness] of 2–3 weeks. A ligament trauma may have to be operated upon which will require 4–6 weeks of immobilisation. Most fractures of the extremities will require at least six weeks of immobilisation. An assessment [is warranted] after convalescence [only] if a significant decrease in function is expected.

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CHAPTER 11 - AVIATION PSYCHIATRY

1 INTRODUCTION

This chapter will outline the major categories of psychiatric diagnoses and consider how those more commonly seen in aviators may influence the assessment of fitness for entry into a career in aviation, or for the continuation of flying duties in the established airman.

In the aviation community, psychiatric disorders, including alcoholism, represent the second most common medical reason for the loss of flying licences.

About 80% of all accidents and 60% of fatal accidents are due to human failure, a high proportion through some error of judgement.

Information processing and the capacity to make decisions and initiate a suitable response may be disturbed by psychiatric illness, organic mental illness resulting from brain injury or damage, infectious illnesses or the influence of drugs. Such disorders may be the cause of both acute or subtle incapacitation in flight. It is of paramount importance therefore, that any condition which might lead to such error is identified and investigated before air crew licensing is agreed.

Medical requirements for fitness of any given role are decided by the tasks to be performed in that role.

The aviator needs:

- a To be aware of his position in space – this requires an adequate sensory input, visual, auditory, proprioceptive etc.
- b The mental capacity to process this sensory information and to initiate the appropriate action to control the aircraft safely.
- c The necessary physical capacity to carry out the course of action decided upon.

The psychiatric requirements for [aeromedical] fitness are determined largely by the second of these tasks.

2 GENERAL PSYCHIATRIC REQUIREMENTS

Medical standards of mental fitness for all categories of air crew require that particular attention should be paid to the following:

- a psychosis;
- b personality disorders, especially if severe enough to have resulted in overt acts;
- c neurotic disorders;
- d alcoholism or alcohol misuse;
- e use or misuse of psychotropic drugs or other substances with or without dependency.

The applicant should have no established medical history or clinical diagnosis of any psychiatric disease or disability, condition or disorder, acute or chronic, congenital or acquired, which is likely to interfere with the safe exercise of the privileges of the applicable licence(s).

3 CLINICAL PSYCHIATRY IN AVIATION MEDICINE

There are several systems of classification used in psychiatry. While differing from one another in important ways all of them share similar principles. For detailed information on current classification of psychiatric illness, such as that of the International Classification of Disease (ICD10) and the American Psychiatric Association Diagnostic and Statistical Manual Classification (DSM IV), reference should be made to standard psychiatric text books.

For the purpose of this chapter a simplified but practical basic classification of mental disorders will be used and where classification indices are shown these are from ICD10.

Basic Classification of Mental Disorder
Personality disorders
Mental retardation
Neurotic, stress-related and somatoform disorders
Organic psychoses
Functional psychoses: schizophrenia, affective psychoses
Mood disorders
Disorders of adjustment
Other disorders
Disorders specific to childhood

In the various systems of classification, mental retardation and personality disorder are separated from mental illness. Mental retardation is present continuously from very early life, personality disorders being recognised from the end of adolescence.

Mental illness arises after a period of normality in adult life.

It should be noted that psychiatric disorders likely to be met in aviation personnel are limited to adult psychiatry and because of the nature of the training required it is axiomatic that an individual with significant mental retardation would be unlikely to consider, or be considered for entry into a flying career. Mental retardation and disorders specific to childhood will, therefore not be considered further in this chapter.

The mental illnesses in this classification are sub-divided into two major groups:

- a The neuroses, being evidenced by anxiety, depression, insomnia, obsessional thoughts etc., arising in a setting of unaltered contact with reality and whose symptoms are close to normal experience.
- b The psychoses, which are major mental illnesses are usually characterised by severe symptoms such as delusions and hallucinations and by a lack of insight. These are further divided into the organic and functional psychoses, the former presenting with a demonstrable physical abnormality, such as general paralysis of the insane, or delirium tremens. The functional psychoses have, to date, demonstrated no underlying physical cause and include schizophrenia and the affective psychoses.

4 DEFINITION OF SOME MENTAL AND BEHAVIOURAL DISORDERS

4.1 Disorders of adult personality and behaviour (ICD F60-F69)

These include a variety of conditions and behaviour patterns of clinical significance which tend to be persistent and appear to be the expression of the individual's characteristic lifestyle and mode

of relating to himself/herself and others. Some of these are evident early in the course of individual development, as a result of both constitutional factors and social experience, while others are acquired later in life.

The specific personality disorders discussed are deeply ingrained and enduring behaviour patterns, manifesting an inflexible response to a broad range of personal and social situations. They represent extreme or significant deviations from the way in which the average individual in a given culture perceives, thinks, feels and, particularly, relates to others. These patterns tend to be stable and to encompass a wide range of behaviour and psychological functioning. They are frequently, but not always, associated with varying degrees of the subjective distress and problems of social performance.

4.2 **Neurotic, stress-related and somatoform disorders (F40-F48)**

a *Phobic anxiety disorders (F40)*

A group of disorders in which anxiety is evoked only, or predominantly, in certain defined situations that are not currently dangerous. As a result these situations are characteristically avoided or endured with dread. Concern may be focused on individual symptoms, such as palpitations or faintness, and is often associated with a secondary fear of dying, losing control or going mad. Contemplating entry to the phobic situation usually generates anticipatory anxiety. Phobic anxiety and depression often co-exist.

b *Panic disorder (F41)*

The essential feature here is recurrent attacks of severe anxiety (panic) which are not restricted to any particular situation or set of circumstances and are unpredictable. There is often secondary fear of dying, losing control or going mad. The dominant symptoms, as with other anxiety disorders, include palpitations, chest pain, choking sensations, dizziness and feelings of unreality (de-personalisation or de-realisation).

c *Obsessive compulsive disorders (F42)*

The essential feature here is that of recurrent obsessional thoughts or compulsive acts. Obsessional thoughts are ideas, images or impulses that enter the individual's mind again and again in a stereotyped form. They are almost invariably distressing and the patient often tries unsuccessfully to resist them. They are, however, recognised as his/her own thoughts, even though they are involuntary and often repugnant.

Compulsive acts or rituals are stereotype behaviours which are repeated again and again. They are not inherently enjoyable nor do they result in the completion of inherently useful tasks. Their function is to prevent some objectively unlikely event which he/she fears might involve harm. This behaviour is recognised by the patient as pointless or ineffectual, and repeated attempts may be made to resist. Anxiety is almost invariably present. If the compulsive acts are resisted the anxiety gets worse.

d *Post traumatic stress disorder (F43.1)*

This arises as delayed or protracted response to a stressful event or situation of a brief or long duration, of an exceptional threatening or catastrophic nature which is likely to cause pervasive distress in almost anyone. This basic symptomatology is as described in the text.

e *Generalised anxiety disorder (F41.1)*

The anxiety that is generalised and persistent but not restricted to, or even strongly predominating in any particular environmental circumstances. The symptoms are variable but include complaints of persisting nervousness, trembling, muscular tension, sweating, light headedness, palpitations, dizziness and epigastric discomfort. Fears that the individual or a relative will shortly become ill, or have an accident, are frequently expressed.

f *Mixed anxiety and depressive disorder(F41.2)*

Anxiety depression or neurotic depression should be used when symptoms of anxiety and depression are both present but neither is clearly predominant and neither type of symptom is present to the extent that justifies a diagnosis, if each is considered separately.

4.3 **Schizophrenia, schizotypal and delusional disorders (F20-F29)**

The schizophrenic disorders are characterised in general by fundamental and characteristic distortion of thinking and perception, and affects that are inappropriate or blunted. Clear consciousness and intellectual capacity are usually maintained although certain cognitive deficits may evolve in the course of time.

The most important psychopathological features include thought echo, thought insertion or withdrawal, thought broadcasting, delusional perception and delusions of control, influence or passivity, hallucinatory voices commenting or discussing the patient in the third person, thought disorders and negative symptoms. The course of the disorder can be either continuous or episodic with progressive or stable deficit, or there can be one or more episodes with complete or incomplete remission.

Such a diagnosis should not be made in the presence of extensive depressive or manic symptoms unless it is clear that the schizophrenic symptoms antedate the disturbance of affect.

Schizophrenia should not be diagnosed in the presence of overt brain disease or during states of drug intoxication or withdrawal.(F06.2 and F10-F19).

4.4 **Mood (affective) disorders (F30-F39)**

These are disorders, in which the fundamental disturbances are a change in affect, or mood, to depression (with or without associated anxiety), or to elation. The mood change is usually accompanied by a change in the overall level of activity. Most other symptoms are either secondary to, or easily understood, in the context of the change in mood and activity. These disorders mostly tend to be recurrent and the onset of individual episodes can often be related to stressful events or situations.

a *Manic episodes (F30)*

1 Hypomania (F30.0)

A disorder characterised by persistent mild elevation of mood with increased energy and activity and usually marked feelings of well-being and both physical and mental efficiency. Increased sociability, talkativeness, over-familiarity, increased sexual energy and a decreased need for sleep are often present but not to the extent that they lead to severe disruption of work or result in social rejection. Conversely, irritability, conceit and boorish behaviour may take the place of the more usual euphoric sociability. These disturbances of mood and behaviour are not accompanied by hallucinations or delusions.

2 *Mania without psychotic symptoms (F30.1) and Mania with psychotic symptoms (F30.2)*

Here, mood is elevated out of keeping with the patient's circumstances and may vary from carefree, jovial to almost uncontrollable excitement. This elation is accompanied by increased energy, over-activity, pressure of speech and a decreased need for sleep. Attention cannot be sustained and there is often marked distractability. Self esteem is inflated with grandiose ideas and over confidence. Loss of normal social inhibitions may result in reckless, foolhardy and inappropriate behaviour.

In addition to the clinical picture described, delusions (usually grandiose) or hallucinations (usually voices speaking directly to the patient) may be super-added or the excitement,

excessive motor activity and flights of ideas, become so extreme that the subject is incomprehensible or inaccessible to ordinary communication.

3 *Bipolar affective disorders (F31)*

This disorder is characterised by two or more episodes in which the patient's mood and activity levels are significantly disturbed, this disturbance consisting on some occasions of an elevation of mood and increased energy and activity (hypomania or mania) and on others of a lowering of mood and decreased energy and activity (depression).

b *Depressive episodes (F32)*

In typical mild, moderate or severe depressive episodes the patient suffers from lowering of mood, reduction of energy and decrease in activity. Capacity for enjoyment, interest and concentration is reduced, and marked tiredness after even minimum effort is common. Sleep is usually disturbed and appetite diminished. Self-esteem and self-confidence are almost always reduced and, even in the mild form, some ideas of guilt or worthlessness are often present. The lowered mood varies little from day to day, is unresponsive to circumstances and may be accompanied by so-called 'somatic' symptoms, such as loss of interest and pleasurable feelings, waking in the morning several hours before the usual time, depression worst in the morning, marked psychomotor retardation, agitation, loss of appetite, weight loss and loss of libido. Depending upon the number and severity of the symptoms, a depressive episode may be specified as mild, moderate or severe.

4.5 **Organic, including symptomatic, mental disorders (F00-F09)**

This comprises a range of mental disorders grouped together on the basis of having in common a demonstrable aetiology in cerebral disease, brain injury or other insult leading to cerebral dysfunction. This may be primary as in disease, injuries and insults that affect the brain directly and selectively, or secondary, as in systemic disease and disorders that attack the brain only as one of the multiple organs or systems of the body that are involved.

5 **NORMAL MENTAL DEVELOPMENT**

The normal conscious mind experiences a continuing stream of thoughts the content of which is usually related to surrounding happenings. Those which concern us catch our attention; those which threaten us make us feel anxious; those which meet our needs are accompanied by feelings of pleasure. Without any external stimulus the thought stream may be occupied by memories of the past or projections into the future.

If needs or fears become extremely pressing they may monopolise the forefront of the mind crowding out images of the happenings around us.

There is gradual development from early life into individuals with well defined patterns of behaviour, some of which are clearly copied from parents and teachers. Personal aims, ambitions and codes of moral values develop which are adhered to with greater or less tenacity of purpose. This drive or motivation to succeed gives some indication of how the individual will behave under stress, those with poor motivation giving up the struggle more quickly in a crisis. From birth memories of experiences are stored and when meeting similar situations in the future allow the individual to choose a course which previously avoided discomfort and danger. With the development of adult reasoning powers it is sometimes in the individual's interest to choose an unpleasant or dangerous course. Such calculated risks run contrary to the instinct of self-preservation and cause transient anxiety. This anxiety, or mental tension, is an unpleasant state of mind which, if severe enough, induces the individual to abandon the dangerous alternative. Gradually, by trial and error, the normal developing individual learns how to modify ambitions and desires to his innate capabilities so that intolerable anxiety does not arise.

Mental resilience to anxiety varies from person to person and can be a very important measure of an individual's predisposition to psychiatric illness. In later life failure, and the depression it may cause, are equally important. Anxiety and depression in normal amounts are everyday mental experiences which guide our actions towards safety and contentment. If depression or anxiety becomes excessive, it may dominate the mind which then is no longer free to make rational decisions. In this state of mind a person is unfit for aviation duties.

There are three ways of dealing with anxiety:

- a The normal, healthy adult will naturally feel anxious when his safety is under threat. This anxiety increases in proportion to the degree of danger, being reduced by action aimed at decreasing the danger and disappears when this has been resolved. Re-exposure to the same threat will cause the same amount of anxiety or less.
- b The anxiety prone person will experience the anxiety for longer periods after exposure to danger and on subsequent exposure to a similar threat will feel anxiety for a longer period of greater intensity. If the tension induced becomes excessive and thus interferes with normal mental life, a neurosis has developed.
- c The individual who suffers from a personality disorder appears unwilling, or unable, to tolerate even normal amounts of mental stress. When subjected to anxiety he will behave in a way which removed him from the anxiety-promoting situation, even though his interest would be better served by accepting it for a short period. The anti-social personality will leave his job rather than tolerate temporary attention. The explosive (irritable) personality may well strike out in a rage whenever provoked, even though his interest would be better served by reacting calmly.

A point of distinction between the neuroses and the personality disorders being that neurosis develops against a background of normal mental life and cures are common, however, so are relapses.

A personality disorder is a chronic state dating from childhood or adolescence and is often referred to as emotional immaturity. The individual tends to learn neither from experience nor punishment and cure is rare. The prognosis is usually poor.

6 PREDISPOSITION TO PSYCHIATRIC DISEASE

It is important both for the Regulatory Authority and the Industry to identify and reject those wishing to enter a career in aviation who are suffering from or prone to, psychiatric illness.

Strong evidence of such predisposition is a history of previous psychiatric illness.

An inherent difficulty in psychiatric assessment is that a history of a past illness may not easily be obtained at the initial medical examination. Answers to questions may well be untruthful, evasive or coloured by what the applicant wishes us to believe. If the examiner is not fully satisfied with the answers given he should seek further information of the applicant's previous history from the family, the family doctor, the school or others for details of the applicant's previous history.

Adults who develop an anxiety or depressive reaction in one stressful situation are very likely to do so again when exposed to a similar stress.

Other indicators of a predisposition to a psychiatric illness are – a history of nail-biting, bed-wetting, sleep disturbances, psychosomatic disorders, a poor academic record, difficulty in mixing and making friends, frequent changes of employment on leaving school, anti-social behaviour (conflict with the law, alcohol excess, abuse of drugs, sexual deviation), significant mood swings or self-rating as being excessively prone to anxiety or marked feelings in inferiority and shyness.

Flight crew applicants who admit to one or more of the symptoms listed, especially if of significant severity or long-standing, require careful assessment which may well include a formal psychiatric consultation.

7 PSYCHOLOGICAL TESTING OF INTELLIGENCE

In its broadest sense intelligence may be defined as the ability to solve new problems through reasoning and a number of tests have been devised to measure this intelligence. Its relevance to aviation is primarily associated with the process of selection and training of new pilots.

Early in this century Alfred Binet devised a series of tests of varying difficulty which could discriminate between children of different ages. From a given score the mental age could then be calculated in terms of the chronological age for which the specific individual's performance was representative. These tests were further developed by Terman and the Stanford-Binet tests emerged. From these developed the notion of the intelligence quotient (IQ) defined as:

$$\text{IQ} = (\text{mental age} / \text{chronological age} \times 100).$$

Other widely used tests include the Wechsler Adult Intelligence Score (WAIS-R). Psychological testing of intelligence is accurate in skilled hands.

It is likely that an individual with an IQ below 90 will have a much greater than average difficulty in learning new and complex skills within a reasonable time, such as those required in aviation. Should the medical examiner consider an applicant's intelligence to be inadequate an IQ test should be administered.

In addition to the intelligence required to learn the theory of flight there is also a need for aptitude to learn the skills of flying. Test batteries giving scores on a range of aptitudes are available and are often used in vocational guidance and acceptance.

As well as the foregoing it should always be remembered that human performance cannot be accurately predicted merely by measuring ability. It is always important to consider the forces that incite the individual to aim for a particular goal.

A high level of motivation and determination will often overcome some minor deficiencies in the foregoing characteristics.

8 PSYCHOLOGICAL TESTING OF PERSONALITY

Personality testing is on a less secure footing than that of intelligence. There are numerous factors that contribute to the make up of the individual personality so it is not surprising that personality testing is less reliable. A great range of tests are available using widely different techniques. The better known are the Maudsley Personality Inventory (MPI) and the Minnesota Multiphasic Personality Inventory (MMPI). Other projection tests are available, such as those of Rorschach, Sentence Completion Tests and Thematic Apperception Tests (TAT). Competently administered these may add weight to a clinical diagnosis, but unlike IQ tests they are not diagnostic in their own right. Psychological testing is discussed further in the Aviation Psychology Chapter.

9 PERSONALITY DISORDERS (F60-F69)

Personality disorders are always troublesome and are more likely to cause administrative or operational problems rather than frank medical problems. They imply lasting, deeply ingrained, inflexible behaviour patterns which, if severe enough, impair social interactions or produce symptomatic subjective distress in response to external stressors. In lesser form these are

referred to as personality traits which exist for years in the 'odd', non-conforming personality and do not cause severe problems.

The majority of mankind learns to conform to society's norms by means of the example set by parents, teachers, religious precepts and fear of punishment. A small number fail to integrate one or more of their anti-social tendencies and retain their childhood selfishness, aggression, timidity or sexual deviation. Neither punishment nor persuasion seem to help such individuals to conform socially. This condition is called a personality disorder and differs from the neurotic reactions by being a steady state dating from early life, while a neurotic illness has a more definite and identifiable onset and termination.

The term 'personality' refers to the enduring features an individual shows in his way of behaving in a wide variety of circumstances. Some of personality features may make an individual more vulnerable to the development of neurotic illness when facing stressful situations. Those who have always worried over minor problems are more likely to develop an anxiety state when faced with difficulties that would not affect another person in the same way. With such a degree of vulnerability in the personality, abnormal behaviour occurs only in response to stressful events.

In more abnormal personalities unusual behaviour may occur even in the absence of stressful events. Some personalities are obviously very abnormal, for example, those of a violent and sadistic nature who repeatedly harm others yet show no remorse. There is no agreed classification of such disorders.

There are other personality traits which predispose to certain psychotic and neurotic illness, thus the 'schizoid' and 'cyclothymic' personalities may culminate in schizophrenic illness, mania and depression. The 'paranoid' personality may develop a true paranoid reaction, the 'obsessive-compulsive' personality often developing an obsessive or compulsive neurosis. However, the existence of such traits does not imply a certainty that psychiatric illness will necessarily occur, but if such people do become psychiatrically ill they are likely to develop the illness suggested by their personality type. Such personality traits, which predispose to psychiatric illness, are mentioned in the various descriptions of psychiatric syndromes and will not be described as separate entities.

Those personalities which are important in the context of this chapter are also called 'sociopathic'.

9.1 Sociopathic personality disorders

a *Dissocial personality disorder (F60.2)*

Persons with this disorder show a bewildering variety of abnormal features. Basically four features are usefully recognised. A failure to make loving relationships, lack of guilt, impulsive actions and a failure to learn from past experience. The individual is self-centred and heartless. This lack of feeling is in marked contrast to a usually superficial charm. Marriage is marked by a lack of concern for the partner, sometimes violence, and many end in separation or divorce.

Impulsive behaviour patterns are reflected by an unstable work record, often with frequent dismissal, the whole pattern of the individual's life lacks any plan or goal. Offences against the law often commence in adolescence with petty acts of larceny, lying, truancy and vandalism. Some violent, dangerous and incorrigible criminals are representative of this group. This diagnosis includes sociopathic personality disorder, associal or antisocial personality disorder.

Alcohol and drug abuse makes such behaviour patterns more extreme.

b *Emotionally unstable personality disorder (F60.3)*

People with this disorder cannot adequately control their emotions and are subject to sudden and unrestrained outpourings of anger. These outbursts may also include physical violence leading at times to serious injury. Unlike the dissocial personality this group does

not have other difficulties in their relationships. This personality disorder includes explosive personality disorder. There are two types: impulsive type (F60.30) and borderline type (F60.31).

c *Dependent personality disorder (F60.7)*

People with this disorder appear weak-willed and unduly compliant, passively falling in with others wishes. They avoid responsibility and lack self reliance. Some are more determined but achieve their aims by relying upon other people's assistance while protesting their own helplessness. Some drift down the social scale, others may be found among the long term unemployed and the homeless.

9.2 **Sociopathic personality disorders and fitness for aviation duties**

From the preceding brief description of a representative group of sociopathic personality disorders it should be abundantly clear that an individual with such a disorder must be assessed as unfit for any class of flying licence. The great majority of those with personality disorders are unresponsive to any form of treatment and once the applicant is deemed unfit because of such a disorder, the decision should be permanent.

The initial assessment of such a disorder is critical and often difficult for the non-specialist. Significant indicators for sociopathic personality disorder may be found in a family or personal history of repeated clashes with the law, of drug dependence, of alcoholism, of gross immorality or serious psychiatric illness. Disregard for society's rules is a cardinal symptom and this may be manifested in their childhood by truancy from school, acts of cruelty, of prosecutions in juvenile courts, while in adult life alcoholism, drug dependence, sexual perversion, frequent court appearances or violent outburst are similar evidence.

The most difficult evaluations are of those who have never clashed with the law but who have been unreliable or inadequate throughout their lives. Where there is suspicion or established evidence that an applicant suffers from a personality disorder, he should be referred for psychiatric opinion and advice.

10 **NEUROTIC, STRESS RELATED AND SOMATOFORM DISORDERS (F40-F48)**

Neurotic, stress-related and somatoform disorders have been brought together in one large group because of their historical inter-relationships and the association of many of them with psychological stress.

The diagnostic categories included within this section of neurotic stress-related and somatoform disorders are referring to the phobias, panic attacks, obsessive-compulsive disorders, post traumatic stress disorders and generalized anxiety disorders.

The various forms of clinical depression of mild or moderate degree are also included except those with psychotic features such as delusions (see paragraph 11.1 b below).

A mixture of symptoms is common, especially the ones of depression and anxiety. In this situation it is usually best to try to decide which is the predominant symptom for diagnostic purposes.

Somatoform disorders include somatization disorders, hypochondrial disorders, somatoform autonomic dysfunctions.

Dissociative (conversive) disorders include amnesia, fugues, stupor, multiple personality and other similar situations; these are totally incompatible with any form of flight status and will not be considered further in this chapter.

Anxiety is the chief characteristic of the neurotic disorders. Depression, mild or moderate in degree, also occurs in some neuroses.

a *Generalized anxiety disorder (F41.1)*

The individual complains of increased anxiety which makes life uncomfortable. The anxiety usually covers many things such as health, money or safety. This anxiety state may be acute and short-lived, or chronic – of lower intensity and more prolonged. Anxiety leads to over-arousal causing difficulty in falling asleep and nocturnal restlessness. Because worries keep crowding into the forefront of the mind concentration becomes impaired, prevents the proper retention of information, leading to a complaint that the memory is failing. Irritability with colleagues at work especially at home after work, and associated tension headaches, worse towards the end of the day are common.

The illness can often be traced to an identifiable stress, such as money difficulties or domestic friction. The prognosis for cure may be gauged from the history.

If there has been a previous psychiatric illness, a marked predisposition to neurosis, and if the precipitating cause cannot be permanently corrected, the chance of a permanent cure is not great.

If, however, the neurosis was precipitated by maladjustment to a situation which is capable of correction, the prognosis is good.

Such anxiety states usually occur in people who are markedly prone to anxiety and are relatively rare among flight crew.

Anxiety states in flying personnel are more commonly confined to one specific aspect of flying, such as fear of flying in cloud or high altitude flying. Such a localised anxiety is called a phobic anxiety neurosis, in contrast to the general anxiety neurosis where the anxiety is much more diffuse.

b *Phobic anxiety disorders (F40)*

Many normal people have aversions to certain objects, notably snakes and spiders, which date from childhood and have not been caused by any actual frightening experience. Other than avoidance, these illogical fears cause little interference with the individual's life. They have usually been present since early life and become less intense with age.

A phobic disorder is a much more intense and incapacitating fear, again frequently illogical, which interferes with the individual's life to such an extent that medical aid is often sought. A common example is claustrophobia (a specific phobia), or a fear of entering enclosed space, the act of so doing or even the thought of so doing, causing apprehension, faints, palpitations, sweating, nausea, tremor and panic.

The phobic disorder is an acquired anxiety neurosis confined to one specific situation and is relatively common among flight crew. Early experiences in flying training or the stress of flying training may sometimes cause a generalised anxiety state in individuals with a low threshold for anxiety. Trained and experienced flight crew with a high anxiety threshold, occasionally develop significant anxiety about a single aspect of flying. There are potentially many experiences which may precipitate such a phobic disorder and if of sufficient intensity may, in a vulnerable individual, require that his career is terminated.

A special form of phobic anxiety disorders is flying phobia.

c *Panic disorder (episodic paroxysmal anxiety) (F41.0)*

The essential feature is recurrent attacks of severe anxiety (panic), which are not restricted to any particular situation or set of circumstances and the attacks are therefore unpredictable. The dominant symptoms include a sudden onset of palpitations, chest pain, choking sensations, dizziness and feelings of unreality (depersonalisations or derealisation).

d *Obsessive-compulsive disorder (F42)*

An obsession is a thought or urge to undertake a specific action which recurs repetitively and insistently in the mind. When this type of symptom becomes so persistent that it interferes with normal mental life and activities the illness is an obsessive neurosis. These obsessions may take many forms. Some sufferers must dress according to a strict ritual which, if broken, demands that it is started again from the beginning. If the basis is a fear of dirt or contagion the individual may feel compelled to wash the hands each time anything is touched. In the extreme form can waste so much time that normal work becomes impossible. Such symptoms are most often seen in those individuals with a meticulous perfectionist or rigid personality. Because such symptoms often date from early life and are usually resistant to treatment this disorder can usually be identified at the initial medical examination and the individual excluded from training.

e Reaction to severe stress and adjustment disorders (F43.0, F43.1, F43.2)

1 Acute stress reaction (F43.0)

That is a transient disorder that develops in an individual without any other apparent mental disorder in response to exceptional physical and mental stress and which usually subsides within hours or days.

2 *Post traumatic stress disorder (F43-1)*

As the name implies this neurosis arises in response to an overwhelming event outside of normal human experience. Emotional and psychiatric adjustment to such a mishap can be significantly disturbed in a variety of groups of individuals directly or indirectly involved in the event.

- i Those directly involved in aircraft accidents/incidents – the crew, cabin staff, passengers and those involved immediately on the ground.
- ii Professional disaster workers – police, ambulance personnel, fire fighters, hospital staff etc.
- iii Relatives and friends of those involved.
- iv The community – witnessing or involved in the incidents and also supervisors, leaders and co-workers who may feel some responsibility or guilt.
- v The emotionally unstable who over-identify.

Symptoms may arise at any time after the event, sometimes many years afterwards. There is always a vivid memory of the event with flashbacks continually intruding into consciousness.

The disorders in this section are thought to arise always as a direct consequence of acute severe stress or continued trauma. These disorders can be regarded as maladaptive responses to severe or continued stress, in that they interfere with successful coping mechanisms and therefore lead to problems of social functioning.

Predisposing factors, such as personality traits (e.g. compulsive, asthenic) or previous history of neurotic illness may lower the threshold for the development of the syndrome or aggravate its course but they are neither necessary nor sufficient to explain its occurrence. Typical features include episodes of repeated reliving of the trauma in intrusive memories (“flashbacks”), dreams or nightmares, occurring against the persisting background of a sense of “numbness” and emotional blunting, detachment from other people, unresponsiveness to surroundings, anhedonia and avoidance of activities and situations reminiscent of the trauma. It usually starts with autonomic hyperarousal with hypervigilance and enhanced startle reaction and insomnia. Anxiety and depression are commonly associated with the

above symptoms and signs, and suicidal ideation is not infrequent. The onset follows the trauma with a latency period that may range from a few weeks to months. The course is fluctuating but recovery can be expected in the majority of cases. In a small proportion of cases the condition may follow a chronic course over many years with eventual transition to an enduring personality change (F62.0).

Alcohol and substance abuse may occur as a secondary phenomenon in a misguided attempt to lessen the symptomatology.

Risk factors for the development of a disorder include the nature and intensity of the stressors, the nature of the involvement (direct or indirectly as a witness). There is no sex difference but older age groups would appear to report an increased incidence of anxiety symptoms. Previous exposure to disaster, such as the case of ambulance/medical staff, may help to avoid the development of symptoms, but this is not invariably so.

The goal of intervention must be to limit symptoms and return individuals to normality as quickly as possible by attending to these emotional reactions. Education into the normal emotional reaction to physically and emotionally traumatic experiences is very important. Victims should be made aware of the range of reactions which may occur and should be clearly warned about the risk of increasing drug and alcohol use, of memory and cognitive disturbances and of intrusive thoughts. Encouragement to ventilate their experiences by 'talking through' seems important.

Most victims respond well to these simple measures but a proportion not responding will need formal psychiatric counselling and possibly medication.

The use of beta blockade and anti-depressive medications, together with psychotherapy offers considerable hope of alleviation of symptoms.

The importance of this stress reaction in aviators lies not only in the symptomatic disorders described above but the very real potential for the development of loss of confidence in, and a fear of flying. Such a development would almost certainly lead to disqualification from continuing certification in a high proportion of such individuals. The role of the airline medical officer, the authorised medical examiner and the psychiatric services, is paramount in such situations.

3 *Adjustment disorders (F43.2)*

The manifestations vary and include depressed mood, anxiety or worry in a mixture of this, a feeling of inability to cope, as well as some degree of disability in the performance of daily routine.

f *Dissociative (conversion) disorders (F44)*

These disorders have previously been classified as various types of "conversion hysteria" but nowadays it is found more appropriate to avoid the term "hysteria" because of its various meanings.

The common themes that are shared by dissociative or conversion disorders are a partial or complete loss of the normal integration between memories of the past, awareness of identity and immediate sensations and control of bodily movements, as well.

They are presumed to be psychogenic in origin, being associated closely in time with traumatic events, insoluble and intolerable problems or disturbed relationships. The symptoms often represent the patient's concept of how a physical illness would manifest. Medical examination and investigation do not reveal the presence of any known physical or neurological disorder. In addition there is evidence that the loss of function is an expression of emotional conflicts or needs. The symptoms may develop in close relationship to psychological stress, and they often appear suddenly. These symptoms can be classified in two groups:

i conversion symptoms – a loss of bodily function solving the patient's dilemma. There are dissociative motor disorders including aphonia, disphonia; dissociative convulsions, dissociative anaesthesia and sensory loss;

ii dissociative reactions, an alteration of consciousness such as loss of memory usually of important recent events (dissociative amnesia) or dissociative fugue, dissociative stupor, etc.

These disorders occur in highly emotional, over-dramatic individuals.

g Somatoform disorders (F45)

The main feature is a repeated claim and presentation of assumed physical symptoms together with persistent requests for medical investigations, in spite of repeated negative findings and reassurances by doctors that the symptoms have no physical basis. The individual shows a refusal to discuss the possibility of a psychological cause, even if the symptoms onset and evolution prove a close relationship to unhappy life events or hardships and conflicts.

With this kind of disorders there is a behaviour or focusing on catching the attention of the people around; it is common that the individuals have an acute feeling of their incapacity to persuade the physicians about the somatic nature of their illness and the need of a new investigation.

Somatoform disorders include:

1 Somatization disorder (F45.0)

The main features are multiple, recurrent and frequently changing physical symptoms that have persisted many years before the individual's coming to the psychiatrist.

The symptoms can affect each part of the body, nevertheless, the most common sensations are gastrointestinal ones (pain, feeling bloated and full of gas, regurgitation of food, nausea, vomiting) and skin symptoms (unpleasant numbness or tingling, burning sensations, itching). Sexual and menstrual complaints are also common.

The course of the disorder is chronic and fluctuating and is often associated with disruption of social, interpersonal and family behaviour.

2 Hypochondrical disorder (F45.2)

The essential feature is a persistent preoccupation with the possibility of having one or more serious and progressive physical disorders. The individuals show persistent somatic complaints or a persistent preoccupation with their physical appearance.

Normal or commonplace sensations are often considered by these individuals as abnormal and distressing, and attention is usually focused upon only one or two organs or systems of the body. Marked depression and anxiety are often present and may justify additional diagnosis.

There is persistent refusal to accept medical reassurance that there is no real physical cause for the symptoms in discussion.

3 Somatoform autonomic dysfunction (F45.3)

Symptoms are presented by the individual as if they were due to a physical disorder of a system or organ that is largely or completely under autonomic innervation and control, i.e. the cardiovascular, gastrointestinal, respiratory and urogenital systems.

The most common and significant complaints are the ones referring to the cardiovascular system (cardiac neurosis or Da Costa's syndrome or neurocirculatory asthenia), to the respiratory system (hyperventilation, psychogenic cough), to the

gastrointestinal system (gastric neurosis, neurotic diarrhoea, irritable bowel syndrome, flatulence) and also to the urogenital system (dysuria and increased frequency of micturition).

The symptoms are usually of two types neither of which indicates a physical disorder of the organ or system concerned. Firstly, there are complaints based upon objective signs of autonomic arousal, such as palpitations, sweating, flushing, tremor and expression of fear and distress about the possibility of a physical disorder. Secondly, there are subjective complaints of a non-specific or changing nature, such as fleeting aches and pains, sensations of burning, heaviness, tightness and feelings of being bloated and distended, which are referred by the individual to a specific organ or system.

h Neurasthenia (F48.0)

In many countries neurasthenia is not generally used as a diagnostic category. Many of the cases so diagnosed in countries where this diagnostic is in use would probably meet the current criteria for depressive disorder or anxiety disorder. They are however, individuals whose symptoms fit the description of neurasthenia better than that of any other syndrome, and such cases seem to be more frequent in some cultures than in others.

With neurasthenia there is a variety of unpleasant physical feelings such as: dizziness, tension headaches, feeling of a general instability, irritability, anhedonia, sleep disturbance, worry about decreasing mental or bodily well-being.

i Dysthymia (F34.1)

In this form of a chronic depression, lasting at least several years, there is much in common with the concepts of depressive neurosis and neurotic depression.

It is characteristic for dysthymia that the duration of the depressive mood episodes is not long enough duration to justify a diagnostic of severe, moderate or mild recurrent depressive disorder (F33). Periods of normal mood rarely last for longer than a few weeks.

10.2 [Aeromedical] Assessment of neuroses

a *The initial applicant*

The medical examiner has a great responsibility in evaluating an applicant's fitness to train for a career in professional aviation. The cost to the individual in learning to fly is considerable and the investment of an employing airline into further training employees is vast. The examiner has to decide not only upon the individual's fitness at the time of the examination but must also try to form an opinion and give advice concerning the likelihood of the applicant remaining fit to fly for some years to come.

A decision about psychiatric fitness for flight crew training must be based upon the history of the applicant and that of his family. A history of childhood neurotic traits, or a family history of psychosis should lead to very careful scrutiny.

If the applicant has suffered a psychiatric illness of significant severity requiring a period, or periods, of psychotropic medication, or has required admission to a psychiatric hospital or undergone prolonged out patient care, he should normally be [assessed as unfit] for both commercial flying and air traffic control duties. (Referral for formal psychiatric assessment may allow a [fit assessment for a] private pilot [] in certain circumstances.)

In all cases it is important that the consultant psychiatrist should be familiar with the aviation environment[, if] such advice is sought.

Some indicators of predisposition to psychiatric illness were discussed earlier in this chapter, and should a group of these be evident at the initial interview it would be wise to seek further specialised advice before making a final decision[].

b *Established flight crew*

The established pilot has proved himself to be competent by successfully completing flying training. The decision as to his suitability to maintain a [medical certificate] may, therefore, be considered more sympathetically than is the case with the initial applicant.

- i During the acute phase of any neurotic illness the presence of anxiety or depression is likely to interfere with decision making and the individual must be assessed as [temporarily] unfit to follow his profession until there has been full recovery.
- ii The use of psychotropic medication to treat psycho neurotic illness is incompatible with aviation duty and while any form of major or minor psychotropic drug [aeromedical fitness is deemed to] be suspended. This suspension must remain in force until a suitable period has elapsed following the cessation of medication to ensure that stability is maintained.
- iii A single episode which clears completely in less than three months should be considered compatible with a return to flying.
- iv A protracted illness with poor response to treatment or characterised by relapses will normally lead to permanent [unfit assessment].

11 THE PSYCHOSES

The psychotic disorders present with gross impairment of the individual's ability to perceive reality and are usually characterised by severe symptoms of delusions, hallucinations and total lack of insight.

11.1 Functional psychotic disorders

Include such disorders as schizophrenia, delusional disorder, acute and transient psychotic disorders, mood disorders, bipolar affective disorder (manic-depressive psychosis) paranoid disorders and others. A history of, or the occurrence of, such disorders should be considered permanently disqualifying for any class of [medical certificate], unless in certain rare cases a cause can be unequivocally identified as one which is transient, has ceased and will never recur. While such judgement may be difficult at times the decision should always err on the side of caution. Some psychoses permanently change the personality so that following recovery or remission the individual remains unfit for flying by reason of the personality damage. The functional psychoses may also recur without warning and for this reason a history of even a single attack must be permanently [disqualifying].

a *Schizophrenia, schizotypal and delusional disorders (F20-F29)*

1 Schizophrenia (F20)

Schizophrenia is characterised by a loosening of the bonds between the different aspects of mental life. Mood, memory, perception, motor activity, reality, language and thinking cease to be co-ordinated. There is a severe interference with thought processes and eventual disorganisation of the personality.

The symptoms that occur in schizophrenia are numerous and include delusions, visual and auditory hallucinations, thought blocking, feelings of being controlled by outside influences (radio, television, telepathy etc.) and blunting of emotion, all arising in a setting of clear consciousness.

More important than the individual symptom, or symptom-complex, is the change in personality of which the patient is often aware, with a loss of emotional warmth, an air of secrecy or unexplained mood fluctuations. When fully developed it is no longer possible to establish a close rapport with the patient who usually prefers to remain in isolation. Others may be restless with inappropriate affect, with smiling or grimacing, or assume odd and long sustained posturings, such as occur in the catatonic variant.

Schizophrenia is the most frequent cause of admission of the young adult to psychiatric hospitals and its highest incidence occurs between 17 – 25 years for men and 25 – 35 for females. In recent years treatment with phenothiazines and other psychotropic drugs has greatly improved the prognosis and the florid may remit with treatment. Nevertheless such a diagnosis, once made, must, as stated above, be [disqualifying for all classes of medical certificates].

Schizotypal disorder (F21)

A disorder characterised by eccentric behaviour and anomalies of thinking and affect which resemble those in schizophrenia, although no definite and characteristic schizophrenic anomalies occur at any stage.

3 Persistent delusional disorders (F22)

The major symptom in this group is a conviction of persecution and unlike the paranoid reaction in schizophrenia, where reason is clearly affected, the paranoid reaction occurs in a setting of clear sanity. The paranoid reaction is elaborate and frequently starts with a belief that some inner personal secret has been discovered and made public so that passing strangers and acquaintances know of it, or the individual may become convinced that his failure to attain promotion is due to victimisation by his superiors. The key symptomatology is that of an over-valued idea in an otherwise rational being. Logical argument does not enable them to see that their views are wrong and much time and money can be wasted on repeated lawsuits in an effort to prove the correctness of their viewpoint. This includes: paranoia, paranoid psychosis, paranoid state, paraphrenia and Sensitiver Beziehungswahn. Such a condition is very resistant to treatment and the individual who develops such a psychosis is most unlikely ever to be [assessed] as fit[].

4 Acute and transient psychotic disorders (F23)

This is a heterogenous group of disorders characterized by the acute onset of psychotic symptoms such as delusions, hallucinations and perceptual disturbances and by a severe disruption of behaviour. Acute onset is defined as a crescendo development of a clearly normal clinical picture in about 2 weeks or less. An abrupt onset within 48 hours is possible.

b **Mood (affective) disorders (F30-F39)**

These disorders are severe illnesses in which the primary symptoms are excess of sadness or joy. These illnesses tend to recur, often periodically, but with a complete return to normality between the attacks.

Some individuals will have no more than a single depressive illness in their life, from which a complete recovery is possible. The dilemma for the AMS is to identify those who will make a full recovery and never relapse.

If the patient has hitherto been free of excessive mood swings and if the depression follows a non-recurring stress, such as death of a close relative etc., the prognosis for freedom from further attacks is good.

The occurrence of even a single attack of a hypomanic or manic illness must [be disqualifying for all classes of medical certificates], whether or not the condition has been controlled by medication.

1 Manic episodes (F30)

In manic-depressive illness (manic type (F30)) which is much more rare, the patient becomes over active and joyful. There is a bounding self confidence and a feeling that any task could be capably tackled, even those well outside of the individual's

normal province. The increase in energy and drive leads to reduction in sleep and judgement is very severely impaired by a complete loss of self critical faculties.

2 Bipolar affective disorder (F31)

Synonyms are manic-depressive illness or manic-depressive psychosis. There are 2 or more episodes in which the patient's mood and activity levels are significantly disturbed (hypomanic, manic, depressed or mixed).

3 Depressive episode (F32)

In manic-depressive illness (depressed type (F32)) energy is reduced and gloom is profound. Sleep may be significantly impaired and early morning waking and rumination is common. Delusional symptoms, usually of guilt or impending doom, may occur and suicidal intentions may arise in the most severely affected. Reason is otherwise not impaired although the stream of thought may be significantly slowed.

4 Recurrent depressive disorder (F33)

This disorder is characterized by repeated episodes of depression as described for depressive episode (F32) without any history of independent episodes of mood elevation and increased energy (mania).

5 Cyclothymia (F34.0)

Cyclothymic disorder is symptomatically a mild form of bipolar disorder, characterized by episodes of hypomania and mild depression.

A persistent instability of mood involving numerous periods of depression and mild elation, none of which is sufficiently severe or prolonged enough to justify a diagnosis of bipolar affective disorder (F31) or recurrent depressive disorder (F33).

12 Organic (including symptomatic mental) disorders (F00-F09)

Organic mental illnesses are characterised by psychiatric disturbances occurring in response to an identifiable physical cause, such as infections, metabolic disturbances, head injuries, psychoactive substances or degenerative disorders. In such illnesses the prognosis for an eventual return to aviation duties is entirely dependent on the complete resolution of psychiatric disturbances following the resolution of the physical cause.

a *Acute organic brain syndromes*

These are characterised by clouding of the mind, delirium, fleeting hallucinations and shortlived delusions. These may occur in the course of overwhelming infections such as pneumonia, enteric fever or meningitis and encephalitis.

They may occur in the course of acute toxic states induced by alcohol (delirium tremens), psychoactive drug abuse and are common following severe head injuries and multiple traumatic injuries.

Disorders of thyroid function and other endocrine disorders may also induce acute or sub-acute organic psychotic symptoms as may the therapeutic use of corticosteroids.

When the cause of such an acute disorder is clearly identifiable, is responsive to treatment and is non-recurrent, a return to aviation duties may be [considered for] all classes of [medical certificates]. This will, however, be dependent upon demonstration of complete physical and mental recovery which will involve psychiatric and psychometric assessment.

(Such disorders arising as a result of alcohol or psychoactive drug abuse require very special consideration as outlined in paragraph 14 below.)

b *Chronic organic brain syndromes*

These arise where there is progressive and irreversible destruction of brain tissue and are characteristically associated with intellectual impairment, impaired judgement, loss of recent memory, disorientation of time and space and loss of drive and emotional control.

Such changes are 'normal' in extreme old age (senile dementia (F00-1)) but can occur in the younger age group (pre-senile dementia (F00-0)) and are characterised by a history of affective disturbance, with decreasing ability to learn in everyday activities, or in psychological tests and marked inconsistency in performance. The diagnosis is difficult and may be mimicked by other illness, notably depressive syndromes, alcohol or drug induced organic brain syndromes etc.

Such dementing disorders are also seen in association with defined psychiatric syndromes, such as Alzheimer's disease, cerebral syphilis (GPI), Huntingdon's chorea, Creutzfeld-Jacob and Pick's disease.

Cerebral atheromatous disease and slow growing lesions, occupying cerebral space may also cause dementia and produce a similar psychiatric picture.

[All] of these progressive dementing disorders [are disqualifying for all classes of medical certificates].

13 Post traumatic psychiatric disorders

Impairment of consciousness occurs after all but the mildest closed head injuries, but is less common after penetrating injuries. The cause is uncertain, but is probably related to rotational stresses within the brain causing neuronal fibre shearing.

After severe head injury there is often prolonged phase of confusion and sometimes behaviour disorder, disturbance of mood, hallucination, delusions and disorientation.

On recovery of consciousness defects of memory are usually apparent. The period of post traumatic amnesia (PTA) is the time between the injury and the resumption of normal continuous memory. The duration of amnesia is closely correlated with:

- a neurological complications such as motor disorders e.g., epilepsy, dysphasia, and persistent deficits in memory; and
- b psychiatric disability and generalised intellectual impairment and possibly a change of personality.

When head injuries are followed by post traumatic amnesia of more than 24 hours they are likely to give rise to persisting cognitive impairment proportional to the amount of brain damage sustained. Following a closed head injury, this may vary in severity, from slight defects becoming apparent only during intellectually demanding activities, to obvious dementia. Personality change is particularly likely after frontal lobe damage and there may be some coarsening of behaviour, irritability, lack of drive and, occasionally, loss of control and aggression.

The above changes may improve gradually with time and require very careful and informed psychiatric and neurological assessment.

14 Immunological disorders

Impaired immune function may affect the CNS and alter its function. CNS, auto-immune and viral processes, in association with systemic or neurological disease may induce neurological,

behavioural or neuro-psychological impairment. Such phenomena may classically be seen in CNS involvement in systemic lupus erythematosus (M32), multiple sclerosis (G35) and HIV disease (B22).

The various systematic disorders associated with SLE and MS will, in the majority of cases, [be disqualifying for all classes of medical certificates].

15 HIV disease (B22-0)

Neuropsychiatric and psychosocial disorders are among the most common complications seen in HIV disease and are the most likely to have an adverse impact on the maintenance of medical certification in the aviator. The medical management of the individual is the responsibility of the relevant specialist, but in the light of current knowledge the following guidelines are suggested for aeromedical management.

a *Initial diagnosis*

At initial diagnosis, stress disorders, anxiety and reactive depressive disorders may arise. These are normally transient but may require active psychiatric support.

The possibility of serious suicidal intent is high, as is the possibility of substance abuse. Careful monitoring and counselling during this period will almost certainly be required and it would be wise to suspend [a medical certificate] at least temporarily.

b *Subsequent assessment*

A long relatively symptom-free period follows the initial infective illness, the individual looking, feeling and performing well and for all practical purposes is well. During this period which may last for a number of years, it would seem possible to maintain [a fit assessment] with the proviso that very strict follow-up is instituted, with both physical and psychiatric assessment at regular intervals of no greater than six months duration. [A multi-pilot (Class 1 'OML') limitation may be required.]

During this sub-clinical period the following markers of disease progression are important in offering prognostic information:

- i the requirement for anti-viral therapy
- ii prophylaxis to opportunistic infection, and
- iii a determination of fitness for continued flight status.

Staging of HIV disorders can be summarised as follows:

- i antibodies only
- ii lymphadenopathy – but not in all cases (AIDS Related Complex)
- iii T4 helpers lymphocyte count (CD4+) – falls below 400/ μ l
- iv earliest functional immunological deficits are seen
- v candidiasis
- vi other opportunistic infection (PCP etc.).

It would seem reasonable to suggest - with such regular surveillance, informed psychiatric/psychologic assessment and monitoring of disease markers - that [a fit assessment with a multi-pilot (Class 1 'OML') limitation] could safely be sustained in stages 1 and 2. Further progression of the infection would not permit continued medical certification (See also the Chapter on sexually transmitted diseases.).

16 THE AGEING PILOT

With increasing age new skills take longer to learn and to retain. Thus an experienced captain may find it difficult and take an increasing time to become competent on new aircraft as compared with his juniors. Anxiety and reactive depressive disorders may result from the fear that 'senility' is responsible.

Sympathetic handling and possibly psychological evaluation may prove helpful and may demonstrate that no dementia exists. Further difficulty can arise when the ageing pilot fails to master the handling techniques of a new aircraft. In both cases the pilot will have tried his best but finds insuperable difficulty learning the new techniques – or may indeed have lost his motivation to fly. The first case will require careful evaluation for revalidation or renewal of his medical certificate. In the second case revalidation or renewal of the medical certificate cannot be supported.

17 SUICIDE

It is not unknown, but uncommon, for an individual to use an aircraft as a means of committing suicide and a brief review of assessing an individual 'at risk' is relevant.

There are differences between those who successfully complete the act of suicide and those who survive after overdose or deliberate self harm.

Those who commit suicide are more often male and the majority suffer from a psychiatric disorder. The act is carefully planned, precautions taken against discovery, and the method is usually violent. The majority are suffering from a depressive disorder, many have significant social problems and alcoholism is a feature in about 15% of cases. In the younger age groups personality disorders feature largely, often associated with alcohol or drug abuse, and adverse social factors.

Deliberate self harm is usually an impulsive act, committed in such a way as to invite discovery. Overdosage with minor tranquillisers, antidepressants and non-opiate analgesics are common. Here again personality disorders with alcohol and drug abuse are prominent features together with social isolation and deprivation, but frank psychiatric illness is uncommon. In assessing potential risk the following factors should be considered:

- a a history of direct statement of intent;
- b a history of previous self harm;
- c a previous or current depressive disorder, particularly those in the early phase of recovery;
- d alcohol dependence, particularly where physical complications or severe social damage exists;
- e drug dependence;
- f social deprivation or loneliness.

At the initial selection interview those with a history of previous suicidal attempts should be very carefully and searchingly evaluated psychiatrically and it would be wise not to allow such individuals to enter a flying career.

Those who develop depressive illnesses should be excluded from flying and fully evaluated on recovery before reinstatement in a flying role. It is particularly important that those with alcohol dependence or abuse are assessed as temporarily unfit following diagnosis and treated as outlined in paragraph 18 below. Those individuals with significant personality disorders should be carefully excluded at the initial examination, if at all possible.

18 DRUG, ALCOHOL OR OTHER SUBSTANCE USE, ABUSE AND DEPENDENCE MENTAL AND BEHAVIOURAL DISORDERS DUE TO PSYCHOACTIVE SUBSTANCE USE (F10-F19)

In ICD-10, mental and behavioural disorders due to use of psychoactive substances are classified by the third-character of the code according to substance, and by the fourth and fifth character according to clinical condition. Amongst licensed personnel in the aviation workplace, mental and behavioural disorders due to the use of alcohol (F10) are far more common than those due to any other psychoactive drugs (F11-F19), with the possible exception of nicotine (F17). Most attention will therefore be given here to alcohol, but some additional comments will be made regarding other drugs.

18.1 Mental and behavioural disorders due to the use of alcohol (F10)

a Acute intoxication with alcohol (F10.0)

This is a concern in the aviation workplace, even when it is otherwise uncomplicated (F10.00), by virtue of the way in which it impairs psychomotor performance. It may potentially lead to accidents and injury (F10.01) of a minor or catastrophic form. These potential complications arguably render it impossible by definition to consider any episode of acute intoxication in a pilot on duty as “uncomplicated”. (ie F10.00 is a category which is effectively excluded on principle in this population).

b Harmful use of alcohol (F10.1)

That is associated with damage to the physical (e.g. hepatitis) or mental health of the individual (e.g. depressive episodes), but in the absence of a diagnosis of the alcohol dependence syndrome (F10.2). Certain specific and severe consequences of alcohol misuse may also be diagnosed separately – notably alcoholic hallucinosis (F10.52), Korsakoff’s psychosis (F10.6), and alcoholic dementia (F10.73).

c The alcohol dependence syndrome (F10.2)

This is a cluster of biological, psychological and social phenomena that may be diagnosed where three or more of the following features may be identified during the preceding year:

- i A strong desire/compulsion to drink;
- ii difficulties in controlling drinking;
- iii a physiological withdrawal syndrome associated with abstinence (F10.3);
- iv increased tolerance to alcohol;
- v neglect of other activities due to drinking;
- vi persistence of drinking despite harmful consequences.

d Alcohol withdrawal (F10.3)

That is associated with mild to severe symptoms, including sweating, nausea, tremor and anxiety. However, it may be associated with serious complications, including convulsions (F10.31), or delirium (“Delirium tremens”, F10.4).

A variety of screening tests are available to assist in the detection of alcohol use/misuse:

- i Breathalyser

The breath alcohol meter is easy to use and provides immediate results. It is useful in screening for intoxication, but does not detect harmful use, dependence or other complications of alcohol use.

ii Gamma glutamyl transpeptidase (GGT)

GGT is raised in about 80% of heavy drinkers, but is not a completely specific marker for harmful use of alcohol.

iii Mean corpuscular volume (MCV)

The MCV is raised above normal values in about 60% of alcohol dependant people and, like GGT, is not a completely specific marker. The values takes several weeks to return to normal during abstinence.

iv Carbohydrate deficient transferrin (CDT)

CDT has similar properties to GGT in so far its use as a screening test is concerned. It is more specific to heavy drinking than GGT, but perhaps less sensitive to intermittent "binge" drinking.

All of these tests may also be useful to confirm and monitor abstinence during follow-up of a person who has been previously identified [to] have a drinking problem. However, the usefulness of GGT, MCV & CDT for this purpose is confined primarily to those cases where it has been demonstrated that the test has been abnormal during periods of drinking. Where it is known that the test has remained normal during a period of heavy drinking, it is clearly unlikely to be useful in the monitoring process (unless subsequent heavier drinking produces an abnormality, where previous "less heavy" drinking has not to do so). In some cases, particularly where a patient presents following successful treatment, test results obtained during a period of heavy drinking may not be available. In such cases, all 3 tests should be conducted at regular intervals (usually by the [Aviation Psychiatrist (AP)] - see below) in support of the monitoring process. However, an awareness of the limitation of the value of these tests must then be maintained, since there can be certainty that any of them will become abnormal if drinking is resumed.

[18.1.1] [Aeromedical assessment]

The experience of certain major and airlines authorities is that success in rehabilitation of the alcohol dependent pilot can be achieved by early intervention and treatment, adhering to the strict protocol outline below. By using this programme it has been possible to return air crew to active flying [within] three to four months.

a Immediate action

The individual must be assessed as temporarily unfit on reasonable suspicion of intoxication whilst on duty, harmful use of alcohol, alcohol dependence, or other alcohol related problems. This action may be taken by airline's own medical officer or by the AME.

In support of the ensuing assessment process, it is essential that information is obtained from all possible sources. In addition to taking the individual's history the medical examiner/aviation psychiatrist (AP) may find it helpful to see a close relative, usually the partner, to develop the history further and to obtain some idea of the domestic picture. However, partners/relative should not normally be put under any pressure to provide such assistance. A report should also be obtained from the patient's family doctor who should be involved and kept informed of progress throughout the programme. The opinion of the pilot's training captain is often invaluable if this can be discreetly obtained without pre-judging the issue or suggesting to the employer that such a problem must exist. The individual must be seen by an the [Aviation Psychiatrist (AP)]. If the opinion given is that the problem is not

related to alcohol, or other psychiatric disorder, the report should be available to, and reviewed by, the [AMS] of the licensing Authority before the individual may be [assessed as] fit to return to flying. There may occasionally be information on file that is unknown to the airline or family doctor. Before divulging/obtaining the above reports, it is important to obtain written consent from the individual concerned.

Where a pilot is thought to be intoxicated whilst on duty, particular care and sensitivity are required on the part of the OP. The action taken will depend in part upon the Company's drug and alcohol policy. However, where possible, it is important to obtain an objective assessment of the alleged intoxication at the earliest opportunity. This might involve use of a breath alcohol meter, a blood alcohol analysis or urinary drug testing. Such procedures may only be conducted with the patient's consent. However, a smell of alcohol is rather subjective physical sign, and such tests offer the opportunity to confirm objectively that a person was or was not intoxicated. Given that blood alcohol concentration falls rapidly with abstinence, such testing should be conducted as soon as possible. Obviously refusal of testing, and any reasons given for this, should also be recorded carefully.

b Treatment and rehabilitation

If psychiatric opinion and examination confirm "alcohol, psychotropic drug or substance abuse with or without dependency" then a rehabilitation programme can be considered, including, if necessary, an in-patient treatment. The treatment programme undertaken should be entirely at the discretion of the treating psychiatrist and may or may not include pharmacotherapy with disulfuram and/or acamprosate. If dependency is not confirmed a treatment programme including a four weeks inpatient can be considered.

The JAR requirement is a stringent one, and constitutes more than would normally be clinically indicated in many cases. If the diagnostic criteria for the diagnosis "alcohol, psychotropic drug or substance abuse with or without dependency" (note that this terminology is not conform with ICD 10 diagnostic terminology) are not fulfilled, but there is still a degree of suspicion of an alcohol related matter, an unambiguous diagnosis or exclusion of alcohol abuse requires a four week residential treatment programme under current regulations. Arguably, heavy drinking as a cause of an elevated GGT or hypertension, but without any other complications or problems, might be an example of such circumstances.

An isolated offence of driving under the influence of alcohol does not fulfil ICD-10 criteria for harmful use of alcohol (note: the threshold breath/blood alcohol concentration vary from one member state to another). However, such offences do indicate an increased probability that other alcohol related problems might be identified, and this probability increases still further where there have been multiple drink-driving offences committed. Depending upon the number of such offences identified, it might be considered appropriate to arrange for a pilot to receive a 4 week residential treatment programme. In isolated cases, out-patient or day-patient treatment might be recommended by the AMS / the [Aviation Psychiatrist (AP)] as being sufficient. It might be noted that de FAA now prohibits the licensing of pilots who are convicted of 2 or more drink-driving offences within a 3 year period.

c Follow-up and monitoring

The Aeromedical Section of the Authority should be advised as soon as treatment is considered necessary so that follow-up review may be arranged to commence immediately following discharge from in-patient care.

The [Aviation Psychiatrist (AP)] should review the patient after discharge from in-patient care and again immediately before or after revalidation. On-going review should be at 3 monthly intervals (or more frequently if indicated) for at least 2 years, and less frequently thereafter. Overall monitoring should be for not less than 3 years and in most cases will

continue virtually indefinitely, or until the pilots retire. This is because of the significant risk of relapse, which continues for many years following treatment. Review will require supportive, confirmative evidence of continuing abstinence from the family, the family doctor and from others in close contact at home or in the workplace. At each review blood tests should be repeated in support of the monitoring process (see above).

Continued attendance at Alcoholics Anonymous or an equivalent organisation, or follow-up by the treatment programme after discharge, should be required in most cases. It should also be required that a peer group member on the same aircraft fleet should act as a "buddy" to supervise the individual's progress and report to the relevant authority at intervals.

d Treatment goals

In most cases, total abstinence will be the only acceptable treatment goal. For less serious cases (eg an elevated GGT with no other evidence of problems arising from alcohol consumption), an attempt at controlling drinking may be allowed, and in such circumstances in-patients treatment will not be required. However, this will be the exception rather than the rule and, in cases of doubt, in-patient treatment and abstinence should both be considered mandatory.

e [Fit assessment]

At the end of the twelve weeks, provided that abstinence is secure, the pilot may be allowed to resume his/her flying role but only in a multi-pilot environment. A period of at least two years [with a multi-pilot (Class 1 'OML') or safety pilot (Class 2 'OSL') limitation] is required, assuming good progress. Failure to enter the programme or to maintain the protocol [is disqualifying].

f Relapse

Following treatment, relapse may lead to permanent [disqualification]. However, the definition of a relapse is sometimes not clear cut, and each case should be assessed carefully by an aviation psychiatrist.

18.2 **Mental and behavioural disorders due to the use of other psychoactive drugs (F11-F19)**

Intoxication, harmful use, dependence, psychotic disorders and disorders associated with psychoactive drugs other than alcohol are much less common in aircrew. However, when they are identified they are potentially a very serious concern and should always be assessed by an [Aviation Psychiatrist (AP)]. The ICD-10 classification specifies diagnosis according to the following groups of substances:

- Opioids (F11)
- Cannabinoids (F12)
- Sedatives or hypnotics (F13)
- Cocaine (F14)
- Caffeine (F15)
- Hallucinogens (F16)
- Tobacco (F17)
- Volatile solvents (F18)
- Multiple and other substances (F19)

In general, illicit drug use will involve substances in categories F11, F12, F13, F14, F15, F16 and F19. The use of volatile solvents (F18), although usually associated with teenage years, and although technically not illegal, would be an equal cause for concern in the aviation environment if it should occur.

Socially acceptable drug use in categories F15 and F17 will not normally pose a clinical or occupational problem. However, significant problems can arise with respect to use of these

substances, and this may sometimes require psychiatric or other medical assessment. Excess caffeine use can cause or exacerbate somatic symptoms of anxiety. Technically, of course, harmful use of tobacco (F17.1) includes a wide range of medical conditions all of which might render a licence holder unfit to exercise the privileges of that licence. However, psychiatric assessment would only be appropriate where problems of tobacco dependence and withdrawal were specifically the cause of concern.

Use of prescribed drugs (F13, or sometimes F11) may pose problems for licensed personnel, especially if the pilot and physician do not notify the occupational physician, the AME or the aviation authority. Prescription of drugs in these categories should always be associated with suspension of the medical certificate. Dependence or other problems arising from prescribed drug use should be subject to assessment by an [Aviation Psychiatrist (AP)].

18.2.1 [Aeromedical assessment]

Drugs alter the mental state, interfere with judgement, alertness, vision and co-ordination and where abuse or dependence upon any such psychoactive substances is suspected the [pilot] should be immediately assessed as temporarily unfit and individually assessed under supervision of the AS. If dependence on such drugs is confirmed, a temporarily unfit assessment should continue until treatment has been shown to be completely successful, the individual is on no medication and fully rehabilitated. The management protocol for alcohol dependence is a useful model to follow or adjust according to AMS advice.

19 PSYCHIATRIC TREATMENT

19.1 Medication and drugs

According to the JAR-FCL 3.205 and 3.325 Psychiatric requirements (class 1 and class 2), and according to the JAR-FCL 3.115, psychiatric disorders that need the use of medication or drugs are incompatible with flying status.

The use of psychiatric medication such as, neuroleptic, antidepressant, normothimic, barbiturates, anxiolytic, hypnotic and others, which may affect alertness and upper brain functions should be forbidden, even for therapeutical purposes and under medical supervision.

In order to preserve the quality of sleep, during stop-overs in long-hauls flights, and only for this purpose, the ingestion of very short half-life hypnotics, may be tolerated, but always under medical supervision.

19.2 Psychotherapy

Different approaches of psychotherapy should be used according to different mental disorders. If pilots undergo psychoanalysis treatment, they must be considered unfit for flying during its course, due to eventual unconscious defence mechanisms.

The most appropriate technique is known as Psychotherapy Brief, centralised in concept of the Focus, (the symptoms which lead the pilot to the psychotherapist).

The aim of psychotherapy should be helping the pilot to solve conflicts, and make decisions.

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CHAPTER 12 - AVIATION NEUROLOGY

[1 INTRODUCTION

Despite the increasing automation of modern civil aircraft, human pilots will remain a necessity just as long as their brain continues to be more comprehensive and flexible than aircraft systems. The effectiveness of a pilot as a control system is normally assessed operationally during his/her training and subsequent flying career. This assessment is subjective, giving few comparable parameters by which performance change can be recognised and so 'pilot error' remains the single major reported cause for aircraft accidents. Given that 'pilot judgmental error' is such an important aspect of aviation safety with so few specific parameters it is not surprising that those areas of cerebral activity that can be measured and examined receive very close scrutiny by the aviation medical physician, frequently out of proportion to the risk involved. The neurological assessment for aviation fitness must therefore be assessed not only in terms of what can be measured and examined but also regarding the aviation risk involved.]

2 PATHOLOGY OF THE NERVOUS SYSTEM

Pathology of the nervous system may:

- a Reduce or distort the sensory input from, and appreciation of the external and internal environment [(flight instruments and aids)].
- b Impair assessment, judgement and decision making.
- c [Affect the motor skills necessary for good piloting. Effects of such pathology may be episodic, potentially recurring, static or progressive. Neurological assessment should include careful history and physical examination with particular attention being paid to those areas mentioned in the standards and particularly recognised as aviation problems. Consultation with appropriate specialists is essential in doubtful cases or when questionable findings are noted.]

3 NEUROLOGICAL FITNESS

A satisfactory assessment may be achieved if:

- a [There is no demonstrable abnormality of history, examination or performance];
- b Any abnormality noted has an acceptable risk of hazard to the safety of the flight operation concerned. Such abnormality may be congenital or acquired, it may additionally be a single event, static, progressive or intermittent but potentially recurrent. The condition may improve but subsequently relapse. Neurological 'fitness' for aviation purposes must therefore be demonstrated at initial examination and maintained throughout the defined period of medical certificate validation].

4 EXAMINATION TECHNIQUES

4.1 GENERAL

The neurologic examination begins with observations of the patient while the history is being obtained. The manner in which the patient tells the story of his illness may betray confusion or incoherence in thinking, impairment of memory or judgment, or difficulty in comprehending or expressing ideas. A common error is to pass lightly over inconsistencies in history and inaccuracies about dates and symptoms, only to discover later that these flaws in memory were the essential features of the illness. Asking the patient to give his own interpretation of the possible meaning of symptoms may sometimes expose unnatural concern, anxiety, suspiciousness, or even delusional thinking. One then generally proceeds from an examination of the cranial nerves, neck, and trunk to the testing of motor, reflex, and sensory functions of the upper and lower limbs. This is followed by an assessment of the function of sphincters and the autonomic nervous system and suppleness of the neck and spine (meningeal irritation).

Gait and station (standing position) should be observed before or after the rest of the examination. In addition, it is often instructive to observe the patient in the course of his natural activities, such as walking or dressing; this may disclose subtle abnormalities of gait and movement that might not be evident in formal testing

Brief neurologic examination in the general medical patient (performed in 5 minutes or less)

1. Orientation, insight into illness, language assessed during taking of the history
2. Size of pupils, reaction to light, visual and auditory acuity
3. Movement of eyes, face, tongue
4. Examination of the outstretched hands for atrophy, pronating or downward drift, tremor, power of grip, and wrist dorsi flexion
5. Biceps, supinator, and triceps tendon reflexes
6. Inspection of the legs during active flexion and extension of the hips, knees, and feet
7. Patellar, Achilles, and plantar (Babinski) reflexes
8. Vibration sensibility in the fingers and toes
9. Finger-to-nose and heel-to-shin testing of coordination
10. Gait

4.2 TESTING OF HIGHER CORTICAL FUNCTIONS

These functions are tested in detail if the patient's history or behaviour during the general examination has provided a reason to suspect some defect. Questions should then be directed toward determining the patient's orientation in time and place and insight into his current medical problem. Attention, speed of response, ability to give relevant answers to simple questions, and the capacity for sustained and coherent mental effort all lend themselves to straightforward observation. Useful bedside tests of attention, concentration, memory, and clarity of thinking include the repetition of a series of digits in forward and reverse order, serial subtraction of 3s or 7s from 100, recall of three items of information or a short story after an interval of 3 min, and naming the last six presidents or prime ministers. The patient's account of his recent illness, medical consultations, dates of hospitalization, and his day-to-day recollection of medical procedures, meals, and other incidents are excellent tests of memory; the narration of the illness and the patient's choice of words (vocabulary) provide information about his intelligence and coherence of thinking. Many other tests can be devised for the same purpose. Often the examiner can obtain a better idea of the clarity of the patient's sensorium and soundness of intellect by using these few tests and noting the manner in which he deals with them than by relying on the score of a formal intelligence test. If there is any suggestion of a speech or language disorder, the nature of the patient's spontaneous speech should be noted. In addition, his ability to read, write, and spell, execute spoken commands, repeat words and phrases spoken by the examiner, name objects and parts of objects, and solve simple arithmetical problems should be assessed. The ability to carry out commanded tasks (praxis) has great salience in the evaluation of several aspects of cortical function. Bisecting a line, drawing a clock or the floor plan of one's home or a map of one's country, and copying figures are useful tests of visuospatial perception and are indicated in cases of suspected cerebral disease.

4.3 TESTING OF CRANIAL NERVES

The function of the cranial nerves must be investigated more fully in patients who have neurologic symptoms than in those who do not. If one suspects a lesion in the anterior fossa, the sense of smell should be tested in each nostril; then it should be determined whether odors can be discriminated. The olfactory defect can be verified readily enough by presenting a series of nonirritating olfactory stimuli (vanilla, peanut butter, coffee, tobacco, etc.), first in one nostril, then in the other, and asking the patient to sniff and identify them. Ammonia and similar pungent substances are unsuitable stimuli because they do not test the sense of smell but have a primary irritating effect on the mucosal free nerve endings of the trigeminal nerves. Unilateral gustatory impairment can be identified by withdrawing the tongue with a gauze sponge and using a moistened applicator to place a few crystals of salt or sugar on discrete parts of the tongue; the tongue is then wiped clean and the subject is asked to report what he or she had sensed.

Visual fields should be outlined by confrontation testing, in some cases by testing each eye separately; if any abnormality is suspected, it should be checked on a perimeter and scotomas sought on the tangent screen or, more accurately, by computed perimetry. Pupil size and reactivity to light and accommodation during convergence, the position of the eyelids, and the range of ocular movements should next be observed. To examine the eye movements, the patient may be asked to look quickly to each side as well as up and down (saccades) and to follow a moving target (pursuit of a light, the examiner's or the patient's finger, or an optokinetic drum).

Sensation over the face is tested with a pin and wisp of cotton; also, the presence or absence of the corneal reflexes may be determined. Facial movements should be observed as the patient speaks and smiles, for a slight weakness may be more evident in these circumstances than on movements to command. The auditory meati and tympanic membranes should be inspected with an otoscope. A 256 double-vibration tuning fork held next to the ear and on the mastoid discloses hearing loss and distinguishes middle-ear (conductive) from neural deafness. Audiograms and other special tests of auditory and vestibular function are needed if there is any suspicion of disease of the eighth nerve or the cochlear and labyrinthine end organs. The vocal cords must be inspected with special instruments in cases of suspected medullary or vagus nerve disease, especially when there is hoarseness. Voluntary pharyngeal elevation and elicited reflexes are meaningful if there is a difference on the two sides; bilateral absence of the gag reflex is seldom significant. Inspection of the tongue, both protruded and at rest, is helpful; atrophy and fasciculations may be seen and weakness detected. Slight deviation of the protruded tongue as a solitary finding can usually be disregarded. The pronunciation of words should be noted. The jaw jerk and the snout, buccal, and sucking reflexes should be sought, particularly if there is a question of dysphagia, dysarthria, or dysphonia.

4.4 TESTS OF MOTOR FUNCTION

In the assessment of motor function, it should be kept in mind that observations of the speed and strength of movements and of muscle bulk, tone, and coordination are usually more informative than the state of tendon reflexes. It is essential to have the limbs fully exposed and to inspect them for atrophy and fasciculations. The next step is to watch the patient maintain the arms outstretched in the prone and supine positions; perform simple tasks, such as alternately touching his nose and the examiner's finger; make rapid alternating movements that necessitate sudden acceleration and deceleration and changes in direction, such as tapping one hand on the other while alternating pronation and supination of the forearm; rapidly touch the thumb to each fingertip; and accomplish simple tasks such as buttoning clothes, opening a safety pin, or handling common tools. Estimates of the strength of leg muscles with the patient in bed are often unreliable; there may seem to be little or no weakness even though the patient cannot arise from a chair or from a kneeling position without help. Running the heel down the front of the shin, alternately touching the examiner's finger with the toe and the opposite knee with the heel, and rhythmically tapping the heel on the shin are the only tests of coordination that need be carried out in bed. The maintenance of both arms against gravity is a useful test; the weak one, tiring first, soon begins to sag, or, in the case of a corticospinal lesion, to resume the more natural pronated position ("pronator drift"). The strength of the legs can be similarly tested, either with the patient supine and the legs flexed at hips and knees or with the patient prone and the knees bent. Also, abnormalities of movement and posture and tremors may be exposed.

4.5 TESTS OF REFLEX FUNCTION

Testing of the biceps, triceps, supinator (radial-periosteal), patellar, Achilles, and cutaneous abdominal and plantar reflexes permits an adequate sampling of reflex activity of the spinal cord. Triggering tendon reflexes requires that the involved muscles be relaxed; underactive or reflexes difficult to trigger can be facilitated by voluntary contraction of other muscles (Jendrassik maneuver). The plantar response poses special difficulty because several different reflex responses can be evoked by stimulating the sole of the foot along its outer border from heel to toes. These are:

- (1) the quick, high-level avoidance response;
- (2) the slower, spinal flexor nocifensive (protective) reflex (flexion of knee and hip and dorsiflexion of toes and foot, "triple flexion") — dorsiflexion of the large toe as part of this reflex is the well-known Babinski sign;

- (3) plantar grasp reflex; and;
- (4) support reactions. Avoidance and withdrawal responses interfere with the interpretation of the Babinski sign and can sometimes be overcome by utilizing the several alternative stimuli that are known to trigger the Babinski response (squeezing the calf or Achilles tendon, flicking the fourth toe, downward scraping of the shin, lifting the straight leg, and others). An absence of the superficial cutaneous reflexes of the abdominal, cremasteric, and other muscles are useful ancillary tests for detecting corticospinal lesions. The finding of absent Achilles reflexes and diminished vibratory sense in the feet and legs alerts the physician to the possibility of diabetic or alcoholic-nutritional neuropathy even when the patient has no symptoms referable to these disorders.

4.6 TESTING OF SENSORY FUNCTION

This is undoubtedly the most difficult part of the neurologic examination. Usually sensory testing is reserved for the end of the examination and, if the findings are to be reliable, should not be prolonged for more than a few minutes. Each test should be explained briefly; too much discussion of these tests with a meticulous, introspective patient may encourage the reporting of useless minor variations of stimulus intensity. It is not necessary to examine all areas of the skin surface. A quick survey of the face, neck, arms, trunk, and legs with a pin takes only a few seconds. Usually one is seeking differences between the two sides of the body (it is better to ask whether stimuli on opposite sides of the body feel the same than to ask if they feel different), a level below which sensation is lost, or a zone of relative or absolute analgesia (loss of pain sensibility) or anesthesia (loss of touch sensibility). Regions of sensory deficit can then be tested more carefully and mapped out. Moving the stimulus from an area of diminished sensation into a normal area enhances the perception of a difference. The vibration sense may be tested by comparing the thresholds at which the patient and examiner lose perception at comparable bony prominences. We usually record the number of seconds for which the examiner appreciates vibration at the malleolus or toe after the patient reports that the fork has stopped buzzing. The finding of a zone of heightened sensation ("hyperesthesia") calls attention to a disturbance of superficial sensation.

Variations in sensory findings from one examination to another reflect differences in technique of examination as well as inconsistencies in the responses of the patient.

4.7 TESTING OF GAIT AND STANCE

The examination is completed by observing the patient stand and walk. An abnormality of stance and gait may be the most prominent or only neurologic abnormality, as in certain cases of cerebellar or frontal lobe disorder; and an impairment of posture and highly automatic adaptive movements in walking may provide the most definite diagnostic clues in the early stages of Parkinson disease and progressive supranuclear palsy. Having the patient walk tandem or on the sides of the soles may bring out a lack of balance and dystonic postures in the hands and trunk. Hopping or standing on one foot may also betray a lack of balance or weakness, and standing with feet together and eyes closed will bring out a disequilibrium that is due to deep sensory loss (Romberg test). When confronted with a disorder of gait, the examiner must observe the patient's stance and the attitude and dominant positions of the legs, trunk, and arms. It is good practice to watch patients as they walk into the examining room, when they are apt to walk more naturally than during the performance of special tests. They should be asked to stand with feet together and head erect, with eyes open and then closed. A normal person can stand with feet together and eyes closed while moving the head from side to side, a test that eliminates both visual and vestibular cues and induces certain compensatory trunk and leg movements that depend on proprioceptive afferent mechanisms. As already mentioned, the Romberg sign - marked swaying or falling with the eyes closed but not with the eyes open - usually indicates a loss of postural sense, not of cerebellar function, although with vestibular or cerebellar dysfunction there may be a less pronounced exaggeration of swaying with eyes closed and feet together. Swaying due to nervousness may be overcome by asking the patient to touch the tip of his nose alternately with the forefinger of one hand and then the other. Next, the patient should be asked to walk, noting in particular any hesitation in starting and negotiating turns, width of base, length of stride, foot clearance, arm swing, and cadence. A tendency to veer to one side, as occurs with unilateral cerebellar disease, can be brought out by having the patient walk around a chair. When the affected side is toward the chair, the patient tends to walk into it; when it is away from the chair, there is a veering outward in ever-widening circles. More delicate tests of gait are walking a straight line heel to toe

(“tandem walking test”), walking backward, and having the patient arise quickly from a chair, walk briskly, stop and turn suddenly, walk back and then sit down again. It is instructive to observe the patient’s postural reaction to a sudden push backward and forward or to the side. With postural instability there is a delay or inadequacy of corrective actions. Finally, the patient should be asked to hop on one leg and to jog. If all these tests are successfully executed, it may be assumed that any difficulty in locomotion is not due to impairment of a proprioceptive, labyrinthine-vestibular, basal ganglionic, or cerebellar mechanism.

5 HEADACHE-FACIAL PAIN

Of all the painful states that afflict humans, headache is undoubtedly the most frequent. Overall, more than 90% of the headache patients examined annually suffer from the primary headache disorders — migraine, tension-type, or cluster headache. The remaining patients have headache secondary to tumor, meningitis, giant cell arteritis, sinusitis, or other medical conditions. Intracranial pathology is extremely uncommon among patients with primary headache disorders. Only 0.18% of patients with migraine and a normal neurological examination will have a significant intracranial abnormality.

Clinical classification and prevalence of different types of headache in the general population (%)	
<i>(Primary %)</i>	
Muscle contraction/tension-type headache	69
Idiopathic stabbing headache (ice cream/ice pick headache)	33
Migraine	16
Exertional headache	1
Cluster headache	0.1
<i>(Secondary %)</i>	
Systemic infection	63
Head injury	4
Drug induced headache	3
Vascular disorders	1
Subarachnoid haemorrhage	<1
Brain tumour	0.1

Aetiology of headache		
	<i>Adults</i>	<i>Elderly</i>
	<i>(17–65 years)</i>	<i>(65+ years)</i>
Tension headache	+++	+
Migraine	+++	+
Idiopathic stabbing headache	+	+
Exertional headache	++	–
Cluster headache	++	+
Post-traumatic	+++	+
Drug-induced headache	++	++
Cervicogenic (referred from neck)	+	+++
Cranial arteritis	+	+++
Subarachnoid haemorrhage	++	+
Subdural haematoma	++	++
Brain abscess	+	+
Brain tumour	++	++
Idiopathic intracranial hypertension	++	–
Glaucoma	+	++
Paget’s disease of the skull	+	++
Cerebral venous sinus thrombosis	+	+
Arnold–Chiari malformation	+	+/-

5.1 CLINICAL HISTORY

- Types of headache: how many types of headache do you suffer from?
- Length of history of headache: is this a new headache or not; has it changed in character, severity or frequency?
- Features of the headache itself:
 - Location/site of headache.
 - Onset.
 - Type/quality of headache (throbbing, steady).
 - Timing.
 - Severity.
 - Radiation.
 - Associated features (e.g. nausea, photophobia, phonophobia, symptoms of aura, fever, neurological symptoms such as weakness, diplopia, clumsiness, disturbance of balance, altered cognitive function; altered consciousness).
 - Exacerbating factors (e.g. physical activity, bright light, noise).
 - Relieving factors.
 - Duration of headache.
 - Predisposing factors.
 - Premonitory features.
- Family history.
- Medications/drugs.

Most often, secondary headache can be suspected when 1 or more of the features shown in Table 1 are present.

Table 1: Red flags symptoms

Systemic symptoms/signs (fever, myalgias, weight loss)
Systemic disease (malignancy, acquired immune deficiency syndrome)
Neurologic symptoms or signs
Onset sudden (thunderclap headache)
Onset after age 40 years
Pattern change
– Progressive headache with loss of headache-free periods
– Change in type of headache

5.2 SELECTED DIAGNOSTIC TESTING

Physical examination

Metabolic evaluation

- Hematological
- ESR/CRP
- Endocrinological
- Chemistry
- Toxicology (drug screens, etc.)

Standard x-rays

Neuroimaging

- CT
- MRI/MRA/MRV

Dental and otological exam

Lumbar puncture

Diagnostic blockades

5.3 MIGRAINE

A symptom complex, or syndrome, that manifests as discrete episodes of headache associated with other features of sensory sensitivity.

5.3.1 **Migraine variants**

5.3.1.1 **Ophthalmoplegic migraine:**

Paralysis of the >1 ocular cranial nerves, usually the IIIrd nerve, at the height of a migraine headache. The paralysis usually resolves but may persist after recurrent episodes.

5.3.1.2 **Vertebrobasilar migraine**

Gradual onset and evolution over several minutes of brainstem, cerebellar and visual disturbances, often accompanied or followed by headache and syncope.

5.3.1.3 **Hemiplegic migraine**

Hemiparesis preceding or occurring with a migraine headache.

5.3.1.4 **Migrainous infarction**

Permanent focal neurological symptoms persisting beyond 24 hours after the cessation of migraine headache.

5.3.2 **Aeromedical Status**

Migraine cannot be treated in pilots with ergotamine and other drugs, because such medications are unacceptable in aviation due to side effects. Known migraineurs should not be selected for professional aircrew training due to the unpredictability and disabling nature of the condition, but those who present after qualification either through worsening of the condition or an in-flight incident should be neurologically assessed and any causal factor addressed. If no other structural abnormality is found and the individual is migraine free for 3 to 6 months, a return to flying may be approved with a multi-pilot (Class 1 'OML') limitation. A fit assessment for solo operations must be evaluated against the history and type of operation. Some prophylactic treatments such as propranolol, may be acceptable with each case being reviewed individually.

A similar assessment applies to Class 2.

The following must be considered:

- Frequency of headaches
- Degree of incapacitation caused by the headache.
- Drugs used to treat the headache.

Adverse factors for aeromedical certification include:

- Sudden significant neurological symptom such as loss of vision, weakness and incoordination with no warning
- Failure or of prophylactic treatment with frequent attacks
- Requirement for intensive treatment
- Short prodrome that does not allow effective use of acute treatment before symptom onset.

5.4 **MUSCLE CONTRACTION/TENSION TYPE HEADACHE**

An episodic or chronic continuous headache due to sustained muscle contraction.

5.4.1 **Aeromedical Status**

Most applicants should be considered fit. Special Aeromedical assessment should be considered in case of use of chronic tension headaches that require treatment such as anxiolytics or other drugs likely to cause a decreased state of alertness or diminished performance. The chronic use of medication is against fitness to fly.

5.5 CLUSTER HEADACHE

A form of primary headache marked by recurrent episodes, lasting 15–180 minutes, of excruciating unilateral periorbital pain and associated autonomic features, that tend to occur once or twice a day in bouts or clusters, lasting from weeks to months at a time, separated by remission periods of months or 1–2 years.

5.5.1 Aeromedical Status

Cluster headaches are extremely painful and unpredictable – they require neurological assessment and pharmacological treatment is often unacceptable for flying. Individuals with such conditions need an extended pain free period of temporarily unfit assessment before being considered for a return to multi-pilot flying. A similar assessment applies to Class 2 'OSL' and Class 2.

5.6 TRIGEMINAL NEURALGIA

Specialised neurosurgical assessment may be needed. Consideration must be given to the side effects of medications commonly used in its treatment

5.6.1 Aeromedical Status

(see under cluster headache)

6 ACQUIRED METABOLIC DISEASES OF THE NERVOUS SYSTEM

6.1 HYPOXIC ENCEPHALOPATHY

Brain dysfunction caused by a lack of oxygen to the brain as a result of failure of the circulation or respiration.

6.1.1 Aeromedical Status

The applicants should be considered unfit. However, in case of mild disease each case should be considered individually by the AMS considering:

- Causal factor
- Clinical features of encephalopathy
- Presence of neurological defects
- Present cognition status

6.2 HEPATIC ENCEPHALOPATHY

A clinical neuropsychiatric syndrome characterized by abnormal mental status occurring in patients with severe acute, subacute, or chronic hepatocellular insufficiency.

6.2.1 Aeromedical Status

The applicants should be considered unfit.

7 AUTONOMIC NERVOUS SYSTEM DISORDERS

7.1 AUTONOMIC NEUROPATHY

7.1.1 Disorders affecting CNS

Primary autonomic failure
Spinal cord lesions above T6

Cerebrovascular disease.
Brainstem tumours.
Multiple sclerosis.
Tabes dorsalis.

7.1.2 Disorders affecting the peripheral nervous system

Diabetes.
Acute inflammatory radiculoneuropathy (Guillain–Barré syndrome).
Acute intermittent porphyria.
Alcoholism and nutritional diseases.
Metabolic disorders (vitamin B12 deficiency, chronic renal failure, chronic liver disease).
Charcot–Marie–Tooth disease.
Malignancy.
Rheumatoid arthritis.
Systemic lupus erythematosus.
Chronic inflammatory neuropathy.
HIV infections.

7.1.3 Drugs

- Antidepressants.
- Anti-hypertensive drugs.
- Barbiturates.
- Phenothiazines.
- Atropine.
- Epidural anaesthesia.

7.1.4 Clinical Features

The most common clinical manifestations of autonomic dysfunction are:

- Postural (orthostatic) hypotension; impotence.
- Disorders of bladder function.
- Abnormalities of sweating.
- Vasomotor disturbances.

Sympathetic adrenergic failure

- Postural hypotension.
- Ejaculatory failure.

Sympathetic cholinergic failure

- Anhidrosis.

Parasympathetic failure

- Fixed heart rate.
- Sluggish urinary bladder and bowel.
- Erectile failure.

7.1.5 Aeromedical Status

The applicants should be considered unfit. However, in cases with minor manifestations each case should be considered individually by the AMS considering:

- Flight safety
- Causal factor
- Clinical symptoms

8 DISORDERS OF CONSCIOUSNESS

8.1 NARCOLEPSY

A syndrome of excessive sleepiness and abnormalities of rapid-eye-movement (REM) sleep.

8.1.1 Clinical Features

Excessive sleepiness
Cataplexy
Hypnagogic hallucinations

8.1.2 Aeromedical Status

The applicants should be considered unfit.

8.2 SYNCOPE

A transient loss of postural tone and consciousness resulting from an acute reduction in blood flow to the brain.

History of the event is paramount in differentiation of the causes.

Specific features that will help in differentiating the physiological system involved are:

- Prodrome: absence or present.
- Posture at the time of the episode.
- Period: ie, duration of attack.
- Postictal orientation.
- Activity before, immediately and within 24 hr preceding.
- Head trauma.
- Frequency.
- Urinary incontinence.
- Tongue biting.
- Observer report: confirmation of patient's account, particularly concerning convulsive movements. Time course to any convulsive movement is important ie, did it occur at the same time as LOC, or seconds later?
- Bystanders' action: e.g., promptly placing patient in prone or coma position, or keeping patient sitting/upright.
- Family and/or past history.
- Known cardiovascular history or risks.
- History of infection such as recent viral infection that may support labyrinthitis.

Depending on the historical features elicited, the need for referral to relevant specialist/s can be determined.

Prognosis depends on the cause.

8.2.1 Aeromedical Status

Each case should be considered individually by the AMS considering:

Cause
Clinical symptomatology
Flight safety
Remission rate
Precipitating factors

9 CRANIAL NEUROPATHIES

9.1 OLFACTORY (CRANIAL NERVE I) NEUROPATHY

Disorder of the 1st cranial, or olfactory, nerve resulting in a disturbance of smell sensation (anosmia).

9.2 OPTIC (CRANIAL NERVE II) NEUROPATHY

Special concern should be given to optic neuritis as a multiple sclerosis early sign. About 15% of patient will develop clinically definite MS within the next 2 years, 22% within 5 years, 35% in 10 years, and about 50–60% of patients with optic neuritis will eventually develop MS.

Following optic neuritis *MS is less likely to occur*

- in childhood than in adults.
- With bilateral simultaneous onset.
- With absence of pain.
- With marked disc oedema.
- If there are no oligoclonal bands in the CSF.
- If the brain MRI is normal

MS is more likely to occur

- If previous ill-defined non-specific neurological symptoms are present.
- If there is an history of previous optic neuritis.
- With increased CSF IgG.
- If the brain MRI is abnormal with three or more lesions suggestive of demyelinating disease:
- Possibly, if there is a family history of MS.

9.3 HORNER'S SYNDROME

Horner's syndrome presents as unilateral ptosis, miosis and anhidrosis due to damage to the ipsilateral oculosympathetic pathway. Prognosis depends on the cause. Generally benign in isolated, new onset postganglionic Horner's syndrome.

9.4 CRANIAL NERVE III, IV, V (OCULAR MOTOR) NEUROPATHIES

These disorders, along with disorders of the extraocular muscles, that are innervated by these nerves, cause dysconjugate eye movements and thus binocular diplopia (unless either eye is closed, blind or amblyopic). Prognosis depends on the cause.

9.5 TRIGEMINAL (CRANIAL NERVE V) NEUROPATHY

Prognosis depends on the cause.

9.6 FACIAL (CRANIAL NERVE VII) NEUROPATHY

Differential diagnosis should be made between Upper and lower motor neurone facial weakness. Prognosis depends on the cause.

Acute Idiopathic Facial Paralysis (Bell's Palsy) is a unilateral, lower motor neurone facial paralysis that is probably due to acute viral inflammatory demyelination of the facial nerve causing swelling and secondary nerve ischaemia within the facial canal. 60–80% of patients recover completely. In these cases, recovery usually begins within 8 weeks and is complete by 6–12 months. The most favourable prognostic sign is an incomplete rather than complete facial palsy. If weakness is severe or complete, recovery commencing within 3 weeks is a favourable sign. The longer the delay in return of movement the poorer the recovery.

Predictors of incomplete recovery are:

- Complete facial weakness.
- Pain other than in or around the ear (i.e. back of head, cheek, other).
- Systemic hypertension, diabetes or psychiatric illness.
- Older age.
- Hyperacusis.
- Decreased tearing.

9.7 VESTIBULAR-COCHLEAR (CRANIAL NERVE VIII) NEUROPATHY

An ENT assessment will be needed. Prognosis depends on the cause.

9.8 AEROMEDICAL STATUS

These disorders are assessed on the basis of the nature and degree of deficit. Each case should be considered individually by the AMS considering:

- Cause
- Residual neurological defects
- Associated clinical-laboratory findings
- Flight safety concerns

10 DEGENERATIVE DISEASES OF THE NERVOUS SYSTEM

10.1 DEMENTIA

Dementia is characterized by progressive intellectual deterioration that is sufficiently severe to interfere with social or occupational functions. Memory, orientation, abstraction, ability to learn, visuospatial perception, language function, constructional praxis, and higher executive functions, such as planning, organizing, and sequencing, are all impaired in dementia.

10.1.1 Causes of dementia

- | | |
|------------------------------------|-----------|
| Alzheimer's disease | : 50–55%. |
| Vascular dementia | : 15–20%. |
| Diffuse Lewy body disease | : 15–25%. |
| Parkinson's disease | : 5–10%. |
| Brain injury: alcohol, head trauma | : 5%. |
| Other causes | : 5%: |
- Normal pressure hydrocephalus .
 - Intracranial mass lesion: frontal or temporal lobe tumour, chronic subdural haematoma.
 - Metabolic/toxic: chronic drug intoxication (e.g. alcohol, barbiturates, sedatives), chronic hepatic encephalopathy.
 - Endocrine: hypothyroidism, Cushing's syndrome.
 - Autoimmune: SLE.
 - Nutritional: vitamin B12 deficiency ; Wernicke– Korsakoff syndrome .
 - Syphilis (general paresis of the insane) ; HIV.
 - Creutzfeldt–Jakob disease : myoclonus and rapidly progressive dementia.

Multiple causes (i.e. combinations of the above): 10–15%


Mini-Mental Scale (MMSE) is a useful tool for clinical practice to identify in early stages some cognition decline It should be applied in pilots over 40's. Mild Cognitive Impairment (MCI) is an early stage of Alzheimer disease. In most studies, 10 to 20 percent per year of such affected patients will be found to have acquired Alzheimer disease.

MMSE \leq 27 should needed further evaluation

10.1.2 Aeromedical Status

Applicants with dementia are permanently unfit. In the small number of cases where the cause of the dementia is known and treatable and the condition has been resolved, applicants may be considered for a fit assessment at revalidation / renewal.

“Mini-Mental” status test of Folstein, Folstein, and McHugh

TASK	INSTRUCTIONS	SCORING	
Date orientation	“Tell me the date?” Ask for omitted items.	One point each for year, season, date, day of week, and month	5
Place orientation	“Where are you?” Ask for omitted items.	One point each for state, county, town, building, and floor or room	5
Register three objects	Name three objects slowly and clearly. Ask the patient to repeat them.	One point for each item correctly repeated	3
Serial sevens	Ask the patient to count backwards from 100 by 7. Stop after five answers. (Or ask them to spell “world” backwards.)	One point for each correct answer (or letter)	5
Recall three objects	Ask the patient to recall the objects mentioned above.	One point for each item correctly remembered	3
Naming	Point to your watch and ask the patient “what is this?” Repeat with a pencil.	One point for each correct answer	2
Repeating a phrase	Ask the patient to say “no ifs, ands, or buts.”	One point if successful on first try	1
Verbal commands	Give the patient a plain piece of paper and say “Take this paper in your right hand, fold it in half, and put it on the floor.”	One point for each correct action	3
Written commands	Show the patient a piece of paper with “CLOSE YOUR EYES” printed on it.	One point if the patient’s eyes close	1
Writing	Ask the patient to write a sentence.	One point if sentence has a subject, a verb, and makes sense	1
Drawing	 Ask the patient to copy a pair of intersecting pentagons onto a piece of paper.	One point if the figure has ten corners and two intersecting lines	1
Scoring	A score of 24 or above is considered normal.		30

10.2 PARKINSON’S DISEASE

A slowly progressive, age-related, degenerative disorder of the CNS, characterized clinically by tremor, bradykinesia, rigidity, and disturbed postural reflexes (parkinsonism).

10.2.1 Aeromedical Status]

Most applicants with Parkinsonism suffer physical and/or cognitive deficits which render them unfit. Individuals who have minimal Parkinson’s disease, such that they do not require L-dopa or an L-dopa agonist, may [be assessed as fit]. All patients licensed with Parkinson’s disease must have a detailed neurological assessment at each [revalidation /renewal] and more frequently if clinically indicated. This assessment applies to Class 1 and Class 2.

10.3 MULTIPLE SYSTEMS ATROPHY (MSA)

A sporadic, adult-onset progressive, degenerative disease of unknown aetiology which is clinically protean, characterized by autonomic dysfunction, parkinsonism, and ataxia in any combination,

10.3.1 Aeromedical Status

Applicants with MSA are permanently unfit.

11 DEVELOPMENTAL DISEASES OF THE NERVOUS SYSTEM

11.1 ARNOLD–CHIARI MALFORMATION

A number of developmental anomalies of the hindbrain, base of skull, and upper cervical canal characterized by caudal displacement of the cerebellar tonsils, and sometimes more of the cerebellum and lower brainstem, through the foramen magnum into the cervical spinal canal.

11.1.1 Aeromedical Status

Applicants are permanently unfit.

11.2 NEUROFIBROMATOSIS

The neurofibromatoses are a group of neurocutaneous syndromes primarily affecting tissues derived from the neural crest. NF-1 type more common type, with better prognosis

11.2.1 Aeromedical Status

Each case should be considered individually by the AMS considering:

- Symptomatology
- Number of lesions

12 EPILEPSY

12.1 PROGNOSIS

Risk of a second seizure after a first seizure

- 31–71%, depending on other risk factors:

EEG: epileptiform discharges: 80% risk; non-specific abnormalities: 40% risk; normal: 12% risk.

12.2 GENERALISED TONIC-CLONIC SEIZURES (GRAND MAL)

- Age group: any age.
- Symptoms:
 - Premonitory irritability, headache, elation, depression in some; others have no warning.
 - Focal onset (an aura) indicates initial partial seizure.
 - Tonic phase (15–30 seconds): contraction of facial, jaw, limb, chest, trunk muscles, initial cry sometimes as air is expelled loss of muscle tone (fall) cyanosis; tonic convulsions.
 - Clonic phase: rhythmic jerking/convulsions of limbs.
 - Post-ictal phase: muscle relaxation slow deep breathing through clenched jaws deep sleep, stupor, confusion for minutes to hours awareness of headache and muscle soreness later.
- Duration: 1–3 minutes.
- Special features:
 - Tongue biting and urinary incontinence sometimes.

- A succession of tonic-clonic seizures, without regaining consciousness for more than 30 minutes, is known as convulsive status epilepticus

12.3 ABSENCES (PETIT MAL)

- Age group: children and juveniles.
- Symptoms: sudden brief loss of consciousness, staring and blinking; immediately regain consciousness.
- Duration: few–30 seconds.
- Special features:
 - Long absences may be accompanied by: simple actions (automatisms) upward rolling of the eyes lip smacking, chewing, fiddling, fumbling with clothing slight jerking of limbs (myoclonus), passing urine, falling to the ground (akinetetic attack)

12.4 JUVENILE MYOCLONIC EPILEPSY

This is the most common form of idiopathic generalized epilepsy in older children and young adults. It begins in adolescence, typically about age 15, with a range that essentially spans all of the teenage years. The patient comes to attention because of a generalised seizure, often upon awakening or because of myoclonic jerks in the morning that involve the entire body; sometimes absence seizures are prominent. The family reports that the patient has occasional myoclonic jerks of the arm and upper trunk that become prominent with fatigue, during early stages of sleep, or after alcohol ingestion. The disorder does not impair intelligence and tends not to be progressive, but a proclivity to infrequent seizures usually continues throughout life. Valproic acid in particular and some other anticonvulsants have been highly effective in eliminating the seizures and myoclonus; they should be continued indefinitely. Withdrawal of anti-epileptic medication is associated with a high relapse rate (in 80% of patients).

12.5 PARTIAL EPILEPTIC SEIZURES

12.5.1 Simple partial seizures (focal)

- Age group: any age.
- Symptoms: depend on location of seizure focus; no loss of consciousness and no postictal confusion.
- Duration: seconds to minutes.
- Special features: an 'aura' is a simple partial seizure.
- Subtypes:
 - Focal motor seizures (Jacksonian epilepsy): usually start with twitching of face or thumb which spreads over several seconds to the ipsilateral arm and leg as epileptic activity 'marches' over the contralateral motor cortex.
 - Focal sensory seizures: arise from primary sensory cortex and can take the form of contralateral paraesthesia (somatosensory cortex), unformed visual hallucinations, e.g. light flashes (visual cortex), transient vertigo and simple auditory hallucinations such as crackling, buzzing (auditory cortex-superior temporal gyrus).

12.5.2 Complex partial seizures

- Age group: any age.
- Symptoms: depend on location of seizure focus impaired consciousness; postictal confusion.
- Duration: minutes.
- Subtypes:
 - Olfactory and gustatory hallucinations: usually unpleasant smells and taste, and dreamy state, arise from uncus of temporal lobe.
 - Visual and auditory hallucinations: formed visual hallucinations of objects, animals and people originate in the visual association cortex; complex hallucinations of music and conversation may arise in the auditory association cortex.
 - Emotional disturbances: rapid onset of unexplained fear/terror or elation, may arise in the temporal lobe.

- Memory disturbances (transient): amnesia, *dèja vu* (a false sensation of familiarity), *jamais vu* (a false feeling of unfamiliarity and strangeness), illusion of time passing more quickly or slowly.
- Automatisms: episodes of movements and apparently confused behaviours, with impaired awareness and consciousness (e.g. lip smacking, chewing movements, picking at clothes, fumbling with objects, and driving a car), ictal or post-ictal, patient cannot remember them.

12.5.3 Benign Childhood Epilepsy with Centrotemporal Spikes (Rolandic Epilepsy, Sylvian Epilepsy) and Epilepsy with Occipital Spikes

This type of focal motor epilepsy is unique among the partial epilepsies of childhood in that it tends to be a self-limited disorder, transmitted in families as an autosomal dominant trait. The convulsive disorder begins between 5 and 9 years of age and usually announces itself by a nocturnal tonic-clonic seizure with focal onset.

The seizures are readily controlled by a single anticonvulsant drug and gradually disappear during adolescence.

12.6 FEBRILE SEIZURES

The well-known *febrile seizure*, peculiar to infants and children between 6 months and 5 years of age (peak incidence 9 to 20 months) and with a strong tendency to be inherited, is generally regarded as a benign condition. Usually it takes the form of a single, generalized motor seizure occurring as the temperature rises or reaches its peak. Seldom does the seizure last longer than a few minutes; Recovery is complete. These patients' risk of developing epilepsy in later life is only slightly greater than that of the general population.

12.7 SEIZURES WITH ONSET IN ADULT LIFE AND SECONDARY SEIZURES

12.7.1 Withdrawal Seizures

The possibility of abstinence seizures in patients who had chronically abused alcohol, barbiturates, or benzodiazepine sedative drugs must always be considered when seizures occur for the first time in adult life

12.7.2 Infections

Bacterial meningitis, acute herpes simplex encephalitis

12.7.3 Endogenous Metabolic Encephalopathies

12.7.4 Medications as a Cause of Seizures

12.7.5 Global Arrest of Circulation and Cerebrovascular Diseases

12.7.6 Seizures with Acute Head Injury

12.8 MANAGEMENT OF FOCAL OR GENERALIZED SEIZURES IN LATE ADULT LIFE

A person in the later age group who begins to have seizures of either partial or generalised type is always to be suspected of harboring a primary or secondary tumor or an infarct that had not declared itself clinically. This is a matter usually settled by the neurologic examination and by CT or MRI. Tumor, either primary or secondary, will be found to account for about half the cases of seizures occurring for the first time in late adult life. Previous infarcts are by far the most common lesions underlying status epilepticus in late adult life, and an old trauma is as common as well. Cortical and subcortical encephalomalacia, the result of previous traumatic contusions, is a particularly important cause of seizures among alcoholics; the lesions are revealed by brain imaging and are typically located in the anterior frontal and temporal lobes.

Brain abscess and other inflammatory and infectious illnesses are less common except in tropical regions. Seizures as a result of Alzheimer and other degenerative diseases do occur but are uncommon. In the not infrequent cases of an adult with a first seizure that remains unexplained after thorough evaluation, it is a

practice to administer an anticonvulsant and to re-evaluate the situation in a matter of 6 to 12 months, with the goal of eventually discontinuing medication. Usually, a second MRI and EEG are performed to exclude focal abnormalities that were not appreciated during the initial evaluation, but often these studies are again unrevealing. One-third of patients with a single unprovoked seizure will have another seizure within 5 years; the risk is even greater if there is a history of seizures in a sibling, a complex febrile convulsion in childhood, or a spike-and-wave abnormality in the EEG. Moreover, the risk of recurrence is greatest in the first 24 months. In patients with two or three unexplained seizures, three-quarters have further seizures in the subsequent 4 years.

12.9 DISCONTINUATION OF ANTICONVULSANTS

Withdrawal of anticonvulsant drugs may be undertaken in patients who have been free of seizures for a prolonged period. There are few firm rules to guide the physician in this decision. A safe plan, applicable to most forms of epilepsy, is to obtain an EEG whenever withdrawal of medication is contemplated. If the tracing is abnormal by way of showing paroxysmal activity, it is generally better to continue treatment. After 2 years on a single anticonvulsant during which no seizures had occurred, the rate of relapse was 40 percent 2 1/2 years later and 50 percent at 5 years after discontinuation; this compared to the seizure recurrence rate of 20 percent for patients remaining on medication. Patients with juvenile myoclonic epilepsy, even those with long seizure free periods, should probably continue with medication lifelong, but there have been no thorough studies to our knowledge to support this dictum. The appropriate duration of treatment for postinfarction epilepsy has not been studied, and most neurologists continue to use one drug indefinitely.]

[12.10] Aeromedical Status

Those which are alcohol-provoked and have no demonstrable EEG abnormality would seem to have the best prognosis and may be considered [with a multi-pilot (Class 1 'OML') or a safety pilot (Class 2 'OSL') limitation] after full consideration of any alcohol abuse problem. Ultimately, any single unprovoked seizure after the age of five [must be considered disqualifying (vide infra) particularly if associated with EEG abnormality with the consideration that a little more latitude in the area of 'provocation' can be allowed for established aircrew. An applicant with a history of a single, uncomplicated febrile convulsion between the age of 1 and 5 years will still be eligible for pilot training. If, however, the convulsion was complicated, the applicant will no longer qualify, i.e.

- i. A convulsion before the age of 1 year. This holds the risk for mental retardation and epilepsy later in life.
- ii. Multiple febrile convulsions.
- iii. Duration of convulsions longer than 5 minutes.
- iv. Lateralising signs during febrile convulsions.

An individual with a single epileptiform seizure is initially unfit for medical certification. A case may be reconsidered five years from a seizure, if the following conditions are met:

- Specialist neurological examination is normal
- Repeated EEGs, including sleep-deprived EEGs, do not reveal any significant abnormalities
- Studies incorporating additional nasopharyngeal or minisphenoidal electrodes, if relevant, do not reveal any significant abnormalities
- Neuro imaging, preferably by MRI, has demonstrated normal brain structure.

In case of Benign rolandic seizures the applicant may assessed as fit by the AMS.]

[12.11] THE ELECTROENCEPHALOGRAPH IN AVIATION NEUROLOGY

The EEG is a clinical tool of value to neurological specialists and although widely used for screening aircrew applicants, its sensitivity and specificity under such circumstances remains ill-defined. [EEG is required when indicated by the history of the applicant or on clinical grounds.]

[12.11.1] Electroencephalograph technique.

In order to reduce variation in interpretation, the technique used must be standardised where possible. The national aeromedical department shall ensure EEG recording facilities are to a high standard [and that the reading and interpretation follows standardised, international procedures.]

Recommended procedure

- a 20 leads with 10/20 (international) placement.
- b The montage and machine settings shall be indicated on the tracing.
- c Calibration is required at the beginning and end of each complete tracing.
- d Each montage recorded should include eyes open as well as closed.
- e There should be 2–3 minutes of hyperventilation.
- f Photic stimulation should be carried out in a darkened room with at least 10 exposures between 1 and 30 Hz.
- g A minimum of 20 minutes of recording on a 16 channel machine (or equivalent) is required.
- h If a subject falls asleep during the recording, it should be continued through the progressive phases of sleep, with intermittent arousal as appropriate.

Interpretation of EEGs.

There has been much discussion regarding the significance of various wave forms, particularly in predicting convulsive episodes. There is general agreement that paroxysmal phenomena (epileptiform or seizure patterns), the photoconvulsive response and spike-and-wave complexes (2–4 Hz, irregular, generalised or focal) are significant. Although such cases appear to be only 0.5% of apparently normal applicants, the published data [indicate] a risk of convulsion exceeding 1% per annum and therefore beyond that acceptable for professional aircrew or solo private pilotage.

12.11.2 Definitions

Epileptiform pattern.

Interpretive term. Applies to distinctive waves or complexes, distinguished from background activity, and resembling those recorded in a proportion of human subjects suffering from epileptic disorders and in animals rendered epileptic experimentally. Epileptiform patterns include spikes and sharp waves, occurring singly or in bursts lasting at most a few seconds. Comments:

- (1) This term refers to interictal paroxysmal activity and not to seizure patterns.
- (2) The probability of association with clinical epileptic disorders is variable.

Seizure pattern.

Phenomenon consisting of repetitive EEG discharges with relatively abrupt onset and termination and characteristic pattern of evolution, lasting at least several seconds. The component waves or complexes vary in form, frequency and topography. They are generally rhythmic and frequently display increasing amplitude and decreasing frequency during the same episode. When focal in onset, they tend to spread subsequently to other areas. Comment: EEG seizure patterns unaccompanied by clinical epileptic manifestations detected by the recordist and/or reported by the patient should be referred to as 'subclinical'. (cf. epileptiform pattern.)

Paroxysm.

Phenomena with abrupt onset, rapid attainment of a maximum and sudden termination, distinguished from background activity. Comment: commonly used to refer to epileptiform patterns and seizure patterns. (cf. epileptiform pattern; seizure pattern, EEG.)

Spike.

A transient, clearly distinguished from background activity, with pointed peak at conventional paper speeds and duration from 20 to under 70 ms, i.e. 1/50–1/14 s, approximately. Main component is generally negative relative to other areas. Amplitude is variable.

- Comments:
- (1) EEG spikes should be differentiated from sharp waves, i.e. transients having similar characteristics but longer durations. However, it is well to keep in mind that this distinction is largely arbitrary and serves primarily descriptive purposes. Practically, in ink written EEG records taken at 3 cm/s, spikes occupy 2 mm or less of paper width and sharp waves more than 2 mm.
 - (2) EEG spikes should be held in clear contradistinction to the brief unit spikes recorded from single cells with microelectrode techniques. (cf. sharp wave.)

3 Hz spike-and-slow-waves.

Characteristic paroxysm consisting of a regular sequence of spike-and- slow-wave complexes which:

- (1) repeat at 3–3.5 Hz (measured during the first few seconds of the paroxysm),
- (2) are bilateral in their onset and termination, generalised and usually of maximal amplitude over the frontal areas,
- (3) are approximately synchronous and symmetrical on the two sides of the head throughout the paroxysm. Amplitude is variable but can reach values of 1000 μ V (1 mV).

Photoconvulsive response.

A generalised discharge of spikes or spike wave activity consistently elicited by intermittent photic stimulation, which is autonomous occurring asynchronously with respect to the stimulus, and self-sustaining outlasting the stimulus train by at least 100 msec.

[13 DISORDERS OF THE CSF CIRCULATION

13.1 HYDROCEPHALUS

Hydrocephalus is defined as an increase in volume of the CSF in association with dilatation of the cerebral ventricles.

13.1.1 Clinical features

Raised intracranial pressure causing

- Headache, often worse in the early morning.
- Nausea and vomiting.
- Blurred vision, occasionally.
- Diplopia, due to VIth nerve palsy may occur.
- Papilloedema sometimes; its absence does not exclude raised intracranial pressure.
- Optic atrophy with progressive visual loss and poor pupillary reaction to light: a late complication of chronic papilloedema due to raised intracranial pressure.
- Upgaze paresis.
- Increasing unsteadiness of gait occurs, culminating in frequent falls due to a combination of ataxia, spasticity and dyspraxia of gait.
- Urgency of micturition and eventual incontinence

13.2 NORMAL PRESSURE HYDROCEPHALUS (NPH)

A chronic hydrodynamic hydrocephalus that occurs in adults and is associated with a delay in the circulation or absorption of CSF and progressive neurological deficit comprising Hakim's triad of gait apraxia, urinary incontinence, and progressive dementia.

13.3 AEROMEDICAL STATUS

These applicants will be unfit for flying duties.]

14 INFECTIONS OF THE NERVOUS SYSTEM

14.1 MENINGITIS AND ENCEPHALITIS

14.1.1 ACUTE PYOGENIC (BACTERIAL) MENINGITIS

Fever, headache, meningismus (neck stiffness), and signs of cerebral dysfunction (confusion, delirium, vomiting or declining consciousness) are found in about 85% of patients at presentation. Cranial nerve palsies, particularly nerves III, IV, VI and VII (30% of cases). Epileptic seizures (30%) or focal neurological signs (10–20% of cases), due to inflammation and thrombosis of cortical arteries and veins and venous sinuses (causing cerebral infarction), or subdural effusion.

14.1.2 SUBACUTE AND CHRONIC MENINGITIS AND/OR ENCEPHALITIS

A syndrome characterized by various combinations of fever, headache, lethargy, stiff neck, confusion, nausea, and vomiting with accompanying CSF pleocytosis, of greater than 4 weeks duration.

14.1.3 TUBERCULOUS MENINGO-ENCEPHALITIS

Neurological impairments persist in 20–30% of survivors, most commonly cognitive dysfunction, epileptic seizures, visual and oculomotor disorders, deafness and hemiparesis.

14.1.4 ACUTE ASEPTIC MENINGITIS

Prognosis determined by the underlying cause. Most cases do not progress; resolution begins within a few days and is complete within 2 weeks in most patients. A few will have persistent malaise and myalgia for some weeks.

14.1.5 VIRAL ENCEPHALITIS

At 10 year follow-up: almost half the survivors have motor dysfunction and educational dysfunction; well over a third have neurological dysfunction, and almost a fifth have behavioural, self-care and sensory dysfunction.

14.1.6 Aeromedical status

All applicants diagnosed with meningitis should not engage in flight duties for six months. Return to flight duties depends on the nature of the infecting agent or cause of meningitis, eg, viral, bacterial or fungal, and the degree of recovery of resultant deficit and risk of development of epilepsy or hydrocephalus.

14.2 INTRACRANIAL ABSCESS

The usual presenting features are the subacute onset and progressive evolution of:

- Fever.
- Headache.
- Lethargy and malaise.
- Seizures.
- Focal neurological signs.
- Symptoms and signs of raised intracranial pressure. Epilepsy is a complication in more than 50% of survivors.

14.2.1 Aeromedical status

Assessment is based on the underlying cause and whether the lesion is:

- Supratentorial, in which case the risk of epilepsy and the degree of deficit must be considered, or
- Infratentorial, where the nature and degree of deficit must be considered.

14.3 NEUROSYPHILIS

Symptoms include headache, nausea and vomiting, neck stiffness, seizures and changes in mental status; patients are often afebrile.

- Ocular or cranial nerve abnormalities, especially VII and VIII, may occur due to involvement at the base of the brain.
- Argyll Robertson pupils.

Antimicrobial therapy can cure meningovascular syphilis and arrest tabes dorsalis, but lightning pains and fixed neurological deficits are likely to remain.

14.3.1 Aeromedical status

Return to flight duties depends on the degree of recovery of the resultant deficit.

14.4 HUMAN IMMUNODEFICIENCY VIRUS (HIV)-ASSOCIATED COGNITIVE/MOTOR COMPLEX (HIV-CMC)

A distinct neurological syndrome of subcortical dementia characterised by slowness and imprecision of cognition and motor control, and called the AIDS dementia complex or HIV-1-associated cognitive/motor complex. It is the most important 'primary' neurological complication of HIV infection. Progressive, may be insidious or rapid.]

[14.4.1] Aeromedical status

Once symptoms of the AIDS-related complex have appeared a temporarily unfit assessment would appear inevitable as, despite remissions, the usual course is of progressive deterioration. The psychological trauma of HIV sero positivity is major and formal psychiatric opinion may be necessary before any return to flying can be considered. More recent publications would indicate that damage to the individual immune response can be staged (see Chapter on Sexually Transmitted Diseases and Other Infections), therefore making assessment somewhat easier. This assessment applies to Class 2. Class 2 'OSL' may be appropriate if immune staging not available.

[15] INFLAMMATORY DISORDERS OF THE NERVOUS SYSTEM

[15.1] MULTIPLE SCLEROSIS

About two-thirds of cases of MS have their onset between 20 and 40 years of age. Of the remainder, most cases begin before the age of 20; in a smaller number, the disease appears to develop in late adult life (late fifties and sixties). Episodic neurological symptoms, often with full recovery, give rise to suspicion of multiple or disseminated sclerosis. Any part of the central nervous system may be affected. Weakness or numbness, sometimes both, in one or more limbs is the initial symptom in about half the patients. In about 25 percent of all MS patients (and in a larger proportion of children), the initial manifestation is an episode of optic neuritis. About half of patients with optic neuritis recover completely, and most of the remaining ones improve significantly. The main point to be made here is that one-half or more of adult patients who present with optic neuritis will eventually develop other signs of MS. Investigations showed that MS developed in 74 percent of women and 34 percent of men by the 15th year after onset of visual loss; the risk is considerably lower (22 percent at 10 years) if the cranial MRI fails to reveal demyelinating lesions. Other initial symptom of MS is acute myelitis. The cumulative probability of developing MS after 2 years is similar after either optic neuritis or transverse myelitis. There are no screening tests for MS but a family history does increase the risk. The duration of the disease is exceedingly variable. A small number of patients die within several months or years of the onset, but the average duration is in excess of 30 years. A relapsing and remitting course occurs in about 80% of patients. Relapse may occur at any time. The average relapse rate is about 0.5 attacks per year but is very variable. A chronic progressive course occurs from onset in the other 20%, particularly if onset occurs after 40 years of age with spastic paraparesis due to spinal cord dysfunction. These patients also tend to have a worse prognosis.

[15.1.1] Aeromedical status

Initial applicants with an established history must therefore [be assessed as unfit. At revalidation / renewal applicants may be assessed as fit with a multi-pilot (Class 1 'OML') of safety pilot (Class 2 'OSL') limitation]. Any neurological event of any note requires specialist neurological assessment.

If multiple sclerosis is considered a strong diagnostic possibility investigation should include cerebrospinal fluid (protein bands) MR scans and evoked responses. [The mean of symptom recurrence is approximately four years with only 5% being sudden and 20% severe. The inflight risk is therefore small (less than 1% per annum or one in 10-7 flying hours)]. Should the probability [of a multiple sclerosis] remain high, but symptoms are fully recovered an individual may be [assessed as fit with a multi-pilot (Class 1 'OML') of safety pilot (Class 2 'OSL') limitation] after six months, [requiring] a six monthly review:

- a ophthalmologically to look for colour contrast acuity phosgenes, after images and post fixation blindness;
- b operationally (simulator) to assess attention overload and judgement.

Any individual who is left with a neurological deficit after an exacerbation must be [assessed as] unfit. A similar assessment is appropriate for Class 2 'OSL'.

[In all cases, [the] assessment depends upon:

- Nature of symptoms
- Time between exacerbations
- Residual deficit
- Likelihood of sudden incapacitation
- Activity of the disease.

A flight test may be necessary to determine the effect of any residual deficit.]

16 INHERITED METABOLIC DISEASES OF THE NERVOUS SYSTEM OF ADULT ONSET

16.1 WILSON'S DISEASE

Pseudosclerotic, with tremor of the limbs (postural and intention) that closely resembles that seen in multiple sclerosis and which can be severe enough to be described as 'wing-beating', titubation of the head, incoordination, limb ataxia, and dysarthria

16.2 MITOCHONDRIAL DISEASES

Generalized seizures. Myoclonus: spontaneous and stimulus-sensitive. Ataxia

16.3 ADRENOLEUCODYSTROPHY

Pseudobulbar palsy: dysarthria; dysphagia; quadriparesis; emotionalism. Dementia (i.e. progressive learning difficulties and decline in scholastic performance). Personality change.

16.4 AEROMEDICAL STATUS

These applicants should assessed as unfit.

17 MONONEUROPATHIES

17.1 RADIAL NEUROPATHY

Partial lesions tend to recover spontaneously and over about 6–8 weeks.

17.2 CARPAL TUNNEL SYNDROME

Paraesthesia (e.g. tingling), with or without numbness and pain, involving the palmar surface of the hand (particularly the thumb, index, middle and ring fingers innervated by the median nerve) and often extending proximally into the forearm, arm and even neck. The symptoms are frequently worse at night weeks.

17.3 ULNAR NEUROPATHY

Partial lesions tend to recover spontaneously and over about 6–8 weeks. Severe ulnar neuropathy caused by compression at the elbow may take 6–12 months after operation to recover, and may not recover at all.

17.4 SCIATIC NEUROPATHY

Wasting and weakness of knee flexion and all movements of the foot and toes.
Diminished sensation of the posterior thigh and calf.

17.5 TIBIAL NEUROPATHY

Wasting and weakness of plantar flexion and inversion and toe flexion. Diminished sensation of the heel, sole of the foot and dorsal aspect of the toes.

17.6 PERONEAL NEUROPATHY

Foot drop Altered sensation (numbness or paraesthesia) of the lateral part of the lower leg and dorsum of the foot

17.7 Aeromedical status

These disorders are assessed on the basis of the nature and degree of deficit.

18 MOVEMENT DISORDERS

18.1 DYSTONIA

A syndrome of intermittent or continuous sustained muscle contractions, frequently causing twisting and repetitive movements or abnormal postures of virtually any part of the body. About 1 in 20 (5%) patients with any form of idiopathic dystonia may experience a spontaneous improvement or even resolution.

18.2 ESSENTIAL TREMOR

A low frequency postural tremor which is absent at rest and not associated with the clinical signs of parkinsonism or other neurological deficits. ET is slowly progressive but seldom becomes severe.

18.3 CHOREA

Involuntary, abrupt, irregular, arrhythmic and purposeless movements of variable amplitude and usually involving the face, hands and feet, which flow randomly from one body part to another. The prognosis depends on the cause. Hemichorea and hemiballismus due to stroke usually resolve within a few weeks or months.

18.4 MYOCLONUS

Sudden, very brief, shock-like involuntary movements caused by muscular contractions (positive myoclonus) or inhibitions (negative myoclonus). Myoclonus is a primarily descriptive term; it is not a diagnosis. Depends on the cause; myoclonus may occur as a transient or persistent phenomenon in many conditions such as viral encephalitis, suppurative meningitis, intoxications with strychnine and tetanus, and metabolic disorders such as uraemia and anoxic encephalopathy.

18.5 AEROMEDICAL STATUS

These disorders are assessed on the basis of the nature and degree of deficit.

19 MUSCLE DISORDERS

19.1 MYOTONIC DYSTROPHY

The most common form of muscular dystrophy in adults. Skeletal muscle wasting and weakness Sudden death is well recognized, and may be due to heart block or arrhythmia.

19.1.1 Aeromedical status

These applicants should be unfit for flying duties.

19.2 DERMATOMYOSITIS

An idiopathic inflammatory myopathy with characteristic cutaneous manifestations.

Initial symptoms include subacute onset of myalgias, fatigue and weakness, manifested as difficulty climbing stairs, raising the arms for actions such as shaving or brushing hair, rising from a squatting or sitting position, or a combination of these features. If treated early, most patients will respond well, with many showing full recovery of muscle function. In most cases the disease will burn itself out, although this may take many years during which time treatment has to be continued.

19.2.1 Aeromedical status

This disorder is assessed on the basis of the nature and degree of deficit.

19.3 POLYMYOSITIS

An acquired inflammatory myopathy characterized by progressive muscle weakness and the presence of inflammatory infiltrates in muscle. Slow onset (weeks to months). Usually symmetrical weakness of proximal limb muscles, typically involving the pelvic more than the shoulder girdle, occasionally with pain and muscle tenderness. Weight loss, neck weakness, dysphagia and voice change are common. The response is less favourable than in dermatomyositis, particularly in those with a long history at presentation. Immunosuppressive therapy usually prevents further progression but significant improvement may not occur.

19.3.1 Aeromedical status

These applicants should be unfit for flying duties.]

[20] NEUROMUSCULAR JUNCTION DISORDERS

[20.1] MYASTHENIA GRAVIS

The clinical hallmarks are muscular weakness and fatigability. The weakness tends to increase with repeated activity and improves with rest. Weakness usually occurs in a characteristic distribution. The eyelid and extraocular muscles are the first muscles to be involved in about 65% of patients, and are affected at some stage of the disorder in >90% of patients, causing ptosis and diplopia, which are typically asymmetrical. Remission or substantial improvement can be expected in 80% of patients and most patients lead normal lives but take immunosuppressive medication indefinitely.

[20.1.1] Aeromedical status

These applicants should be unfit for flying duties.

[21 NUTRITIONAL DEFICIENCY AND THE NERVOUS SYSTEM

21.1 WERNICKE–KORSAKOFF SYNDROME

Wernicke's disease (thiamine deficient encephalopathy) is a disorder [characterised] by rather abrupt onset of any combination of nystagmus, gait ataxia, conjugate gaze palsy and mental confusion in association with nutritional deficiency, especially due to alcoholism. Korsakoff's psychosis is a mental disorder, also associated with alcoholism and malnutrition, in which retentive memory is enormously impaired due to a defect in learning and memory, in an otherwise responsive patient. The Wernicke–Korsakoff syndrome is a symptom complex comprising the manifestations of both Wernicke's disease and the Korsakoff amnesic state.

21.1.1 Aeromedical status

These applicants should be unfit for flying duties.

21.2 VITAMIN B12 DEFICIENCY

Vitamin B12 deficiency is a nutritional disorder of the nervous system that may be characterized by a symmetrical, distal, predominantly sensory peripheral neuropathy due to axonal degeneration, autonomic neuropathy, subacute combined degeneration of the spinal cord (or combined systems disease), optic neuropathy, dementia and other disturbances of higher mental function. The most important factor influencing the neurological response to treatment is the duration of symptoms before treatment is started. If treatment is given early enough, it may not only prevent progression but also reverse some neurological symptoms and signs besides paraesthesia in the feet and optic atrophy.

21.2.1 Aeromedical status

This disorder is assessed on the basis of the nature and degree of deficit.]

22 DISEASES OF THE PERIPHERAL NERVE

22.1 PERIPHERAL NEUROPATHY

Numbness and tingling, usually beginning in the feet (supplied by the longest nerves) are common symptoms of patients with sensory axonal neuropathies, particularly those involving damage to the cell body (e.g. vitamin B12 deficiency). Pain beneath the sole, and a feeling as if the socks are ruffled are other common symptoms. Upper limb symptoms, if present, generally include difficulty picking up small objects such as pins, numbness or a sandpaper feeling on the fingers.

22.2.1 Aeromedical status

These disorders are assessed on the basis of the nature and degree of deficit.

22.2 HEREDITARY NEUROPATHIES

22.2.1 Charcot–Marie–Tooth disease

Progressive, predominantly distal muscle wasting and weakness involves mainly the legs. Depending on the type, the disease has the potential to cause significant disability if ignored and prevention measures are not initiated early and maintained. The level of disability therefore depends on how early the patient is diagnosed and whether there has been consistent use of splints and compliance with exercise.

22.2.1.1 Aeromedical status

These applicants should be unfit for flying duties.

22.3 GUILLAIN–BARRÉ SYNDROME

Progressive symmetrical weakness of the limbs which develops acutely (within days) or subacutely (up to 4 weeks), and progresses over a period of 1–8 weeks in an ascending fashion (caudal to rostral), reaching a plateau, and then spontaneously resolving. Paraesthesiae in the hands and feet: not as prominent as motor signs. The interval from onset to peak disability may vary from hours to weeks. About 30% reach their maximum deficit within 7 days; others progress for up to 4 weeks. About 60% of cases are unable to walk at the height of their illness. Good recovery (includes paraesthesiae, mild weakness): 80%. Unsteady gait with or without orthosis: 5% Walk with callipers: 5%. Wheelchair-bound: 3%. Chronic or relapsing course: 3%. Mortality: 5%.

22.3.1 Aeromedical status

These disorders are assessed on the basis of the nature and degree of deficit.

22.4 CHRONIC INFLAMMATORY DEMYELINATING POLYNEUROPATHY (CIDP)

Typically subacute onset and progressive (over >8 weeks) asymmetrical weakness and/or numbness of the distal and proximal limbs, with pain, sensory ataxia, and areflexia. About 80% of patients respond to treatment, which needs to be continued for many years. About 13% of patients deteriorate sufficiently to become permanently dependent, bed-bound or chair-bound. About 87% of prevalent patients are able to walk without walking aids or other assistance. About half of patients have a relapsing remitting course.

22.4.1 Aeromedical status

These applicants should be unfit for flying duties.

22.5 DIABETIC NEUROPATHY

May be acute, but more commonly insidious. Distal symmetrical predominantly sensory (and motor) loss characterized by sensory impairment in a glove and stocking distribution and distal motor weakness. The sequelae of longstanding severe distal sensory loss, such as neuropathic joints, may be present. Autonomic neuropathy. The cranial nerves III and VII are affected particularly. Poor glycaemic control and low plasma concentrations of insulin independent of concentrations of glucose are associated with increased risk of development and progression of neuropathy. Autonomic neuropathy in diabetes probably carries a poor prognosis (i.e. increased risk of death).

22.5.1 Aeromedical status

These applicants should be assessed as unfit.

23 SPINAL CORD DISEASES

23.1 SPINAL MUSCULAR ATROPHY (SMA)

SMA's are a group of common inherited disorders characterized by degeneration of lower motor neurones, leading to progressive paralysis with muscular atrophy.]

23.1.1 **Aeromedical status**

These applicants should be assessed as unfit.]

[23.2] **MOTOR NEURONE DISEASES**

Motor neurone diseases are a heterogeneous group of inherited and sporadic disorders of upper and lower motor neurones which lead to progressive weakness of bulbar, limb, thoracic, and abdominal muscles with relative sparing of oculomotor muscles and sphincter function.

[23.2.1 **Aeromedical status**

These applicants should be assessed as unfit.]

[23.3] **SYRINGOMYELIA**

A chronic, progressive, degenerative disorder of the spinal cord, which causes progressive neurological symptoms, usually brachial amyotrophy and segmental dissociated sensory loss, as it expands. Usually slowly progressive and ultimately severely disabling but some patients experience a stepwise deterioration, and others 'plateau' and do not progress.

23.3.1 **Aeromedical status**

These applicants should be assessed as unfit.]

[23.4] **CERVICAL SPONDYLOTIC MYELOPATHY AND RADICULOPATHY**

A condition in which the spinal cord (myelopathy) and/or nerve roots (radiculopathy) are damaged, either directly by traumatic compression and abnormal movement, or indirectly by ischaemia due to arterial compression, venous stasis, or other consequences of the proliferative bony changes that characterize spondylosis.

- Neck pain in some.
- Numb, clumsy hands

The natural history is not well known because most patients undergo some form of surgical treatment. Spontaneous

regression and complete remission is unusual. About one third of patients experience a recurrence during a median

time of follow-up of 5 years.

[23.5] **ACUTE 'SLIPPED DISC'**

Back pain with or without radiculomyelopathy. Acute neck and low back pain, in the absence of tumour and other serious underlying disease, usually resolves rapidly within 4–6 weeks. Lumbar discectomy is successful in 80–90% of patients, if properly selected. Patients with severe cauda equina syndrome due to massive midline disc herniation have a guarded prognosis for neurological recovery, even with prompt disc removal and neural decompression.

[23.6] **SPINAL EPIDURAL HAEMATOMA**

Sudden and severe neck or back pain, followed in minutes to hours by progressive motor, sensory and sphincteric disturbances referable to radicular spinal cord or cauda equina origin.]

23.7 SPINAL EPIDURAL ABSCESS

Subacute onset. Systemic upset: fever, headache, malaise. Back pain and tenderness to palpation/percussion: local and severe. Neck/spine rigidity. Nerve root pain.

23.8 SPINAL CORD INFARCTION

Sudden onset. Flaccid paraparesis and weakness of myotomes below the level of the lesion. Recovery is impeded by autonomic dysfunction, pain, paraesthesia, depression. Poor prognosis if extensive deficits are present without initial improvement.

23.9 ACUTE TRANSVERSE MYELITIS

An acute loss of sensory, motor and bladder function due to inflammation of a transverse (\pm rostral-caudal) segment of the spinal cord. Extremely variable: about two-thirds recover to variable degrees and one-third remain paraplegic.

23.10 SPINAL CORD TUMOURS

Prognosis depends on the underlying cause and duration and degree of spinal cord and nerve root compression/ infiltration. In contrast to brain tumours, many spinal tumours are benign and produce their effects mainly by compression of the spinal cord rather than by invasion.

23.11 Aeromedical status

These disorders are assessed on the basis of the nature and degree of deficit. A simple test of the type of movement

and loads involved is the ability to step up onto a kitchen chair or wooden box 40 cms high. If this can be completed without pain, the pilot is considered fit for flying. Surgical procedures such as laminectomy require a similar degree of recovery before clearance to fly and will usually remain unfit for about 3 months

24 TRAUMATIC DISEASES OF THE NERVOUS SYSTEM

Head injury with associated brain damage is common but varies considerably in severity and extent. The basic problem in craniocerebral trauma is at once both simple and complex: simple because there is usually no difficulty in determining causation—namely, a blow to the head—complex because of a number of delayed effects that may complicate the injury. Brain damage occurs following penetration/laceration, deformation and accelerations. Secondary complications may occur subsequent to the loss of cerebrovascular autoregulation and formation of intracranial haematoma or traumatic subarachnoid haemorrhage. Further difficulties may ensue associated with infection, surgery or CSF fistulae. Long term one may see the development of post traumatic epilepsy and hydrocephalus. The aviation neurological assessment of head injury should consider firstly whether any significant CNS injury has occurred. A scalp laceration may appear severe but without loss of consciousness is unlikely to be significant, conversely any scalp injury may be associated with an alteration of consciousness and this possibility should be carefully explored in the history.

The severity of head injury should be assessed by:

- i the presence of demonstrable neurological deficit;
- ii duration of pre and post traumatic amnesia (the use of strong narcotic analgesics may produce amnesia which is not brain injury related);
- iii the presence of cranial fracture and any associated meningeal rupture.

24.1 SUBDURAL HAEMATOMA

Haemorrhage into the subdural space, usually caused by rupture of bridging veins which pass from the pia-arachnoid over the brain to a dural sinus. Usually initial loss of consciousness (from the head trauma),

which may persist or be followed by a short lucid interval of several hours where consciousness is regained, followed by progressive headache, confusion and deterioration of conscious state. Lateralizing neurological signs may be present. 85–90% of patients make a good functional recovery with appropriate treatment.

24.1.1 Aeromedical status

Mild head injury

- Loss of Consciousness/Post Traumatic Amnesia (LOC) / PTA < 30 min
- No neurological deficit
- No compounding factors (skull #, vertigo, headache)

It is recommended that all applicants who sustain a head injury and have impaired consciousness (no LOC) be grounded for at least 7 days, as even they may develop post-traumatic epilepsy. Those who have even a fleeting LOC and amnesia should be assessed as temporarily unfit for a period of 6 weeks. These applicants tend to recover fully, and may then fly without limitations.

Moderate head injury

- LOC / PTA >30 min but <24h
- Focal neurological deficits
- Skull base #
- Surgical penetration of the dura

Following a moderate head injury (particularly if the duration of post-traumatic amnesia is >12h) the applicant should be assessed as temporarily unfit for a period of 2 years (this decision is usually made/confirmed by the AMS.) After 2 years, the applicant may apply for fit assessment. The examination should preferably be coordinated by the designated body or institution and a series of special investigations are required (e.g. sleep deprivation / photostimulation EEG, CT / MRI scans of the brain, neuropsychological evaluation etc.). In addition to these special investigations, a practical flight test is usually required. Pilots may then be assessed as fit, assessed as fit with limitations, or unfit by the AMS.

Severe head injury:

- LOC / PTA 1 to 7 days
- Neurological/intellectual impairment
- Traumatic penetration of the dura
- Depressed skull #
- Traumatic intracranial haemorrhage
- EEG abnormalities persisting for >2 years

These applicants will most likely be assessed as unfit. Exceptional cases with a full clinical recovery may be considered for a fit assessment after 5 years following rigorous assessment (with several specialist reports and special investigations) co-ordinated from the designated body or institution.

Very severe head injury

- LOC / PTA >7 days
 - Missile penetration of the brain
 - Brain abscess
 - Debilitating neurological deficit
- Very severe head injury is disqualifying.

24.2 POSTTRAUMATIC EPILEPSY

Epilepsy is the most common delayed sequela of craniocerebral trauma, with an overall incidence of about 5 % in patients with closed head injuries and 50 % in those who had sustained a compound skull fracture and wound of the brain. The basis is nearly always a contusion or laceration of the cortex. As one might expect, the risk of developing posttraumatic epilepsy is also related to the overall severity of the closed head injury. The risk of seizures after severe head injury (loss of consciousness or amnesia for more than 24 h, including subdural hematoma and brain contusion) was 7 % within 1 year and 11.5 % in 5 years. If the injury was only moderate (unconsciousness or amnesia for 30 min to 24 h or causing only a skull fracture), the risk fell to 0.7 and 1.6 percent, respectively. After mild injury (loss of consciousness or

amnesia of less than 30 min), the incidence of seizures was not significantly greater than in the general population.

The interval between the head injury and the first seizure varies greatly. Some 4 to 5 % of hospitalized head-injured individuals are said to have one or more seizures within the first week of their injury (*early epilepsy*). The immediate seizures have a good prognosis and we tend not to treat them as if they represented epilepsy; on the other hand, late seizures are significantly more frequent in patients who had experienced epilepsy in the first week after injury (not including the convulsions of the immediate injury)

In medical writings, the term *posttraumatic epilepsy* usually refers to late epilepsy, i.e., to seizures that develop several weeks or months after the head injury (1 to 3 months in most cases). Approximately 6 months after injury, half the patients who will develop epilepsy have had their first episode; by the end of 2 years, the figure rises to 80 percent. The longer the interval, the less certain one is of its relation to the traumatic incident. Data derived from a 15-year study of military personnel with severe (penetrating) brain wounds indicate that patients who escape seizures for 1 year after injury can be 75 % certain of remaining seizure-free; patients without seizures for 2 years can be 90 % certain; and for 3 years, 95 % certain. For the less severely injured (mainly closed head injuries), the corresponding times are 2 to 6 months, 12 to 17 months, and 21 to 25 months.

24.2.1 Aeromedical status

The diagnosis of epilepsy is usually made after the second convulsion, but the applicant is unfit to fly after the first convulsion. If there are 3 or more convulsions in the first year, the incidence of persistent epilepsy is as high as 85%. After a head injury, the applicant is seen after 7 days, one month, and then 3 monthly for 2 years to observe for post-traumatic epilepsy and the posttraumatic syndrome. If an applicant does develop convulsions, he / she is seen weekly until they are controlled.

25 TUMOURS OF THE CENTRAL NERVOUS SYSTEM

Benign tumours: complete removal achieves a cure. Even with incomplete removal, prolonged survival is possible with repeated operations and adjuvant therapy.

Malignant tumours: prognosis is poor, despite surgery and radiotherapy; therefore, palliation of distressing symptoms is often the goal of therapy.

- Anaplastic astrocytoma: median survival time with radiotherapy and chemotherapy: 36–48 months.
- Mixed anaplastic astrocytoma and glioblastoma: median survival time with brain irradiation: 9–11 months; 10% of patients with glioblastoma survive 2 years.
- Metastases from the bronchus, gastrointestinal tract and melanoma have a worse prognosis than breast or renal metastases to the brain.

Favourable prognostic factors for adult supratentorial tumours

- Epileptic seizure as the initial presenting symptom.
- Young age (<45 years).
- Absence of focal neurological signs (i.e. hemiparesis).
- Absence of mental signs (confusion, altered awareness, personality change).
- Absence of contrast enhancement on cranial CT scan.
- Presence of cystic change on CT (a circular low density area before enhancement, with clear cut margin).
- Presence of diffuse low density on CT (diffuse, poorly demarcated low density without contrast enhancement).
- Presence of calcification on CT.

25.1 Aeromedical status

Tumours of the Central Nervous System are disqualifying. Potential exceptions are:

- **Supratentorial meningioma**
 - a These applicants should be assessed as temporarily unfit upon diagnosis.
 - b Following successful surgery, they must be asymptomatic, and have no neurological deficit for a period of 2 years before being considered for re-certification by the AMS.
 - c They will require a MR scan of the brain that shows no tumour, and an oncologist's report which states that:
 - i) The applicant is in remission.
 - ii) That he/she never had convulsions.
 - d The AMS may assess the applicant as fit, an annual medical examination (including specialist's report) is required.
- **Infratentorial meningioma, acoustic neuroma, pituitary adenoma, and benign extraaxial tumours:**
 - a Require the same conditions as a supratentorial meningioma.
 - b Except that the stipulated minimum period before a fit assessment is considered is 1 year.
- **Pseudotumour Cerebri:**

[These applicants are assessed as temporarily unfit for a period of at least 6 months, until they have been headache free, and have had normal visual fields.]

Whenever [a fit assessment] is considered, the AMS [has to consider, whether any eventual] neurological deficit is compatible with [flying] (medical flight test), and [whether] the risk of epilepsy is [only] minimal (less than 1% per annum). [A fit assessment] should [require a] multi-pilot (Class 1 'OML') [limitation] for an extended period. Reference should also be made to the oncology chapter. This assessment also applies to Class 2

26 VASCULAR DISEASES OF THE NERVOUS SYSTEM

Vascular lesions cause ischaemia or infarction with a variable degree of brain damage and, although the effects may appear reversible, there may be long term sequelae.

Lesions may be:

- a Haemorrhagic (aneurysms, arteriovenous malformation (AVMs) and spontaneous (intracerebral) bleeds.
- b Vasospastic (as in the initial phase of migraine).
- c Vaso-occlusive (embolism, thrombosis or vascular distortion).

Clinically all such conditions are potentially incapacitating, such incapacitation may or may not be reversible and may recur unpredictably.

Major types of cerebrovascular diseases and their frequency

	HARVARD STROKE	
	SERIES ^a (756 SUCCESSIVE CASES)	BCH AUTOPSY SERIES ^b (179 CASES)
Atherosclerotic thrombosis	244 (32%)	21 (12%)
Lacunae	129 (18%)	34 (18.5%)
Embolism	244 (32%)	57 (32%)
Hypertensive hemorrhage	84 (11%)	28 (15.5%)
Ruptured aneurysms and vascular malformations	55 (7%)	8 (4.5%)
Indeterminate		17 (9.5%)
Other ^c		14 (8%)

[As a group, TIA patients have an increased risk of stroke and other serious vascular events of about 8–10% per year. The risk of stroke is about 4–5% in the first month, 12% in the first year, 29% over 5 years. The risk of a coronary event is about 3% per year.

The average risk of recurrent stroke in patients with a first ever stroke is about:

- 13% in the first year (15 times the risk in the general population).
- 4% per year for subsequent years, so that by 5 years, about 30% will have suffered a recurrent stroke.

Epileptic seizures

- 2% of patients with a first-ever stroke have a seizure at stroke onset.
- 11% have a later seizure in the first 5 years of follow-up, but nearly half of these patients have only one seizure.
- The risk of seizures is increased in survivors of intracerebral and subarachnoid haemorrhage, and total anterior circulation infarction.
- Stroke survivors who are independent at 1 month after stroke have a very low risk of future seizures. Hence, stroke patients who are functionally competent may return to driving after 30 days.

26.1 INTRACRANIAL HAEMORRHAGE

Intracranial hemorrhage is the third most frequent cause of stroke. The frequency of seizures after each type of hemorrhage has not been established, but it is lower than for ischemic strokes. In patients who survive there can be a surprising degree of restoration of function, since, in contrast to infarction, the hemorrhage has to some extent pushed brain tissue aside rather than destroyed it. Function may return very slowly, however, because extravasated blood takes time to be removed from the tissues. About 7% of 30-day survivors suffer a recurrent stroke in the first year, of which at least 25% are haemorrhagic. About 70% of recurrences are fatal.]

[26.1.1 Spontaneous Subarachnoid Haemorrhage]

Spontaneous Subarachnoid Haemorrhage is associated with:

- i aneurysm (80%)
- ii arteriovenous malformation (15%)
- iii unidentified cause (<5%).

Convulsive seizures, usually brief and generalized, occur in 10 to 25 percent of cases. When a diagnosis of (i) or (ii) is confirmed the late epileptic risk would make revalidation extremely unlikely. Surgical repair of aneurysm brings an additional post craniotomy risk of epilepsy, however, where published data demonstrates post-operative criteria for an incapacitation risk <1%, [a fit assessment] may be considered. Patients with the typical clinical picture of spontaneous subarachnoid hemorrhage, in whom an aneurysm or arteriovenous malformation cannot be demonstrated angiographically, have a distinctly better prognosis than those, in whom the lesion can be [demonstrated]. Where no cause is identified and recovery complete, [a fit assessment with a multi-pilot (Class 1 'OML') or safety pilot (Class 2 'OSL') limitation] may be considered in normotensive individuals after 9 months. Class 2 [without limitation] may be considered after 2 years.

[26.1.2 Unruptured Intracranial Aneurysms

Not infrequently, cerebral angiography, MRI, MRA, or CT scanning performed for an unrelated reason, discloses the presence of an unruptured saccular aneurysm. The only clinical feature of significance relative to rupture is aneurysmal size. Studies found an extremely low rate of rupture (aneurysms smaller than 7 mm in diameter: annual risk about 0.1 % yearly; aneurysms between 7 and 10 mm: 0.5 %; lesions between 13 and 24 mm (depending on location): ranging from 0.6 to 3.5 %; aneurysms > 25 mm diameter: up to 10 %; the yearly rates for rupture were higher in all categories if there had been prior bleeding from another site)].

26.2 Cerebral decompression sickness]

Cerebral decompression sickness is postulated as the formation of bubbles in nitrogen supersaturated body fluids following a reduction in ambient pressure. Such bubbles may coalesce and produce local symptoms or, if in the blood, circulate throughout the body including the brain. Decompression sickness is rare in normal aircraft operations but should be considered when unpressurised aircraft are flying above 15,000 feet. It occurs at lower cabin altitudes when flying after SCUBA diving. Individuals who have experienced this condition as divers or in previous military flying should be carefully reviewed as permanent damage may be caused by repeated exposure.

26.2.1 Aeromedical status

Aviation Medicine Section assesses all cases individually.

26.3 TRANSIENT MEMORY LOSS

Loss of memory concerning a period of time (minutes to hours) is not uncommon. Causes include alcohol, epilepsy, migraine, TIA's, certain drugs (e.g. benzodiazepines) and psychiatric disturbances (e.g. psychogenic fugue).

26.3.1 Aeromedical status

Applicants must be assessed according to the underlying cause. The vast majority will be assessed as unfit.

26.4 GIANT CELL ARTERITIS

A systemic angitis that involves a wide variety of medium and large arteries, and tends to affect older people (over 50 years) causing two main clinical syndromes: temporal (cranial) arteritis and polymyalgia rheumatica, which respond rapidly to corticosteroid therapy. Ophthalmic GCA starts as a unilateral condition but may become bilateral after days, months, or years. Between one-third and one-half of patients can stop steroids after 2 years. Relapses are most likely during the initial 18 months of treatment and within 1 year of withdrawal of steroids. Patients should be urged to report back immediately if arteritic symptoms occur.

26.4.1 Aeromedical status

These disorders are assessed on the basis of the nature and degree of deficit.

26.5 CEREBRAL VENOUS THROMBOSIS

The prognosis for recovery of function is generally favourable and much better than in arterial occlusion.

26.5.1 Aeromedical status

These disorders are assessed on the basis of the nature and degree of deficit.

27 VERTIGO

Peripheral vertigo (most common)

Inner ear (semicircular canals, utricle, saccule)

- Benign paroxysmal positional vertigo (25% of cases).
- Vestibular neuronitis ('viral' labyrinthitis).
- Ménière's disease.
- Benign recurrent vertigo.
- Trauma (including perilymph fistula): head injury.
- Infection: otitis media, syphilis.
- Vascular lesions.

Vestibular nerve

- Meningitis.
- Acoustic neuroma and other cerebello-pontine angle tumours (usually cause unsteady gait and rarely cause vertigo, particularly if there is no deafness).
- Ototoxins: aminoglycosides, frusemide (cause imbalance rather than vertigo).

Central vertigo

- Tumours (usually posterior fossa).
- Vertebro-basilar ischaemia (but may also cause infarction of the labyrinth): cerebellar or brainstem infarction.
- Vascular malformation in brainstem (VIII nucleus)
- Multiple sclerosis involving brainstem.
- Trauma to brainstem
- Basilar migraine (may also cause end organ or peripheral involvement).
- Arnold–Chiari malformation.
- Syringobulbia.
- Drugs (alcohol, anti-epileptic drugs, barbiturates).
- Complex partial seizures can cause vertigo but almost always with other more typical symptoms.
- Vertigo is rarely, if ever, due to cervical spondylosis.

Sudden unilateral loss of vestibular function usually causes acute, severe vertigo that persists for hours to days. Even without recovery of the underlying vestibular deficit, resolution of the severe disabling symptoms occurs as a result of equilibration of the tonus in the brainstem vestibular nuclei via the CNS process known as compensation. During this recovery period the spontaneous symptoms resolve, but patients may continue to complain of shortlived episodes of vertigo induced by head or body motion. Persistent motion-induced symptoms following an acute vestibular insult reflect incomplete central compensation. In contrast, recurrent spontaneous episodes of vertigo indicate an unstable vestibular lesion resulting from active underlying pathology. Such conditions demand specific medical or surgical treatment.

27.1 Aeromedical status

These disorders are assessed on the basis of the nature and degree of deficit.

27.2 BENIGN PAROXYSMAL POSITIONAL VERTIGO

Episodic rotational vertigo of brief duration induced by head movement. Spontaneous resolution occurs in most cases. Episodes may last only a few days, but some patients can experience recurrent episodes for 2 months or more. In some cases, episodes occur recurrently for more than a year, and in others it can persist chronically.

27.2.1 Aeromedical status

Assessment is based on the frequency of occurrences, their duration and severity.

27.3 MÉNIÈRE'S DISEASE

Sudden onset of intense vertigo which may take many hours to resolve. Unilateral tinnitus and decreased hearing associated with a sensation of fullness and increased pressure. Recurrence of attacks is a hallmark of the disease. Many patients experience decremental hearing loss with recurrent episodes. Initially hearing low in the low frequencies is observed. As the disease progresses, high frequency hearing loss is seen

27.3.1 Aeromedical status

Applicants with these conditions are usually unable to meet the standard for certification, but require individual assessment.]

[28] EPISODIC NEUROLOGICAL PROBLEMS

[28.1] EPISODIC IMPAIRMENT OF CONSCIOUS LEVEL FATIGUE

Episodic Impairment of Conscious Level Fatigue or sleep loss can produce micro-sleep episodes which are immediately resolved by rest. Any other episodes need to be investigated neurologically as the differential diagnosis is wide – a diagnosis needs to be made and the potential risk of recurrence assessed. Narcolepsy, even when treated, is incompatible with flying. A history of recurrent fainting, whether vasovagal or syncopal is unacceptable as precipitating factors may well arise when flying. Hypoglycaemia is a popular diagnosis but rarely proven – if it is, the condition should be disqualifying. Occasionally an episode may follow alcohol withdrawal, under these circumstances, provided any alcohol abuse is treated and the individual remains asymptomatic, [a fit assessment with multi-pilot (Class 1 'OML') limitation] may be considered.

[28.2] SLEEP APNOEA SYNDROME

The sleep apnoea syndrome most commonly affects overweight males, especially between the ages of 40 and 60 years. The syndrome consists of excessive daytime sleepiness and frequent apnoeas during sleep, associated with loud intermittent snoring. Sleep recordings reveal apnoeic episodes in REM and non REM sleep. There may be an absence of respiratory effort with cessation of diaphragmatic movement. The upper airway can remain open even without airflow (central apnoea) or there may be excessive respiratory effort due to [obstruction of the upper airways]. The chronically disturbed nocturnal sleep and hypoxaemia causes excessive daytime sleepiness. This leads to inappropriate and unrefreshing naps, an obvious safety hazard in a pilot who may also have circadian disruption to deal with. The sleep apnoea syndrome evolves gradually and may not be fully described by the sufferer. It should be considered with any presentation of excessive sleepiness which is not improved by a period of undisturbed sleep. Investigation should include respiratory studies and sleep recordings. The condition can be treated but a diagnosis will require flight crew to be assessed [as] temporarily unfit until all aspects of the recovery and treatment can be considered by the AMS.

[29] CONGENITAL NEUROLOGICAL PATHOLOGY

Congenital conditions include hamartoma and arachnoid cysts discovered incidentally and spinal disorganisation including minor degrees of spina bifida. Each case must be considered individually but usually the decision is one of operational competence rather than risk of incapacitation.

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CHAPTER 13 - AVIATION OPHTHALMOLOGY

1 INTRODUCTION

This chapter is devoted to the assessment of visual functions in relation to aviation duties and to principles of ophthalmological examination techniques. The medical examiner should be familiar with the visual capacity required in various aviation duties and the necessity for a detailed special examination in certain cases.

This guidance material is intended to be applied in conjunction with the Ophthalmological Requirements and thus has regulatory implication; its main purpose is to aid in the implementation of provisions of the Medical Requirements. It intends to aid in the assessment of normal, presumably healthy applicants at initial or periodic examination, and applicants in whom there is a suspicion, or overt manifestation, of symptoms of disturbed visual function or eye disease. The aim is to achieve a measure of European uniformity of procedures and comparable results in the assessment of both normal and borderline cases.

1.1 Effect of the flight environment

The effectiveness of the visual system is of utmost importance if air crew [is] to carry out [its] duties safely and efficiently.

In the case of air crew, the effect of the flight environment influences the visual function by virtue of the following factors:

- a Altitude
- b Cockpit illumination
- c Speed
- d Acceleration
- e Vibration.

Environmental factors specific for air crew may reduce the visual performance to a degree not ordinarily experienced in normal ground tasks and should be taken into account accordingly.

With increasing flight altitude, the normal environmental light distribution reverses; when flying over clouds sunlight is reflected so that the lower part of the visual field is brighter than the upper one. At higher altitudes, the sky becomes more and more dark. The contrast glare thereby created makes reading the instrument panel difficult.

Most commercial aircraft are independent of ambient oxygen pressure due to pressurisation of the cabin. A slight degree of hypoxia, however, as experienced even in pressurised aircraft may influence visual fields, visual acuity, dark adaptation, and fusional range.

If contact lenses are used, the reduced oxygen pressure experienced during long distance flying may result in corneal hypoxia leading to corneal oedema and reduced visual acuity. The low air humidity on the flight deck further aggravates the problems induced by the low oxygen tension and may cause dry eye symptoms even in non-contact lens users.

Space myopia (empty field myopia) may occur at altitude due to scarceness of visual targets outside the cockpit. When there are no objects to fixate, the eyes of some people tend to accommodate thus becoming myopic to a degree of up to 1.5 dioptres. In practice, difficulties may arise when searching for other aircraft, especially at very high altitudes.

Cockpit illumination may produce visual problems for several reasons. At low illumination levels, the visual acuity is reduced and the depth of focus decreased due to the pupillary dilatation. This way presbyopic problems are enhanced. Also colour discrimination deteriorates making the reading of colour maps more difficult. Red light illumination causes even more problems with colours and may also induce a relative hypermetropia (as long wavelengths are less refracted in the ocular media).

It is generally not necessary to reduce cockpit illumination to a level corresponding to a deep mesopic or scotopic adaptation. (Under daylight conditions, only the cones of the retina are in operation and under full dark adaptation only the rods. Mesopic vision is an adaptational level in-between with both cones and rods functioning. It ranges from weak daylight to moonlight.) Most of the in-flight information in commercial aviation is provided by instruments. Likewise the runway illumination on international aerodromes is of such a standard that signals are seen without dark adaptation. In special situations, however, a certain degree of dark adaptation may be required for the correct identification of objects outside the aircraft.

The high speeds of modern aircraft at take-off, cruising and landing put special demands on the visual system. We have good reason to believe that dynamic visual skills, i.e. dynamic visual acuity and the threshold for angular motion is of greater importance than the static skills under these circumstances. The pronounced decrease in dynamic visual ability after the age of 50 to 60 years is of great concern in older pilots.

The effect of high acceleration forces is of minor importance in civil aviation. Under special conditions, however, such as tight manoeuvring in aerobatics or agricultural flying, visual disturbances (greyout, blackout) due to high G-forces may be encountered. Visual problems are likely to occur at positive accelerations greater than 3.5 G (+3.5 Gz) and lasting more than 6–12 seconds.

Vibration, especially within the 22–64 Hz range, may cause difficulties in reading instruments or printed material. In practice, problems arise under special operational conditions such as in helicopters. Vibration within the range of 2–10 Hz encountered in turbulence or on rough runways has a significant detrimental effect on visual performance.

1.2 Visual flight deck tasks

The main visual tasks of the pilot are the following:

- a Distance visual tasks
- b Intermediate and near vision tasks
- c Spatial orientation
- d Processing coloured information.

Based on the necessity of the pilot to be able to perform these tasks reliably, [visual requirements] have been established within the following areas:

- a Distance visual acuity
- b Near vision
- c Visual fields
- d Binocular function
- e Colour perception.

The purpose of the aeromedical eye examination is twofold: to confirm that the visual requirements are fulfilled, and to exclude the presence of eye pathology.

[]

1.3 Examination techniques

The eye examination should include a careful history, a clinical examination, and a precise measurement of the visual capacity.

Certain findings in the history should entail that the applicant is submitted to a more extensive examination, [e.g.]:

- a eye injuries or eye operations
- b regular use of drops or ointments
- c photophobia or the constant use of tinted glasses
- d irritation or itching of the eyes
- e current or previous use of spectacles or contact lenses
- f eye strain or headache, for instance if caused by close work
- g diplopia
- h impairment of vision under reduced illumination.

Information about hereditary eye diseases should be sought, e.g. tapeto-retinal degenerations (retinitis pigmentosa), corneal dystrophies, cataract, and glaucoma. Problems may later arise from manifestations of such diseases.

At the [revalidation or] renewal examinations, the applicant should be questioned about visual symptoms occurring under flight such as the need for tinted glasses (clouding of the ocular media), eye pain or irritation, diplopia, blurred vision, and difficulties with contact lenses or spectacles.

The clinical examination of the eyes and their adnexa should include the position and mobility of the lids, the condition of the eyelid margins and eyelashes, signs of epiphora, the position and movements of the globes, scars and other signs of previous trauma or inflammations, and abnormalities of the normal red pupillary light reflex. Signs of acute inflammatory processes are usually overt: congestion, lacrimation, blepharospasm, irregular pupils etc. Any abnormality should be further evaluated by an ophthalmologist.

The assessment of the various visual functions is detailed in the sections to follow.

2 VISUAL ACUITY

The measurement of visual acuity serves a double purpose: to tell whether the visual system as a whole is working properly and to measure the subject's ability to visually separate or identify details or small objects. In relation to the test effort necessary, probably no other test is so informative.

In practice, visual acuity means detection, resolution ability or recognition. In its strictest sense, visual acuity is the resolving power of the visual system, i.e. the ability to see two or more dots, lines or other objects as separate and not confluent. Tests based on this principle are tedious and cumbersome. Therefore the easier-used letters have become the mostly used objects for testing visual acuity. With these, recognition and other cognitive factors also come into play. Although letter identification is a complex task, testing is easy and the results very informative as to the visual function.

Many attempts have been made to achieve an internationally agreed standard procedure for visual acuity testing. Below, some of the recommendations and points brought forward by the Visual Functions Committee of the International Council of Ophthalmology will be cited.

2.1 Definitions

The applicant's visual acuity is defined by the visual angle to the details of the smallest object that can be seen. In many European countries, a figure is derived from the actual test distance and the distance where the object is seen with a stroke width of 1 minute of arc. As an example, the figures 6/12 ([0,5] or 20/40) are derived the following way: The subject is looking at objects at a distance of 6 metres (or 20 feet). The smallest object that he recognises would have been seen with a stroke width of 1 minute at the distance of 12 metres (or 40 feet); in fact they measure 2 minutes at the actual observing distance. The same figure, although usually written in decimal fractions, is obtained by calculating the inverse of the stroke width (in minutes) of the smallest object seen; 0.5 corresponds to 2 minutes etc.

6/6 or [1,0] is usually considered 'normal' visual acuity, although healthy young subjects often see 6/3 or [2,0]. Charts limited to objects of 6/6 [1,0] size deprive the examiner of the complete acuity testing.

2.2 Factors affecting the visual acuity

Among the factors that influence the outcome of the testing are the character of the test object (size and colour), the object contrast, the state of adaptation, the test distance, and the exposure time. With these held constant, acuity is limited by the refractive state of the eye and the capacity of the retinal-brain system.

2.3 Examination techniques

a *Test object*

Although tests with stripes, checkerboards and the like make possible a pure resolution task, their use is much restricted in practice. The Landolt ring (fig. 1), also predominantly testing the resolving power, has become the reference object to which others are usually compared. The ring has a stroke width and a gap measuring 1/5 of the outer diameter and is shown in different directions, usually the four main meridians. The several attempts to 'internationalise' this object have failed because testing is tedious and difficult to control in practice. The dominating optotypes used are letters, introduced by Snellen in 1862. Recognition of letters is a complex task, but their identification is probably a better means of measuring everyday seeing ability than any other test. Instruction is easy as is evaluation.

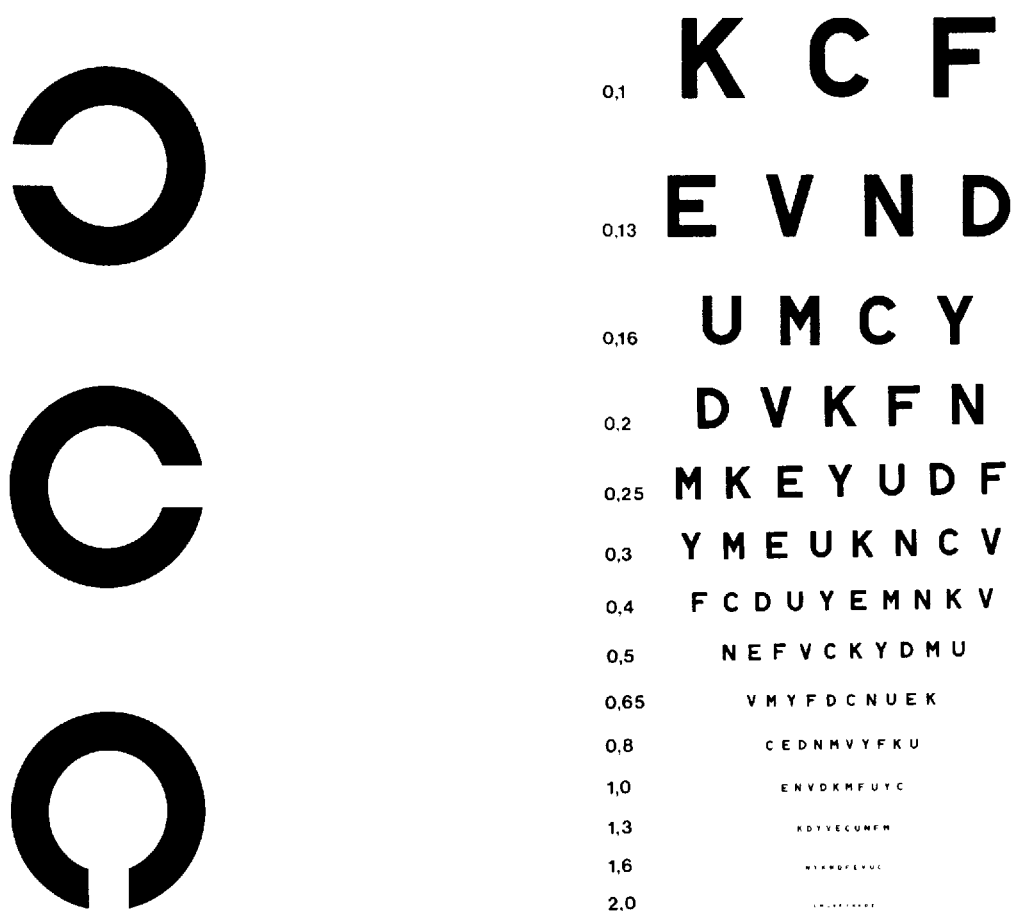


Figure 1 To the left Landolt rings; to the right a visual acuity chart with selected letters shown to be equivalent in legibility with the Landolt ring.

The main problem with letters is their different legibility. Some are easy to identify like L, I and T while others are difficult like G, R and B. A letter chart should include a selected number of letters of about the same legibility and equal to that of the Landolt ring. It is recommended that 10 different letters be used.

b *Object contrast*

Visual acuity decreases with reduced object contrast. A significant decrement does not occur, however, until the contrast decreases below 85%; the luminance of the black print therefore shall not exceed 15% of that of the white background. It is essential that no dirty or yellow charts be used. If a projector is used, it is essential that the object contrast is kept at optimal values.

Even very high levels of contrast may reduce the visual acuity.

c *Illumination*

The visual acuity increases with background luminance up to a maximum and then again decreases when the luminance is so high that glare interferes with seeing. As is evident in fig. 2, there are no significant differences as long as the luminance is kept above 80 cd/m². All commercially available boxes with built-in illumination give a sufficient illumination. If, however, a chart is lit by an extraneous light source, it is important that this gives a proper

illumination. It is easier to measure the light flux falling upon a surface (i.e. the illumination as measured in lux) than the luminance (i.e. the luminous intensity per unit area, usually measured in candelas per square metre, cd/m^2). Numerous other units for luminance exist, often creating confusion. With white paper reflecting about 75%, 1 lux roughly gives $0.24 \text{ cd}/\text{m}^2$.

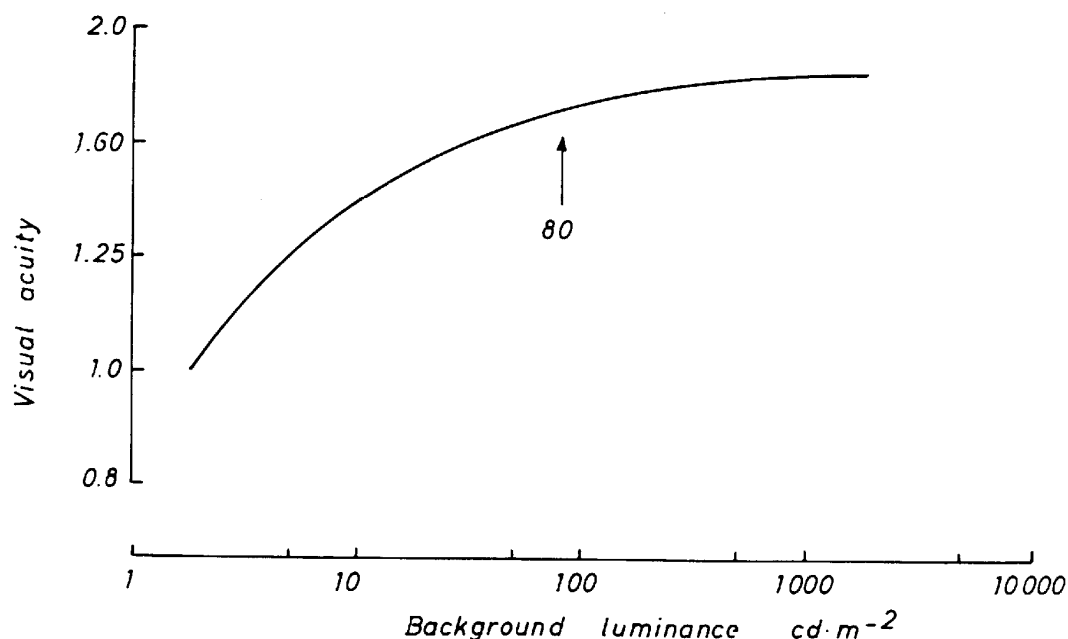


Figure 2 The relation between visual acuity and background luminance. The curve is compiled from several earlier and recent studies.

The illumination given by a 40 Watt desk lamp with a conical reflector at a distance of 1 metre gives a test chart luminance of about $28 \text{ cd}/\text{m}^2$. The luminance changes with the square of the distance between the light source and the surface. In a well lit room, the chart luminance is also well over $100 \text{ cd}/\text{m}^2$.

The area surrounding the test chart should have a luminance of not less than 20% of that of the chart. With ordinary charts, this demand is most easily accomplished when the walls are of light paint and the room light is on.

Thus, a standard office illumination will usually be adequate as background illumination. If visual charts are used, a chart illumination of 500 lux is required. Two standard 60 W bulbs mounted in ordinary office lamps will normally suffice.

The luminance of the test field and its surroundings also influences the diameter of the pupil. Aberrations reduce the acuity when the pupil is larger than about 5 mm. Small pupils act like stenopaic discs whereby optical faults are masked. When smaller than 2 mm, diffraction in the pupil again reduces the acuity.

d Test distance

Visual acuity should from a theoretical point of view be assessed at infinity, but has usually been measured at a distance of 5 or 6 metres (or the equivalent in feet), being the distance closest to infinity practicable under usual circumstances. Mirror readings may be used to obtain the correct measuring distance. From the point of physiological optics, visual acuity values obtained at various distances are equivalent, although departures from the correct distance interfere with the correct measurement. The closer the distance the more

pronounced the error. Acuity testing at near, e.g. 40 cm, gives no additional information except in certain pathological cases.

e *Exposure time*

As long as the object is exposed longer than a few tenths of a second, visual acuity is not influenced by the exposure time. In practice, this factor is of no importance.

f *Practical acuity testing*

For the testing of aviation personnel, Landolt rings or letters proven to be equivalent with these should be used. The Landolt rings should be shown in the four main meridians.

A chart may have just those object sizes which correspond to the limit values of the various visual requirements. Usually, however, ordinary clinical charts are used. These should preferably show rows where the object sizes increase geometrically; the recommended size increment is [1,26] ($=\sqrt[3]{2}$).

Of each size should be shown 5–10 different letters or Landolt rings.

In examinations of aviation personnel, no error is allowed.

Charts with a matt surface and high contrast should be used. The illumination should be checked to concur with the luminance demands. If projectors are used, the slides should be clean and the screen of high reflectance. The ambient illumination should be so adjusted that both the object contrast and the state of adaptation are as high as possible.

2.4 **Reduced vision in one eye**

There are relatively frequent cases of applicants whose vision is reduced but where the visual acuity is still within the Visual Requirements. Reduced visual acuity may be caused by refractive errors, slight amblyopia or organic eye disease. Before such a reduced visual ability is accepted and the applicant assessed as fit, the pathogenesis of the reduced visual acuity should be assessed and taken into consideration.

2.5 **Visual functions related to visual acuity**

a *Mesopic resolution*

Under certain circumstances, especially when the ambient illumination corresponds to a mesopic state of adaptation, the ability to identify/resolve objects of low contrast is of importance. Apparatuses and charts for this purpose have been constructed. Unfortunately, knowledge of the normal capacity is so far limited and standards have not been agreed upon.

b *Contrast sensitivity function*

As mentioned above, best visual acuity is obtained with high contrast objects. With low-contrast objects, the acuity is reduced. The relation between object contrast and resolving power is called the contrast sensitivity function. Correlations have been demonstrated between the contrast sensitivity and the visual performance in simulated flying.

Contrast sensitivity and visual acuity are two separate functions with each its own neurophysiological pathway. There is no doubt that the contrast sensitivity function tells us much more about the visual capacity of the subject than the (high contrast, high frequency) visual acuity alone (fig 3). An examination for contrast sensitivity could reveal abnormalities not shown by other tests. For air force pilots, a superior detection capacity certainly can be of relevance.

In civil aviation, however, this examination still has to be validated. Furthermore, although norms for a 'normal' population are at hand, we do not know which results should be

considered disqualifying for aviation personnel. Further data are needed in order that this examination be included in the vision test battery for routine purposes.

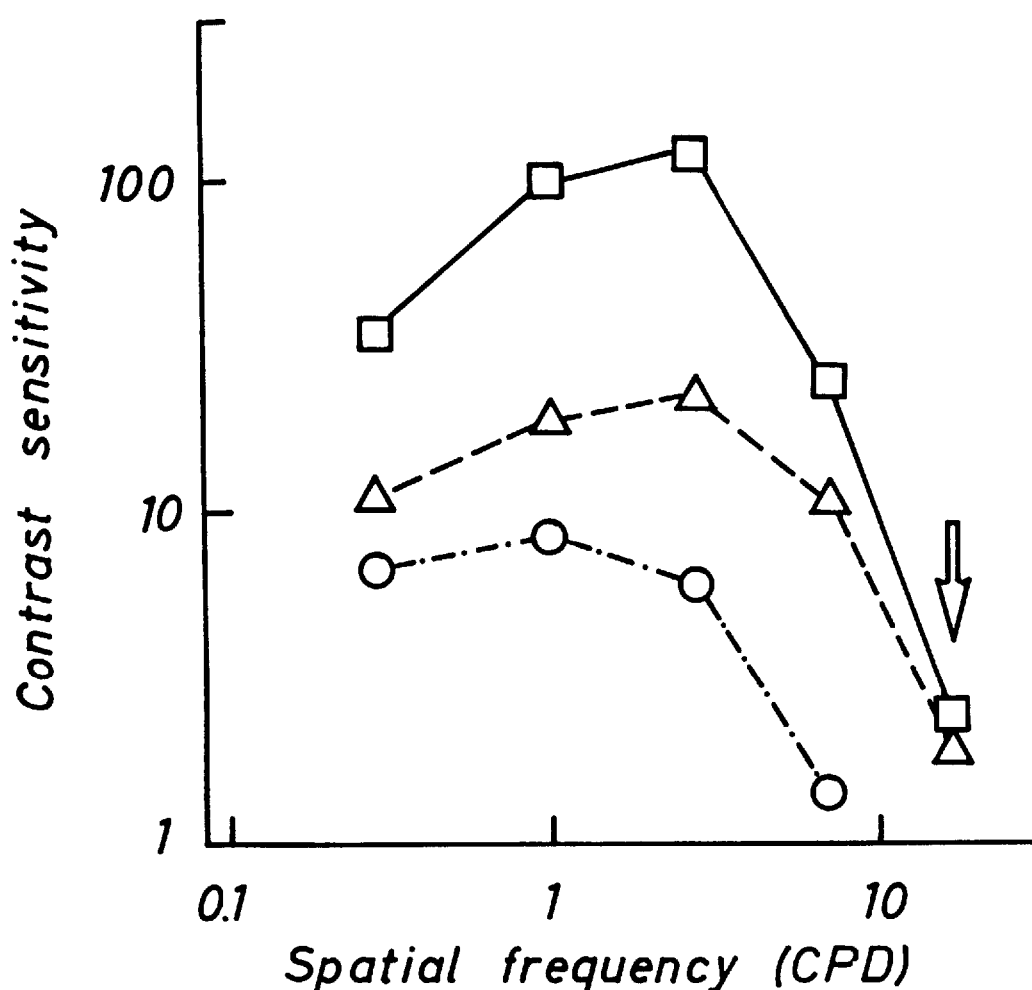


Figure 3 Typical results of contrast sensitivity testing; this is measured for different spatial frequencies of the test objects (in cycles per degree). The uppermost curve (solid, squares) shows the typical intermediate maximum. The middle curve (dashed, triangles) is an example of impaired sensitivity for lower frequencies that will *not* be revealed by visual acuity testing (high frequency, arrow). The lower curve (dash-dots, circles) shows reduced frequency for all frequencies; this will be evident by reduced visual acuity.

c *Dynamic visual functions*

In road traffic, some dynamic visual functions have been shown to be of high validity for the driving capacity. Correlations between a visual function and performance are difficult to prove/disprove for car drivers, and this should be even more so for air crew due to the very limited number of accidents. It is highly plausible, however, that the constant motion of objects in the visual scene of pilots gives these factors a high relevance.

The dynamic visual acuity is the resolving power for moving objects. This capacity decreases with the angular speed of the object and the decrement is more outspoken with increasing age. The threshold of angular movement defines the ability to observe lateral movement and the threshold of angular subtense defines the ability to see whether an object

is coming closer or recedes. These latter have great significance when it comes to the analysis of movements of for example other aircraft. Standards for these functions are not available so far.

d *The relationship between refractive error and uncorrected visual acuity*

With increasing myopia (or hyperopia without accommodation), the visual acuity decreases. In several studies, one has tried to establish the relationship but the results have been contradictory. Some studies have shown a correlation between the amount of ametropia and the logarithm of the visual acuity. If this be true, a certain degree of myopia would correspond to a certain number of rows on a geometric visual acuity chart. In other studies, a linear relation between the ametropia and the visual acuity has been found. Roughly we will expect an uncorrected visual acuity of 6/12 [(0,5)] for $-1,0$ dioptre and 6/60 [(0,1)] for $-2,5$ dioptrés of myopia.

3 NEAR VISION AND ACCOMMODATION

3.1 Printed text

As stated above, no additional information about the resolving power of the visual system is gained by testing the ability to identify single objects at close range (one exception is when a nystagmus is blocked by convergence). Additional information is, on the other hand, given by the ability to read printed text – a task of high relevance to aviation personnel.

The ability to read printed text depends upon the resolving power of the visual system but also highly on complex cognitive factors. There is, therefore, no direct correlation between (distant or near) visual acuity and the reading capacity and the latter is not equivalent to 'near visual acuity'.

In order to measure the reading capacity, the Jaeger text types were constructed. These were never standardized, however, and texts with the same number vary greatly in different editions. No international agreement exists for reading texts. Those that best fulfil modern demands are the British N-types (as adopted by the British Faculty of Ophthalmologists), see fig. 4. Here, the print chosen is 'Times Roman', the most common print in books and papers. Sizes are designated by typographical point numbers. These are based on the height of the body or block of metal which carries the letter and are not the measure of the face. In various countries, the same Times Roman point numbers correspond to slightly different letter sizes. These differences are, however, so small that they are unimportant in practice. If N-types or equivalent texts are not available, other texts can be used. Examples are the Parinaud and the Birkhäuser reading texts. Corresponding legibility is given by texts with a lower-case letter height of [0,9] mm (N 5) and [2,2 - 2,4] mm (N 14).

N.5.

The streets of London are better paved and better lighted than those of any metropolis in Europe: there are lamps on both sides of every street, in the mean proportion of one lamp to three doors. The effect produced by these double rows of lights in many streets is remarkably pleasing; of this Oxford-street and especially Bond-street, afford striking examples. We have few street porters, and rarely indeed a midnight assassination. This last circumstance is owing to the benevolent spirit of the people: for whatever crimes the lowest orders of society are tempted to commit, those of a sanguinary nature are less frequent here than in any other country. Yet it is singular, where the police are so ably regulated, that the watchmen, our guardians of the night, are generally old decrepit men, who have scarcely strength to use the alarm which is their signal of distress in cases of emergency. It does credit, however, to the morals of the people, and to the national spirit, and evinces that the brave are always benevolent, when we reflect that, during a period when almost all kingdoms exhibited the horrors of massacre and the outrages of anarchy, when blood had contaminated the standard of liberty, and defaced the long established laws of nations, while it overwhelmed the freedom it pretended to establish, this island maintained the throne of reason, erected on the firm basis of genius, valour, and philanthropy.

cake acorn venter succour

N.8.

Water Cresses are sold in small bunches, one penny each, or three bunches for twopence. The crier of Water Cresses frequently travels seven or eight miles before the hour of breakfast to gather them fresh: but there is generally a pretty good supply of them in Covent-garden market, brought, along with other vegetables, from the gardens adjacent to the Metropolis, where they are planted and cultivated like other garden stuff. They are, however, from this circumstance, very inferior from those that grow in the natural state in a running brook, wanting that pungency of taste which makes them very wholesome: and a weed very dissimilar in quality is often imposed upon an unsuspecting purchaser.

rose sauce cannon reverse

N.14.

Hot spiced gingerbread, sold in oblong flat cakes of one halfpenny each, very well made, well baked, and kept extremely hot, is a very pleasing regale to the pedestrians of London in cold and gloomy evenings.

sear canoe unseen reserve

N.18.

Door-mats of all kinds, rush and rope, from sixpence to four shillings each, with Table Mats of various sorts, are daily cried through the streets of London.

crave savour concern

Figure 4 Example of N-chart sizes

The N system has been adopted in the Visual Requirements for the testing of reading capacity of aviation personnel. The texts should consist of words in ordinary speech and writing and be spaced as in ordinary printing.

Further information on the reading ability may be obtained by samples of instrument approach and landing charts with their special signs and symbols (Fig. 5).

NEAR VISION ACUITY

SLOAN LETTERS

This chart should be held 16 inches (40cm) from the eyes, at right angles to the line of vision, and illuminated with not less than 10 or more than 25 foot candles of light. [108-269 lux]

LINEAR
SNELLEN
SCALE

$\frac{20}{20}$

.....

$\frac{20}{25}$

.....

$\frac{20}{30}$

.....

$\frac{20}{40}$

CVCRD CSXDR RKSCD
RCVDC RCGSN KYDZV

Equivalent to N5

$\frac{20}{60}$

HNZCO SRVDK RCOSN
KYCHD NHRVZ NKRVD

$\frac{20}{75}$

SOCZNRV DKNZCO

Equivalent to N14

$\frac{20}{100}$

RNHSOKDCZVOS

$\frac{20}{200}$

DONVRCK

AERONAUTICAL CHART READING

Low Altitude Federal Airways are indicated by center line

LF/MF VOR (Enroute) 092 (Alternate) V3E

Federally operated control tower Non Federal control tower Other Airport (no traffic area, no airport advisory service on FSS)

DAYTON 1000 L 70 119.5 257.8 MARTINSBURG 256 L 70 120.5 231.8 SOMERSET 1540 L 37

Aerodrome name may be omitted when same as nearest town name. 1750 - 36 U

Obstruction 2150 UC Rotating light (on top of high structure) 150d g

LOS ANGELES APPROACH CONTROL 225°-044° Sector 124.5 381.6 045°-224° Sector 124.9 269.0 113.6	LOS ANGELES RADIO 113.6 LAX Chan 83 122.2 123.6 126.7 255.4	HAWTHORNE TOWER 121.1 385.5 Operates 0700-2300 GROUND CONTROL 121.5
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Figure 5 Example of a near vision test provided with aeronautical symbols. Observe that this chart tests near acuity and not reading capacity.

3.2 Examination techniques

Near visual capacity should be determined and recorded both without and with correcting lenses, [if needed]. The N-type near vision charts or equivalent should be used (fig 3). The examination should be conducted in a well-lit room with an illumination of the test chart of at least 50 lux.

The applicant should hold the N5 chart at a distance selected by him and appropriate to his regular tasks within the range 30–50 cm (12–20 inches). The N14 chart should be read at a distance of 100 cm (40 inches); this distance may be checked by a string.

The near vision is recorded as the distance at which the applicant can read the N5 chart and by stating whether the N14 chart is read at 100 cm or not.

3.3 Accommodation

When one focuses on an object at a finite distance, the refractive power of the eye has to be increased by accommodation. This is accomplished through contraction of the ciliary muscle and an increased curvature of the lens.

In order to measure this capacity – the range of accommodation (difference, measured in dioptres, between the refractive powers of the eye at maximal accommodation and maximal relaxation) and the near point of accommodation (focal distance, measured in centimetres, at maximal accommodation) are established. This is done with the aid of an object that is moved progressively towards the eye until it just becomes blurred. Alternatively, the object is moved, starting close to the nose, away from the eyes until it is just seen – a method claimed to give more consistent results. In any case, fine print and a rule (special rules are available, the RAF Near-Point-Rule is particularly handy to use) adequately serve the purpose. The applicant shall put maximum effort into the test. The distance from infinity to the near point defines the range of accommodation and can be expressed in distance units or (usually) in dioptres.

With increasing age the accommodative range decreases due to reduced elasticity of the lens (fig. 6). It is nil at an age of about 60 years, but seemingly some accommodative power is left because of the depth of focus of the eye. Also the speed of accommodation is reduced with increased age.

INTENTIONALLY LEFT BLANK

Age	Diopters	Near-point (cm)
16	12.1	8.2
18	11.7	8.5
20	11.3	8.8
22	10.8	9.3
24	10.3	9.7
26	9.8	10.2
28	9.3	10.8
30	8.8	11.4
32	8.3	12.0
34	7.7	13.0
36	7.1	14.1
38	6.5	15.4
40	5.8	17.2
42	5.0	20.0
44	4.3	23.3
46	3.4	29.4
48	2.5	40.0
50	1.8	55.6
52	1.6	62.5
54	1.4	71.4
56	1.3	76.9
60	1.2	83.3
65	1.1	90.9
70	1.0	100.0

Table I Near-point variation by age

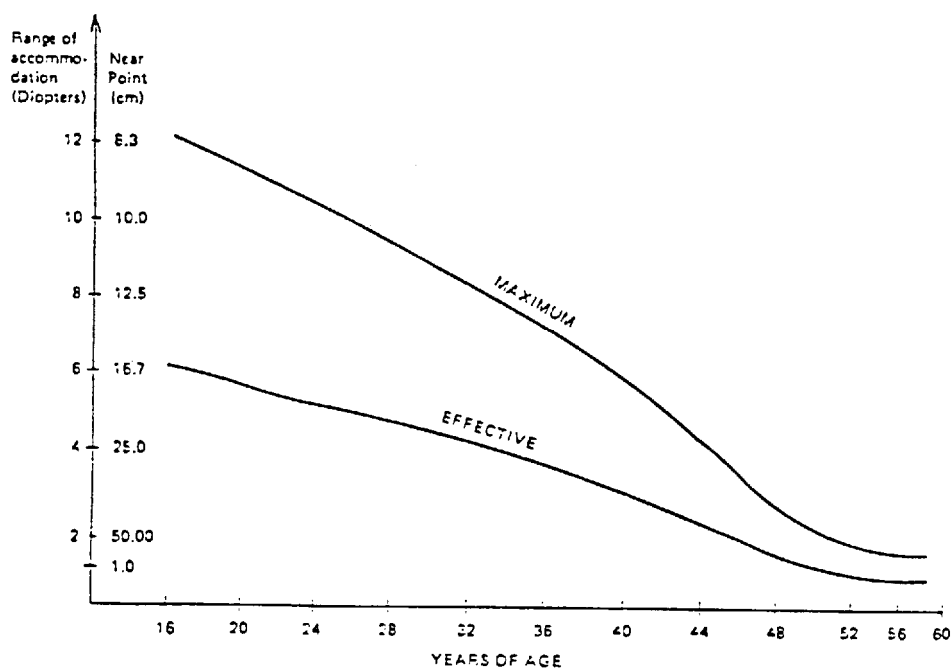


Figure 6 Maximum and effective accommodative range

The term presbyopia is used when the accommodative power, applied without effort, is insufficient for near vision. An emmetropic subject generally first notices the problems at an age of 40–45 years. The hypermetropic subject has to use part of his accommodative power to compensate for the refractive error

and becomes presbyopic at an earlier age. In myopia, the accommodative range is displaced towards the eyes, and presbyopia is thereby retarded (fig. 7).

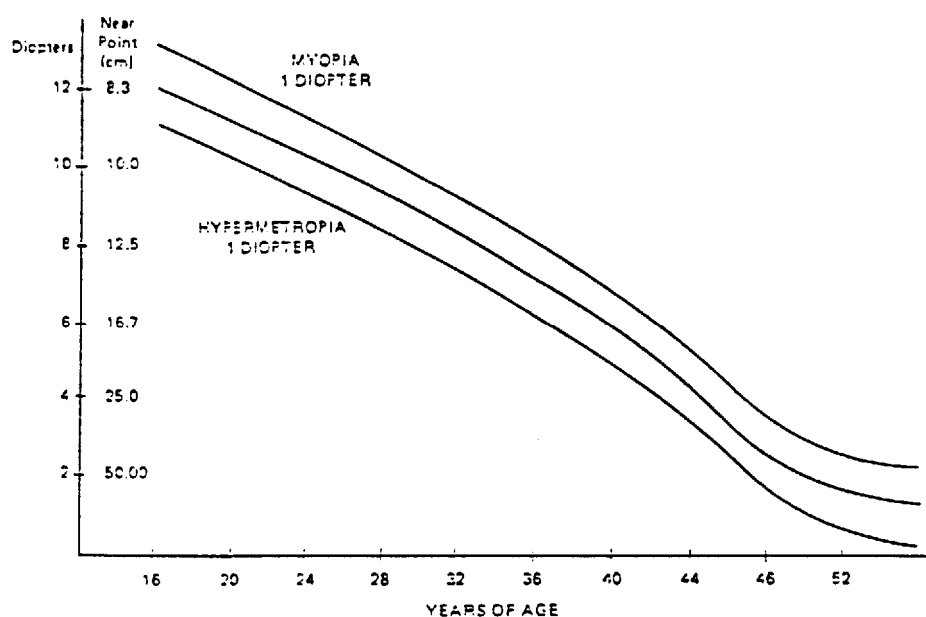


Figure 7 Change of near point by pre-existing ametropia

The near-point is measured with maximum accommodative effort. Comfortable sustained looking is not possible so close to the eyes, and presbyopia is therefore corrected so that there is a reserve power of accommodation. Often the term 'effective accommodation' is used to describe the amount [of] accommodative effort which can be used regularly without causing asthenopia. A practical rule to prevent asthenopia induced by accommodation is to prescribe reading glasses when the working distance is no longer easily matched by the effective accommodation.

The amount of accommodative effort required for a certain task depends on the luminance of the object looked upon (illumination and reflection) and of object contrast. Under mesopic conditions and with low-contrast objects, a stronger than normal presbyopic correction may be necessary.

When the near-point of accommodation exceeds 33 cms (or the accommodative range falls below 3 dioptres), near correction should usually be prescribed.

a *Fatigue of accommodation*

Abnormally high accommodative effort causes a condition characterised by blurring of vision, headache or a burning sensation in the eyes. The principle reason for these problems is presbyopia which is accentuated by physical fatigue. It may, however, be induced or accentuated by other causes as well. Disorders of general health status may transiently reduce the effective power of accommodation, e.g. mental stress, oxygen deficiency, and G-forces. Neurological diseases or intoxications may affect the III nerve or ciliary muscle function. Some drugs likewise reduce the accommodative range, e.g. some tranquilizers and drugs for treatment of hypertension or atropine-like substances for treatment of disorders of the digestive tract. Further causes are eye diseases and cycloplegic drops.

Any of these causes may call for an earlier or stronger than normal presbyopic correction.

b *Eye strain – Asthenopia*

Fatigue of accommodation is only one cause for a condition characterised by a feeling of tiredness in the eyes, intermittent blurring of vision and headache mostly localised in and around the eyes. This condition is called eye strain or asthenopia. General fatigue is often manifested as eye strain. Disorders of the outer eye, like conjunctivitis and blepharitis may induce eye strain. The two most common causes are faulty correction of refractive errors and muscular imbalance. Correction by spectacles or lenses must not only be based on the refraction of the individual eye but also on the tolerance of anisometropic differences. Latent or manifest squint imposes extra demands on the extraocular muscles and can thereby induce asthenopia. A practical rule to prevent asthenopia caused by fatigue of accommodation in presbyopic pilots is to use only half of the existing maximum accommodative capacity and prescribe reading glasses for the rest of the necessary accommodative range.

4 REFRACTION

The refractive state of the eye applies to the condition when the accommodation is completely relaxed. Induced relaxation with cycloplegic [medication] is necessary for retinoscopy, []when, in subjective refraction, an accommodative spasm is suspected [and at the initial examination in hyperopic (> +0,5 diopters) applicants under the age of 25 years].

In emmetropia, rays of light from infinity are focused on the retina. This is a relatively uncommon condition.

Ametropia is any deviation from emmetropia; there are three basic types: hypermetropia (hyperopia), myopia, and astigmatism. Ametropia is measured in dioptres. The limits of refractive error as stated in the Visual Requirements are based on measurements with the optical centre of the spectacles placed 12 mm from the cornea.

4.1 Refractive errors

a *Hypermetropia*

A hypermetropic eye is deficient in refractive power; it is absolutely or relatively too short (fig. 8). Thereby light from infinity is focused on a point behind the retina. Hypermetropia is a synonym of the colloquial term farsightedness which is often confused with presbyopia, a condition caused by a decrease of accommodative power with age.

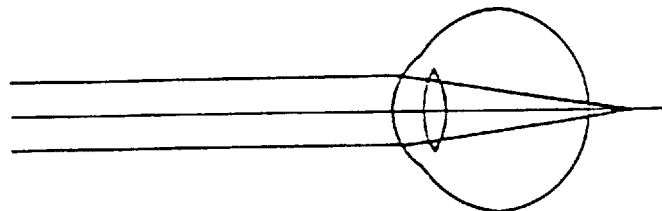


Figure 8a In the not accommodating eye, rays from distant objects are focused behind the retina.

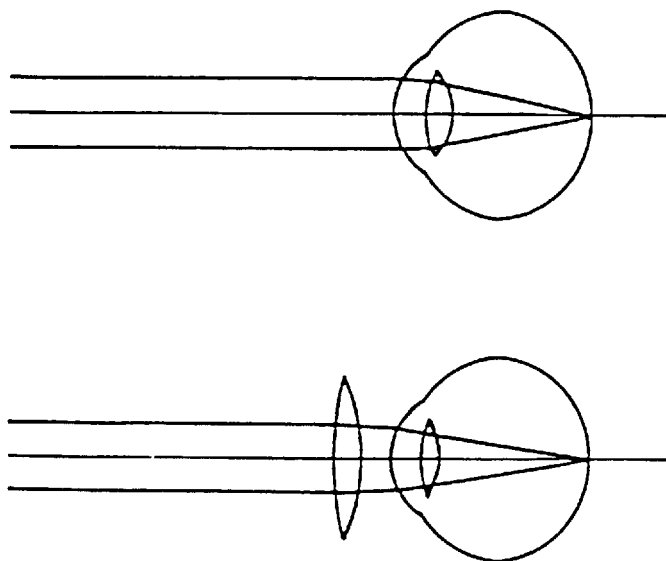


Figure 8b To compensate for this accommodation in the non-presbyopic eye (upper), a convex lens (lower picture) could be used.

Hypermetropia is corrected with a convex, plus or positive lens. Hypermetropia can also be compensated for by accommodation. In the young person, this is recognised as manifest hypermetropia. Cycloplegic refraction will enable the examiner to assess the degree of hypermetropia in Class 1 applicants. A specific manifest hypermetropia screening test is not indicated for Class 2 applicants because the hypermetropic refractive error limit is +5 dioptres. However, Class 2 applicants under the age of 25 will require cycloplegic refraction if their spectacle prescription is greater than +3 dioptres as the prescription may not actually reflect the degree of hypermetropia present. With increasing age, the accommodative range is reduced and at a certain age the subject needs plus correction for sharp distant vision. He also needs reading glasses earlier than emmetropic persons.

A slight or moderate degree of hypermetropia needs no correction in young persons. Higher degrees of hypermetropia demand a constant accommodation which can give rise to eyestrain. Due to the association between accommodation and convergence, it also induces a tendency to latent squint inwards (esophoria) or a proper squint in subjects with a weak fusion lock (esotropia).

[According to experts hypermetropia exceeding + 5 dioptres may lead to narrow angle glaucoma. Therefore, a higher hypermetropia results in an unfit assessment.]

b *Myopia*

In myopia, light rays from infinity are focused in front of the retina (fig. 9) due to increased refractive power of the eye or a lengthening of the eye globe. Distant objects are blurred, even more so with accommodation. The degree of myopia corresponds to the most remote point sharply focused. Myopia is corrected with concave, minus or negative lenses. In order to unveil minor myopias, it is essential to use acuity charts with sufficiently small objects, i.e. corresponding to an acuity of [1,6 or 2,0].

[In case of myopia beyond -3,0 dioptres, other tests may be necessary to rule out a retinal disorder. The risk of chorio-retinal degeneration and retinal detachment rapidly increases if the myopia exceeds 5–6 dioptres. Therefore, higher myopia requires surveillance by an ophthalmological expert in certain time intervals.]

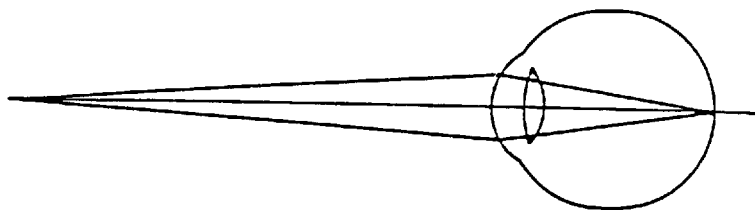


Figure 9a In the myopic eye, there is a far point beyond which objects are imaged sharply.

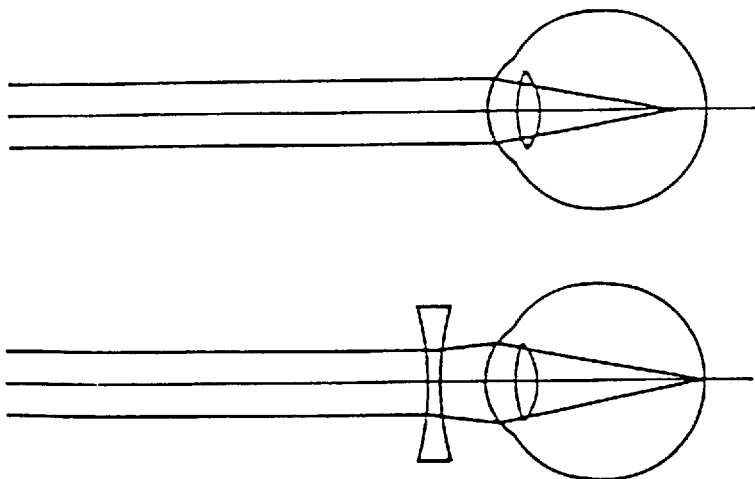


Figure 9b In the myopic eye, distant objects are focused in front of the retina (upper). Correction is only possible with a concave lens (lower picture).

c *Astigmatism*

In astigmatism, the light rays of different meridians are not equally refracted (fig. 10). Regardless of the degree of accommodation, a sharp focus cannot be attained and both distant and near objects are blurred. The reason for astigmatism can be abnormal corneal curvature or lens asymmetry.

In regular astigmatism, the refractive error can be corrected by a cylinder lens. Most commonly, the axes are located in the principal meridians, i.e. at 90° and 180°.

All possible combinations with hypermetropia, emmetropia and myopia exist. To a plus or minus cylinder may have to be added a plus sphere, a plano glass, or a minus sphere for sharp imaging of distant objects.

Irregular astigmatism is caused by an irregular corneal curvature due to trauma, inflammation, scars or degeneration. Usually, this refractive error can only partly be corrected by a cylinder lens but may, if not too large, be completely eliminated by a hard contact lens.

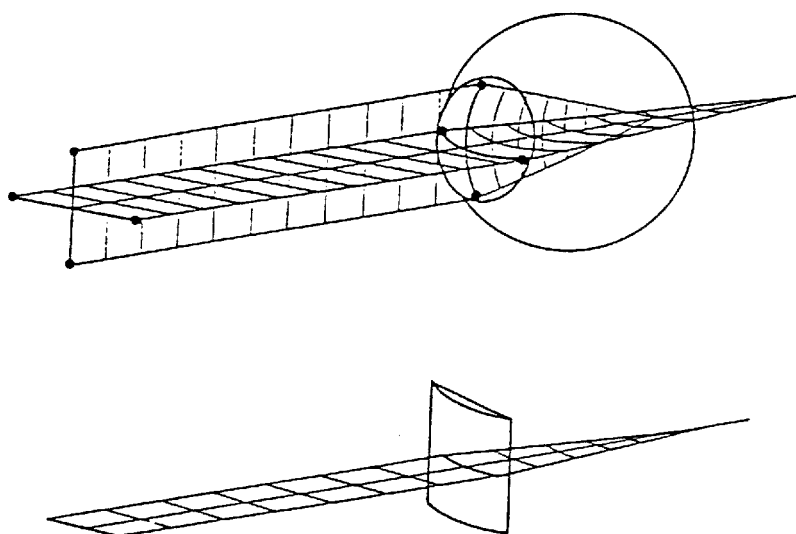


Figure 10 In the astigmatic eye, the refractive power differs in different meridians. To correct this type of error a toric or cylindric lens must be used, often in combination with a spherical convex or concave lens.

d *Stability of refraction*

It is important that the examining ophthalmologist also evaluates the stability of the refractive error.

If the ophthalmological history or the clinical examination indicates a progressive refractive error likely to exceed the limits in the future, the applicant should be assessed as unfit. Re-evaluation may be performed after one year and after licensing the ophthalmological examinations should be repeated at individual intervals until the refractive error is deemed to be quite stable.

4.2 **Measurements of refraction**

Refraction is performed in order to determine the nature and degree of the (possible) refractive errors of the eye. In subjective methods, the applicant has to cooperate by telling which lens combination gives the best vision. Objectively, the refraction can be measured by []skiascopy or with the aid of []automatic refractometers [], which are the standard methods]. To save time and effort, refractometer data can be used when making the final subjective refraction. Cycloplegia may be necessary to establish the degree of refractive error correctly, especially in cases of moderate hypermetropia.

4.3 **Spectacle correction of ametropia**

[]One of the reasons for setting []a limit is the optical aberrations caused by correcting lenses. These optical errors increase with increasing lens power and towards the edge of the lens. With modern materials used in high-quality correcting glasses problems are most unlikely to occur inside the range of $\pm [5,0]$ dioptries.

Distortion of the image due to peripheral angular magnification narrows the effective visual field.

The prismatic deviation gives rise to double vision in myopes and a ring scotoma in hyperopes.

[Refractive disorders lead to significant alteration in visual function affecting most parameters as morphoscopic perception, perception of light, space and colour.

An other reason for setting an upper limit is that high myopia which is defined as a myopia > 6,0 dioptres, has a higher risk of developing retinal detachments and retinal and macular scars and is therefore seen as a pathological condition.]

In anisometropia, the refractive state is different in the two eyes. When corrected with glasses, these give a dissimilar magnification – a condition known as aniseikonia. The illusion created is particularly disturbing during the initial stages of wearing anisometropic spectacles; it is better tolerated when the glasses are prescribed at a young age. As a general rule, an anisometropia of 3 dioptres can be tolerated; if problems arise, a special evaluation as to the practical applicability is necessary.

5 VISUAL AIDS

For distance visual tasks, distance optical correction may be necessary, as discussed further later. The distance to the intermediate objects, i.e. instruments, is shown for some typical aircraft in Table II. These have been measured from the position of a 'reference eye' and small differences between pilots can occur depending on the individual seating position. It is evident that there are some variations between different aircraft and distances typically range between 40 and 120 cm, corresponding to an accommodation or correction of 2,5–0.8 dioptres. Printed material is read at a still closer distance, typically 33–40 cms (2,5–3 dioptres). Among pilots there is some variation in reading habits, i.e. the distance chosen for comfortable reading.

[]

Correction lenses for aviation personnel, when necessary, can be predicted by simple arithmetic if the following facts are known:

- 1 the subject's refraction and accommodative range,
- 2 the distance to the intermediate tasks,
- 3 the preferred reading distance.

Further points of relevance are the actual size of dials, pointers, figures, and text. If these are particularly small, the subject must use a shorter viewing distance in order to increase image size. This is also necessary when the general illumination level or the object contrast is low.

The following example illustrates the necessary calculations. If an emmetropic subject has to view an instrument at a distance of 50 cm ([0,5] m), he has to accommodate $1/[0,5] = 2$ dioptres. If the subject is also ([0,5] dioptr hypermetropic, one must add these ([0,5] which gives ([2,5] dioptres. If the instrument is seen in red illumination, one may have to add another ([0,25] dioptres] of chromatic aberration. This accommodative effort is no problem to a young person. A person of intermediate age may need a correction of +1 to +([1,5] dioptres to aid accommodation, but one over 60 years of age must wear the full correction, i.e. +([2,5] to +([2,75] dioptres.

When correcting lenses are needed for meeting the Visual Requirement, one set of spectacles only should cover the need of distant as well as near correction. A spare set of identical spectacles should be immediately available during flight. In pilots whose uncorrected visual acuity falls below the standard, spectacles should be constructed so as to minimise the risk of being lost during flight.

5.1 Spectacles for aircrew

The aim of prescription of glasses is to give the subject a good and comfortable vision. The fact that the person has a refractive error does not necessarily indicate a need for spectacles. Many

people have some refractive error, often a minor hypermetropia or astigmatism, that gives rise to no troubles at all. It is common experience that spectacles prescribed for these aberrations are not worn. In aviation, a prescription for glasses is needed when a substandard visual acuity is found or in cases where visual fatigue, muscular imbalance or increased glare sensitivity could be explained by an error of refraction.

It has been claimed that air crew are reluctant to use glasses because their use seems to indicate that 'something is wrong with their eyes'. Even if this be the case, it should still be possible to motivate the applicant if the examination shows that either distance or near vision is significantly improved by lenses. The most common need, i.e. the beginning need for presbyopic correction can be demonstrated further by simulating the ordinary working condition: low ambient illumination, small print, etc.

When glasses are prescribed, it should be remembered that their comfortable use depends on a proper fit of the correcting lenses. The axis of a cylinder lens must correspond to the subject's astigmatism and the optical centre of the lens to the visual axis of the eye. Decentration is annoying mainly due to the prismatic effect which is larger when the lens power is high. In these cases it is also important that the distance between eye and lens is correct because deviations give rise to changes in effective lens power.

If glasses are prescribed, it should be recommended that their frames are so constructed that they do not interfere unnecessarily with the visual field. In the case of hypermetropia, a thick frame around the glasses adds to the ring scotoma created by the lens. In the case of myopia, this effect may be beneficial because of the double vision of corrected myopes. The spectacle arms should be thin and placed above or below the level of the eyes; it has been recommended that they should not be wider than 6 mm.

Myopia should always be corrected when it interferes with sharp distant vision. It should be remembered that the myopic refractive error may successively increase up to the age of 25–30 years.

Hypermetropia should be corrected when it causes impaired distant vision, gives rise to eye-strain, or interferes with the muscular balance. The constant accommodation of an uncorrected hypermetropic subject is not always immediately released by a positive lens. Therefore, correction often has to be successively increased.

Astigmatism should be corrected when it causes reduced visual acuity and/or gives rise to eye-strain. An astigmatic correction should be worn all the time. It can be severely disturbing to wear an astigmatic correction when looking only at distance or near.

Presbyopia is usually corrected when the effective range of accommodation is lower than 3–4 dioptres. This means that uncorrected hypermetropes, who use part of their accommodation for sharp distant vision, have to be corrected earlier than emmetropes. When a presbyopic aid should be started, its proper strength can be deduced from the refractive state, the location of the accommodative near point, and the reading capacity of the subject.

Pilots [] have to change their gaze frequently between objects at near, intermediate and long distances. This calls for a correction that enables sharp focusing at several distances. It is stated that the applicant who only meets the requirements for near vision with correction must have the glasses 'available for immediate use', but there is in practice no time to put glasses on and off. The subject who does not need distance correction can preferably use 'look-over' glasses. Those who normally wear distance correction must have a segment for intermediate/near vision ground into the lower part of the spectacle lenses. Such bifocal glasses enable sharp distance vision through the larger upper part of the lens and sharp near vision through the lower segment. The size and location of this lower segment can vary; three common types are shown in fig. 11.

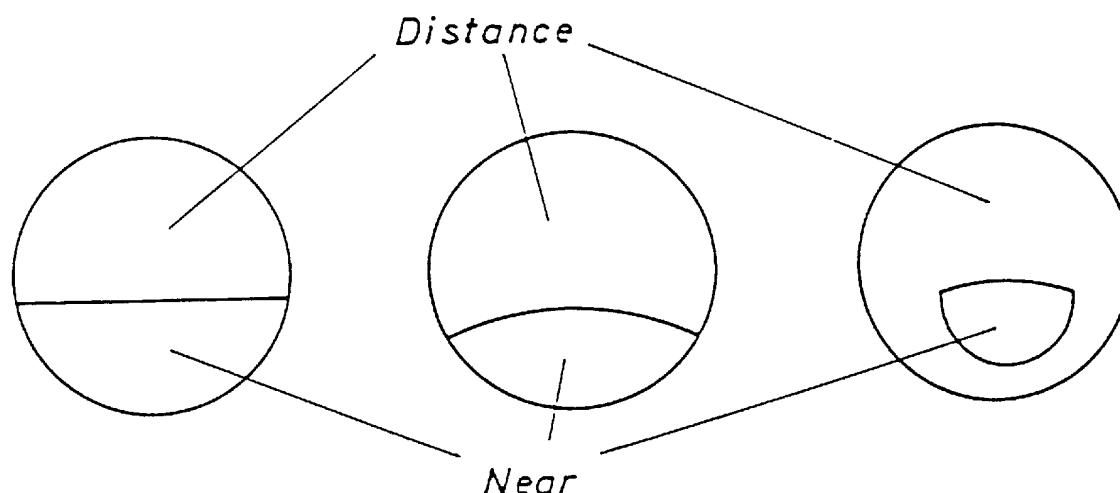


Figure 11 Three examples of bifocal lenses.

An even more sophisticated type of lens is the trifocal lens. Here, a third segment for intermediate vision is placed between the upper distance part and the lower near part. Such lenses must be carefully designed to suit the needs of the pilot. The intermediate segment should cover the instrument panel and pedestal without interfering with vision through the other two parts. Some people have difficulties in getting accustomed to the use of these lenses and most senior pilots prefer the ordinary bifocal glasses.

There are also glasses with a continuous increase in power from the upper to the lower part of the lens. These progressive glasses enable the selection of proper focusing by tilting of the head. The earlier generation of these glasses created an annoying and possibly dangerous distortion to the right and left of the central zone. These distortions are much reduced in the current lenses. Some people are enthusiastic wearers of these lenses while others claim that they prefer ordinary bifocal or trifocal lenses. Whether they will be accepted by the individual subject cannot be foreseen; today, however, there is no reason to condemn their use by air crew.

There is a special problem valid for the presbyopic pilot who has to focus intermediate objects in the upper part of the spectacle lenses, i.e. overhead instruments. As long as the accommodative power is at least 2 dioptres, sharp vision is possible without correction or through the distance correction. The senior pilot, on the other hand, may need a correction for intermediate vision ground into the uppermost part of the lenses, a special type of trifocal lenses (fig. 12).

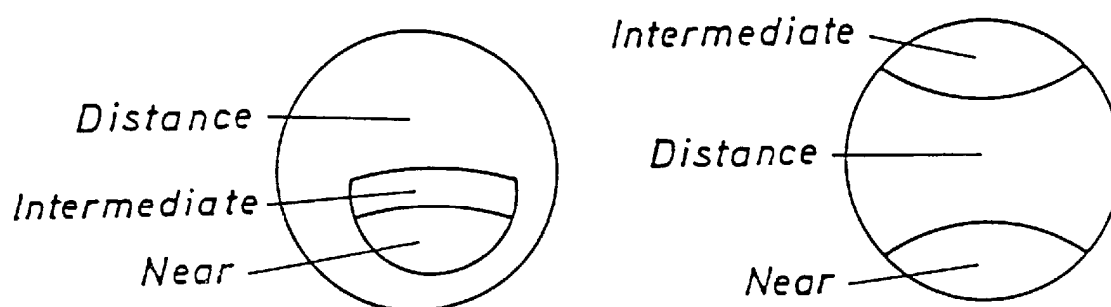


Figure 12 To the left an example of a conventional trifocal spectacle lens. To the right a trifocal lens especially made for pilots.

There are even more sophisticated lenses with four or five segments and there are progressive lenses with a segment for near vision in the upper part.

[]

What kind of prescription that should be selected has to be discussed in detail with the individual pilot. Most senior pilots are satisfied with look-overs or ordinary bifocals. If this is not the case, one of the other possibilities should be considered.

It is important that the size and position of the segments for intermediate and near vision be individually determined. The pilot can aid in determining this by marking an old pair of glasses while sitting in his ordinary cockpit position and shifting gaze as during normal operation of the aircraft.

The examiner should also be aware of the licensing requirements specifying that a spare set of corrective lenses should be available to the air crew member who fulfils the visual requirements only with correction.

5.2 **Sunglasses**

Sunglasses are a desirable and often necessary piece of protective equipment. They reduce the luminous flux entering the eye and therefore improve vision under conditions with large areas of high luminance in the visual field. They may prove particularly useful in flight over clouds. Sunglasses should be neutrally tinted (i.e. shades of grey only) in order not to interfere with colour perception. Polaroid sunglasses can cause problems when used in cockpits with laminated windscreens [and therefore the use should be discouraged].

The so-called photo-chromatic lenses darken when exposed to ultraviolet radiation; their transmission therefore varies with the daylight level. Today's second generation of photochromatic lenses transmits maximally 90% when completely bleached; maximum absorbance varies between 45% and 70%. Glass temperature markedly influences the degree of tinting: high temperatures reduce the degree of darkening and increase bleaching speed. Most of the outdoor UV radiation is filtered out by cockpit windows and also the effect of sunlight on these glasses is reduced by the limited window sizes. Furthermore, the ambient temperature sets a limit to the tinting.

Photo-chromatic lenses darken and bleach according to rather slow exponential curves. It takes several minutes until a sizeable darkening is achieved and about 15 minutes to maximum absorbance. Full bleaching is attained first after about 30 minutes although more than half of the absorption is lost after about 5 minutes.

The pilot who finds their function satisfying can use photo-chromatic glasses provided that they are of the type that gives a small light absorbance under night-time conditions. But generally the use of these glasses should be discouraged. When descending through clouds the glasses react far too slowly, and the pilot who needs a refractive correction must always have an additional pair of non-tinted glasses available.

5.3 **Contact lenses**

Contact lenses provide significant optical advantages compared to spectacles, especially to those who demand a high-power correction. The latest decade has seen a continuously increasing use of contact lenses and the production of several new lens types. They have different characteristics and the individual acceptance varies with the lens type. For use by aircraft personnel, some types are better suited than others.

a *Advantages of contact lenses*

The main advantage of contact lenses over spectacle glasses is their superior geometrical optical characteristics. Since the contact lens is placed on the corneal surface, the distortion and change in image size created by the correction is minimal. The Visual Requirements,

however, normally limit the size of ametropia accepted and these differences are not very significant with lens powers <5 dioptres. With contact lenses, there are no spectacle frame scotomas. Fogging of the lenses, which occurs when the ambient temperature is suddenly increased, is also eliminated. It is further more convenient to wear contact lenses than glasses under a helmet, mask or the like.

Hard (or stable) contact lenses offer a significant advantage over spectacle lenses in cases of corneal astigmatism; with these the anterior refractive surface of the eye is corrected from uneven to even. In cases of irregular astigmatism, these lenses may be the only means of attaining sharp imaging.

In cases of high degree of anisometropia (inter-ocular refractive power difference), contact lenses may offer the only possibility of attaining undisturbed binocular vision. This is particularly the case in monocular aphakia not corrected with an intraocular lens; aphakia normally produces a high degree of hypermetropia.

b *Disadvantages of contact lenses*

The main disadvantages are the risk of intolerance and the handling difficulties. The contact lens is a foreign body placed upon the eye. Somewhat depending on the lens type used, short-term or long-term reactions may occur. Any lens may induce a slight corneal haze or swelling which alters the refractive properties of the eye but normally not the quality of the retinal image. The reduced oxygen tension, caused by the reduced cabin pressure, may result in corneal hypoxia – especially during long distance flying. A small grain between the lens and the cornea is extremely annoying and gives rise to photophobia and lacrimation. If the lens is not immediately taken out, corneal damage may ensue. Similar reactions are the result of bad contact lens cleaning and irregularities of the rear lens surface.

The most common long-term reaction is an inflammatory follicular swelling of the tarsal conjunctiva called giant papillary conjunctivitis (GPC). This reaction is less common with hard than with soft contact lenses. Symptoms are irritation, lacrimation, and a foreign body sensation. When outspoken, the reaction prohibits further use of a contact lens for a certain length of time (or forever). In some cases a soft lens must be replaced by a hard lens to prevent recurrence of the reaction. Another long-term reaction – especially due to improper fitting – is ingrowth of blood vessels into the cornea which calls for immediate lens withdrawal.

c *Hard contact lenses*

Hard contact lenses are normally produced by solid methyl metacrylate. They are usually of small size and 'float' on the corneal surface. These classical lenses are not permeable to oxygen but because of their motion and size, their influence on corneal oxygenization is small. Other kinds of hard lenses are highly permeable to oxygen and are sometimes used as an alternative. Under hypobaric circumstances, a disadvantage of the high oxygen permeable hard lens is the reduction of the so-called contact angle of the material which will hinder the free mobility of the lens.

Hard contact lenses are usually recommendable for aircraft personnel if they are accepted by the wearer and if they do not alter corneal refraction significantly.

d *Soft contact lenses*

Soft contact lenses contain varying amounts of water and are more or less permeable to oxygen. They are usually larger than hard lenses and are tighter fitted. Soft contact lenses are as a rule more easily tolerated by the wearers. They are ordinarily, as are hard lenses, only worn during a restricted part of the day, up to about eight hours. A more recent type of soft contact lens is used day and night for periods of 2–3 weeks, the so-called continuous-wear or extended-wear contact lens. This type of lens calls for a particularly careful wearer selection and instruction and proper control measures.

The cockpit air is often extremely dry, less than 5% relative humidity is quite common. This may cause dehydration of the contact lens and ensuing steep fit and corneal oedema. The result will be changes of the dioptrical value of the contact lens, followed by reduced visual acuity. For this reason, soft contact lenses of low hydration may be advantageous for flying purposes.

In recent years, different types of bifocal contact lenses have been introduced. [There are contact lens designs with a concentric bifocal pattern. In this type of contact lens, the near correction is in a small circle at the centre of the lens, surrounded by a much larger circle containing the distance correction. Two different pictures are presented to the brain at the same time: one for distance and one for near. It is understandable that the brain has severe problems to "select" the right image. Even more problems can occur by using a multifocal design.] So far, experience with these lenses has been disappointing, mainly due to their pronounced tendency to defocus, thus providing a very unpredictable refractive effect. In the diffractive type of bifocal contact lenses, the optical quality of the lens is poor and they reduce the contrast sensitivity which makes them unsuitable for aviation purposes.

Bifocal contact lenses are not acceptable for correction of refractive errors in pilots.

e Practical considerations

Contact lenses should be carefully handled and cautiously cleansed at regular intervals. The user must be highly motivated and properly trained. Insertion, cleaning and sterilisation calls for a clean environment and special equipment. Contact lenses are difficult to replace if they are lost or displaced. This may be particularly complicated on the flight deck and clumsy insertion may cause corneal damage.

It has been reported that gas bubbles may form under contact lenses in rapid decompression. Within a pressurised cabin or at low altitudes, however, there should be no problems. Neither is it necessary to take into consideration the risk of contact lens loss due to high G-forces. Experiments have shown that contact lenses stay into place during flight manoeuvres normally encountered in civil aviation.

Before applicants are authorised to use contact lenses, a thorough examination should be performed by an ophthalmologist and a contact lens optician. Here, any kind of abnormality which contraindicates the use of contact lenses should be ruled out. It should be stated that the applicant is well adapted to the type of lens in question and that he can wear it without problems for the full duty period. Since contact lenses may give rise to long-term ocular reactions, regular examinations should be called for. Unfortunately, the legislation governing the fitting of contact lenses and the medical supervision of the wearers varies greatly between countries. The licensing authorities must be observant of the proper fitting of contact lenses and regular medical control of the condition of the eyes. When contact lenses are first prescribed to a pilot, the medical monitoring should be very close, but after one year of observation, a control interval of 12 months will usually be adequate.

It should be pointed out to the applicant that a spare set of spectacles should also be at hand. Replacing a lost contact lens by the spare set of spectacles may not be fully compensatory if corneal curvature changes or corneal oedema has altered the refraction of the eye.

'Spectacle blur' is a term used about the reduced vision with glasses when used alternately with hard contact lenses. Spectacle blur is at its highest three days after removal of the contact lenses. For this reason it may be better to examine contact lens wearers directly after removal of the lenses. If the visual acuity or the measured refractive error is close to a border value, the lenses should not be worn for 2–3 weeks before definitive measurement of refraction is performed.

[In recent years fashion and designer contact lenses have been brought on to the market. They can be tinted to alter the iris colour or can show all kind of symbols like

smiley's or water drops. Because of the reduced incoming light and the fixed painted pupil they shall not be worn by pilots.

5.4 Orthokeratology

Orthokeratology has many names:

AOK:	Accelerated Orthokeratology
CRT:	Corneal Refractive Therapy
CCC:	Corneal Corrective Contacts
EZM:	Eccentricity Zero Molding
GVSS:	Gentile Vision Shaping Systems

It is a non surgical process which flattens the cornea of the eye using contact lenses to reduce refractive error. Contact lenses for Ortho-K have a reverse geometry design. The central portion of the contact lens fits closer to the eye than a standard contact lens exerting a pressure. The reverse geometry part of the eye surrounds the central visual zone. Ortho-K lenses are worn during night.

The Studies have shown that that there is a considerable variation in refractive error change throughout the day. About 90 days after discontinuing contact lens wear the refractive error, visual acuity and corneal curvature have returned to baseline levels. The results indicate that the level of vision during periods of non-lens wear is unstable and makes it difficult to predict the quality of vision. These are the reasons that orthokeratologic lenses shall not be used.]

6 REFRACTIVE SURGERY

6.1 Radial keratotomy

During the latest decades, several different surgical procedures have been introduced in order to alter the refractive properties of the eye. The aim of [most of] these operations is to change the anterior curvature of the cornea. Most of them are complicated, demand a very high experience of the surgeon and are used on a limited number of patients. One of the methods, the so-called radial keratotomy, is easier to perform and has gained a considerable interest. In this operation, a limited number of radial incisions are made through the corneal stroma whereby the anterior surface is flattened. The method is used to reduce or eliminate myopia.

Large numbers of myopic subjects have been operated with this method. Experiences so far show that the myopia is reduced, and to a greater degree, in patients with larger amount of nearsightedness. It is not possible to predict the effect: some patients end up with hyperopia. Although complications due to the incisions are few, infections occur and have caused blindness. From the functional point of view, two problems are most relevant to aircraft personnel. One is that in some patients the refractive state is not stable and can vary more than 1 dioptre during the day. Another is an increased glare sensitivity due to the corneal scars.

[This procedure is obsolete and should not be used anymore. However there are applicants who received these procedure years ago. If they meet the requirements under Appendix 13 to Subparts B & C 8, a fit assessment may be possible.]

6.2 Photorefractive kKeratectomy

In photorefractive keratoplasty, laser radiation is used to alter the anterior curvature of the cornea by ablation of stromal substance. *The corneal epithelium is abraded, before the laser treatment, which is very painful.* So far, subjects with myopia, [hyperopia] and astigmatism have been treated; the experience is greatest for lower degrees of myopia [(up to -6,0 dioptries).] The results are far more predictable and stable than with radial keratotomy and [] complications [are fewer].

A corneal haze during some months after surgery is, however, common. Increased glare sensitivity has been recorded postoperatively also in patients without visible haze and may be an objection [for a fit assessment. Also instability of refraction may occur.]

6.3 **[Laser-in-situ-Keratomileusis (LASIK)**

Especially because of the pain and the glare, a new technique to correct hyperopia, astigmatism and also high myopia was developed. During the laser in situ keratomileusis (LASIK) a corneal flap is shaved by a microkeratome, is flapped back and a laser ablation is performed in the stromal bed. After the laser procedure the corneal shave is flapped back. The possible complications of LASIK are more severe than in PRK and mostly related to the use of the microkeratome. The flap can be dislocated or be lost and it can be loosened long after surgery. An irregular astigmatism can be produced by the microkeratome. Also with this procedure glare and instability of refraction can occur.

6.4 **IntraLasik**

IntraLasik is exactly like traditional conventional or custom wavefront Lasik, except the corneal flap is created with a femtosecond laser microkeratome rather than a mechanical microkeratome with a metal blade. The advantages of IntraLasik over conventional LASIK are the higher safety and a higher predictability. It provides a vision with better contrast sensitivity. Some patients may experience a short period of increased corneal edema. This slight swelling can cause vision to be blurry, but the swelling normally resolves with healing. Occasionally an IntraLasik patient will experience some photosensitivity. All these issues usually resolve during the six-month healing process.

6.5 **Corneal Rings**

A reversible corneal refractive procedure is the insertion of corneal rings and is indicated in myopia of up to 4 dioptres. An intrastromal corneal ring is inserted into an intrastromal channel in the peripheral cornea. The reduction of the corneal curvature and therefore myopia depends on the ring thickness and diameter. The advantage of this procedure is that it can be rescinded. The possible complications are peripheral haze, glare and reduced night vision.

6.6 **Thermal Keratoplasty**

Thermal keratoplasty consists of heating the cornea to shrink corneal collagen and thereby modify anterior corneal curvature. Nowadays mainly Holium Yag-Lasers are used to produce necessary heat of 55-60° C. 8 to 16 applications are performed in the midperipheral to peripheral cornea. LTK can reduce mild hyperopia up to +5 diopters with high regression during the first 6 months. Best results are obtained in people over 50 with hyperopia of 2 diopters. Because of the opacity of the peripheral cornea, haze and reduced night vision are the biggest problems besides the instability of refraction at least for 6 months. Because of the side effects this procedure is not in wide use. The opacification of the cornea is the main cause that a fit assessment is very unlikely.

6.7 **Conductive Keratoplasty**

CK uses high radiofrequency energy that is delivered with a thin metal tip in concentric rings of multiple spots around the corneal periphery, shrinking collagen and steepening the central cornea. The indication is low hyperopia at the age above 40 years. One of the main side effects are the induced astigmatism with halos and possible diplopia. Because of the instability of refraction a fit assessment may be considered after 6 months.

6.8 **Phakic intraocular lenses**

It has been shown that corneal refractive surgery presents bad results in high refractive errors. To correct high refractive errors, a second artificial lens is implanted in addition to the own lens. There are two possible locations to place the lens: in the anterior or in the posterior chamber of the eye. The procedure works for myopia from -10 to -18 diopters and for hyperopia of +3 to +10

diopters. It is also a procedure that is reversible. Lens implantation is a well known procedure. But it is an intraocular surgery with the possibility of infections, loss of the eye, pupillary block glaucoma, development of cataract, retinal detachment, cornea edema or opacity with resulting keratoplasty due to loss of endothelial cells. For high hyperopia up to +9 diopters a clear lens extraction with intraocular lens implantation is performed. This procedure is not reversible and it is combined with the loss of accommodation and therefore not very useful in young patient eyes. [A fit assessment may be possible after 3 months if no postoperative problems have occurred and especially if the intraocular pressure is not increased.]

[6.9 Assessment

A fit assessment] may be possible after [3 – 12] months, [depending on the preoperative refraction, the thickness of the cornea, the experience of the surgeon, the performed procedure and the side effects of the individual case. A fit assessment may be possible,] provided that post-operative stability of refraction and visual function has been achieved and glare sensitivity is not increased.

7 APHAKIA

Aphakia means 'loss of lens', i.e. that the lens has been removed from the eye, in most cases because of cataract. Often cataract is simultaneous with, or caused by, other eye disease; a fact that should be considered in each case. The refractive power of the lens must be replaced in the aphakic eye and there are three current methods to do this.

7.1 Aphakia with spectacle correction

Aphakia gives rise to hyperopia of the order of 11 dioptries. There are significant optical disadvantages with glasses of this power: a large ring scotoma, peripheral distortions, a 'jack-in-the-box' phenomenon, and image enlargement. These preclude the use of aphakia spectacles in aviation personnel.

7.2 Aphakia with contact lens correction

Compared to the normal eye, the aphakic eye corrected with a contact lens has a somewhat narrower visual field. The optical properties of this correction are otherwise of minor significance. Because it takes time for the eye to heal after a cataract operation, a waiting period of six months following surgery is recommended.

7.3 Aphakia corrected with an intraocular lens

The optical properties of the aphakic eye with an intraocular lens are comparable to those of the presbyopic normal eye. In some cases, a large spherical or astigmatic error remains or is induced by the operation and should be duly paid attention to.

After an operation with the surgical experience and technique present today, the visual result is usually good and the condition stable after about three months. Immediate postoperative complications should, of course, not be present.

[Bi- and multifocal as well as accommodative intraocular lenses have progressed in their quality during the last years. But there are still problematic side effects as possible halos, glare and reduced contrast sensitivity. For the time being, the side effects and the acceptance of the patients as well as the missing study results give enough reasons to still accept only monofocal intraocular lenses.]

7.4 [Assessment

An assessment may be considered] after 3 months, provided that post-operative stability of refraction and visual function has been achieved and that the visual requirements are met either

with contact lenses or with intra-ocular lenses in combination with spectacles. The use of spectacles as a sole means of correction (aphakia spectacles) is not acceptable (see paragraph 7.1 above)

Of practical importance are the progressive proliferations in the posterior lens capsule which give rise to increased glare sensitivity, impaired contrast sensitivity etc. This is quite common (up to 50%) after the procedure currently used, i.e. extracapsular cataract extraction and motivates regular controls by an ophthalmologist.

8 VISUAL FIELDS

With the eye held steady, light can be perceived within a solid angle (an asymmetric 'cone') pointing at the eye; this angle constitutes the visual field. Since it is awkward to illustrate this three-dimensional space, the visual field is usually depicted as a two-dimensional projection of the space. Within the visual field, we see brightness and colour contrasts, identify object forms etc. As a rule, the visual functions deteriorate against the periphery of the visual field; spatial discrimination (i.e. visual acuity) and colour discrimination are both impaired when the object is moved from the fixation point. Colour of all hues (going from one end of the spectrum to the other one passes a series of spectral hues: red, orange, yellow, green, blue, violet etc.) can be seen to the outer limit of the visual field. Against the periphery, however, the object saturation has to be very high in order that the object be seen as coloured (saturation is a measure of 'colourfulness'; light of one wavelength has maximum saturation; white, grey and black no saturation). Colour naming is increasingly difficult the more peripheral the object is in the visual field.

It would probably be of large practical interest to measure the more complex visual functions within the visual field. One is, however, usually restricted to measuring the mere ability to detect objects with brightness contrast to the background. Objects with high contrast or large angular subtense are detected at a more peripheral angle. If, on a field chart, those points that have the same sensitivity are connected with lines, an isoptre is created. The isoptre corresponding to a very bright object gives the outer limit of the visual field. Objects with low contrast or small subtense give smaller isoptres (fig. 14).

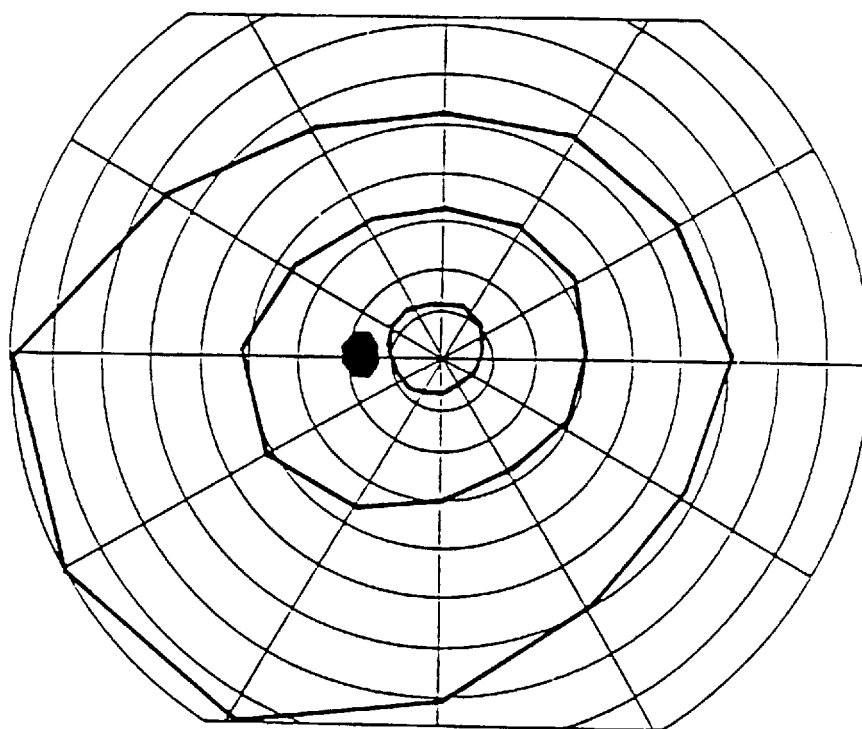


Figure 14 A normal left eye visual field with three isoptres. The outermost shows the outer limit of the field: the two smaller are produced with objects of lower brightness or size. The black area is the blind spot. The circles show the two-dimensional projection of every 10° of a hemispherical surface.

Abnormal, i.e. reduced contrast sensitivity gives rise to a visual field defect or scotoma. When the sensitivity is reduced but still present, we talk about a relative scotoma. When light is not perceived at all, the scotoma is called absolute.

8.1 Monocular and binocular fields

The monocular visual field extends further temporally than nasally and further downwards than upwards (fig. 14). The total extent of the horizontal meridian is about 150°. Nasally and upwards, the useful fields may be restricted by the nose and the brows respectively. The binocular visual field is the sum of the two fields when the eyes are fixating on a certain object (fig. 15). Within the central area, the fields overlap and on each side are temporal crescents solely belonging to one eye.

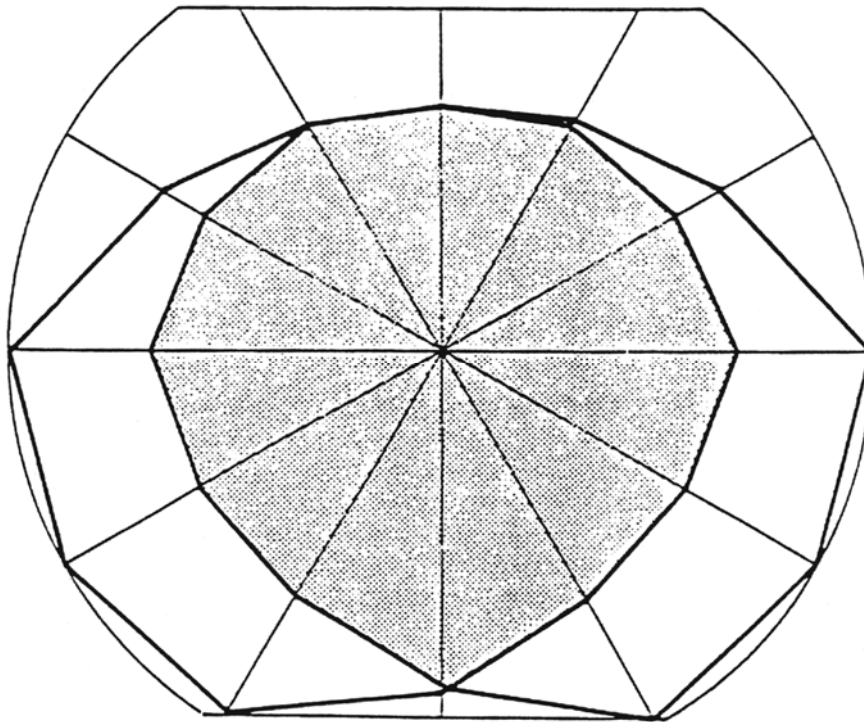


Figure 15 The binocular visual field. The central grey area is common to the two eyes whereas the temporal crescents are unique.

The field of gaze is a larger area determined by the size of the visual field(s) and the mobility of the eyes and the head. The field of gaze can, of course, be measured under monocular or binocular seeing.

8.2 Flight deck considerations

Inside the cockpit, the exterior field of vision is restricted by the size of the windscreen and cockpit windows. These are often narrow, and furthermore the ground is often partly hidden by the nose of the aircraft. Other crew members may conceal parts of the visual field as may broad or unwisely placed spectacle frames.

Hypoxia is said to cause a restriction of the outer limit of the visual field and an enlargement of the blind spot. The latter defect is found already at such low altitudes as 1 000–1 500 meters (3 000–4 000 feet). It has to be remembered, however, that this spot, even enlarged, is covered by the visual field of the other eye.

The extent and quality of the visual fields have a high theoretical validity for all kinds of aviation duties. With 'indirect vision' other aircraft, instrument dials, warning lights etc. are seen. How large the fields must be and what defects can be accepted without reducing safety is impossible to state. Thus, for safety reasons the requirements are very strict: both visual fields shall be normal. Deviations from this requirement are only possible under the waiver clause. Each visual field defect must be individually judged. It is self-evident that small, monocular and peripheral defects are less important than large and central defects. Defects covering corresponding parts in the two eyes, i.e. homonymous defects, are particularly dangerous to flying.

8.3 **Methods of examination**

The visual field can be measured binocularly or, usually, monocularly. The most simple measurement, which can be performed without special equipment, is by so-called confrontation (the expression is derived from the fact that the subject and the examiner face each other). The most often practised method is that designed by Donders and named after him. Here, the applicant and the examiner face each other at a distance of about one metre. Both cover the corresponding eye (the right eye of one and the left of the other) and look into each other's seeing eye. The examiner moves his hand from the periphery towards the center and compares his own seeing with that of the applicant; the latter tells as soon as he sees the hand. This test, of course, demands normal visual fields of the examiner.

The visual field shall be tested in several meridians of each eye, preferably in the eight main meridians (12, 3, 6 and 9 o'clock and the oblique meridians in between). This way of testing the visual field is rough and insensitive and does not provide a basis for comparison or recording. Sensitivity can be increased by using a smaller object or by asking the applicant to tell whether the fingers are moving or steady. If, however, anything but large defects should be found, perimetry or campimetry should be used. These methods are also necessary for the precise recording of field defects.

a *Perimetry*

In the perimeter, an object of defined size and brightness is presented on a stable background. The background can be an arc moved in different meridians or, as most often today, a hemisphere. The object can be a stimulus patch moved by hand or a light dot projected on the background. If the perimeter has not its own illumination, it is essential that it is evenly illuminated by an external light source which must be kept unaltered between examinations.

The eye to be examined is first centred in the perimeter by adjusting the head-and-chin rest. The applicant is told to fixate steadily on the fixation mark or light and to signal when the stimulus is seen. In the bowl perimeters, central fixation can be checked via a telescope.

With a manual arc perimeter, a suitable target is moved by hand from the periphery until it is seen by the applicant. In this kinetic perimetry, several meridians are tested so that an isoptre for the object used can be mapped. With a large object of high contrast, the outer limits of the visual field are found. Using smaller objects of lower contrast, smaller isoptres are recorded as is necessary in order to find subtle defects of retrochiasmal origin.

Projection arc perimeters show a round or oval object which, likewise, is moved from the periphery towards the centre in various meridians. As with the objects moved by hand, at least eight meridians should be tested. If a scotoma is found, it can be mapped by moving the object from the centre of the defect in various directions.

The arc perimeters have largely been replaced by the bowl perimeters. Here the subject is placed with his eye to be tested in the centre of a hemisphere which is evenly illuminated (usually to 10 cd/m^2). A light dot of variable brightness and size can be presented anywhere within the hemisphere via a projection system. Most often performed is kinetic perimetry where a varying number of isoptres is recorded by steady movement of different objects in several meridians. Examination is fairly simple to perform and evaluate. Precision is high and even small defects are detectable by this kind of perimetry. Unfortunately, the apparatuses are rather expensive.

b *Automated perimetry*

Manual perimetry is tedious and subject to variations between examinations due to the examiner's experience, expectation bias etc. To overcome these disadvantages, a number of automated perimeters have been constructed. Almost all of them work by static perimetry, i.e. fixed stimuli varying in stimulus brightness. The stimuli are located in areas of particular interest for detecting various field defects. There are programmes for screening and for finding scotomas caused by glaucoma or neurological diseases. A computer directs the random selection of stimulus location and target brightness. In some screening programmes, all stimuli are of the same intensity above threshold. In other programmes, which are more sensitive, intensity is adjusted to the overall threshold increment against the periphery. Some perimeters measure the threshold sensitivity in some or all points chosen.

Automated perimetry has been shown to be highly sensitive in finding visual field defects. Reproducibility is high because the variations caused by the examiner have been eliminated.

High pass resolution perimetry is a new method where the subject only detects the object (a ring) if it is discriminated by other visual channels than those active in luminance contrast detection. This method has proved to be more sensitive to the loss of visual channels than ordinary perimetry and is easily performed. The outcome clearly shows – also to the subject – an impairment of the visual field.

c *Campimetry – tangent screen*

In campimetry, the applicant faces a black screen of [1,0, 1,5] or 2 metre square at a distance of 1 or 2 metres. Targets attached to a black rod (or projected light spots) are used to map small isoptres or central and paracentral scotomas. Test equipment is cheap and the method highly sensitive. It demands, however, great experience and is not suitable for visual field screening. It is mainly used to find and follow glaucomatous visual field defects and to reveal malingering.

8.4 **Visual field defects**

Visual field defects are caused by diseases within the eye, the optic nerve, the optic tracts and optic radiation, and the occipital lobe. Lesions located in front of the chiasm cause a defect of one eye. Chiasmal disturbances give complex defects, usually in both eyes. When located behind the chiasm – a retrochiasm disorder – the lesion gives rise to defects of the contralateral half of the two eyes. In general, these defects are more congruent the further posteriorly the lesion is.

Media opacities (as cataract) may reduce the retinal illumination and the image quality giving a generally reduced sensitivity within the visual field.

Retino-choroidal disorders cause reduced sensitivity in the area affected. Examples are retino-choroiditis and retinal detachment. If the function of a nerve-fibre bundle is likewise affected, wedge-shaped defects may ensue. In retinitis pigmentosa, an annular scotoma is characteristic in the early phase.

In glaucoma, the most frequent early defect is a paracentral scotoma within the central 15–25°. With progressive disease, the number of scotomas and their size increase, and they may

coalesce to the characteristic arcuate Bjerrum scotomata which stretches from the blind spot to the nasal hemi-field. A so-called nasal step is also an early finding (fig. 16). Late in the course of the disease, the last remaining areas are usually the central field and a temporal island.

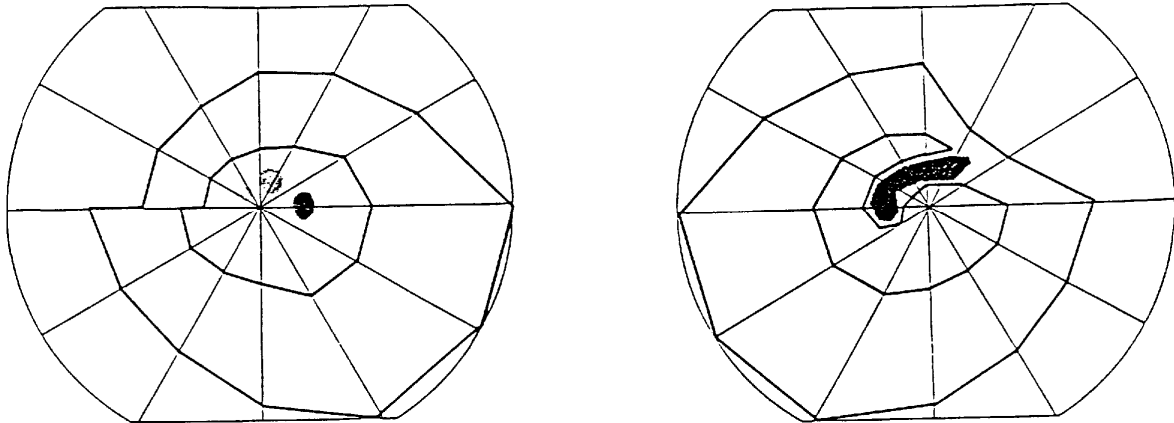


Figure 16 To the left early glaucomatous visual field defects; nasal steps in the upper field and two paracentral relative scotomatas. To the right a Bjerrum scotomata with an absolute scotomata inside (dark area).

Optic nerve disease most often gives central/paracentral defects (fig. 17). The central lesion also typically affects visual acuity and colour vision.

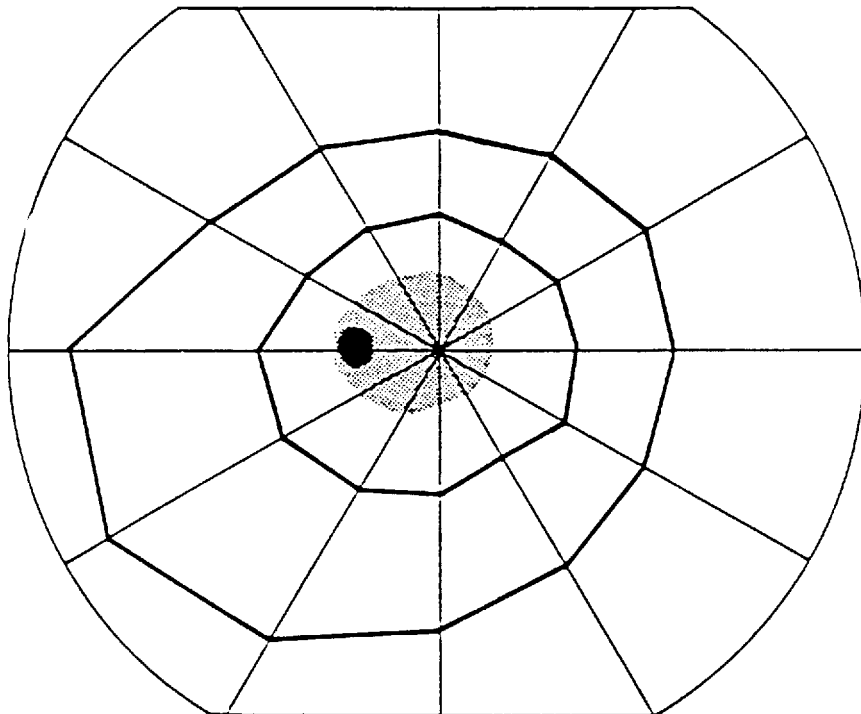


Figure 17 A caecocentral scotomata , i.e. a depression in the visual field including the fixation point and the blind spot.

A lesion in the middle of the chiasm primarily affects the two temporal hemi-fields (fig. 18), as in tumours of the pituitary gland (hypophysis).

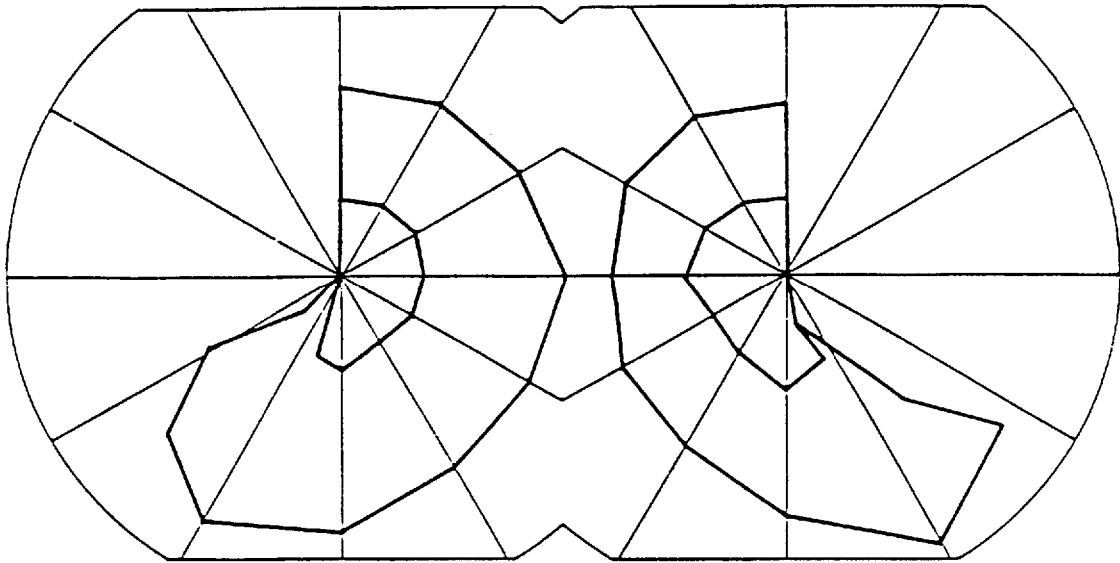


Figure 18 Bitemporal field defects, in this case caused by a tumour compressing the chiasm from below. This way the field defects are more outspoken in the upper parts of the fields. Small isoptres are typically more affected than the larger.

Retro-chiasmal defects are more or less congruent and only affect one half of the visual fields. Depending on the size and location of the lesion, small or large parts of the fields are disturbed (fig. 19).

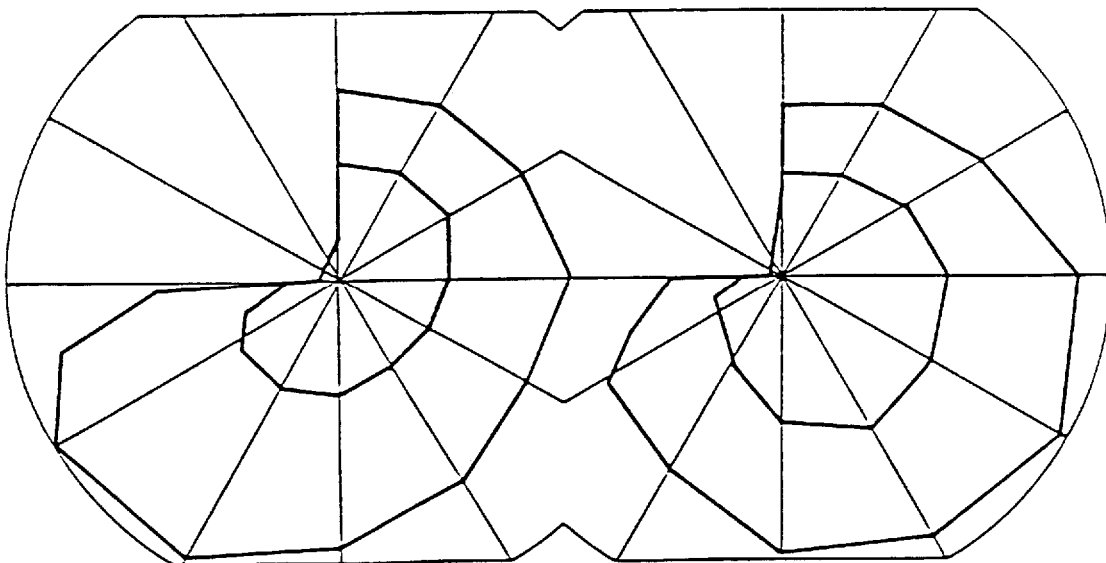


Figure 19 Homonymous upper left quadrant defects.

9 OCULAR MUSCLE BALANCE – BINOCULAR VISION

9.1 Stereopsis

The two eyes are normally directed at the same point. Stereopsis is made possible by virtue of the binocular seeing of the same visual scene, as there is a small difference between the images of the two eyes. This capacity to determine the third dimension of the visual space is most important for near objects. Beyond about [200] metres distance, its importance is negligible. In theory, aviation personnel should benefit from stereopsis when judging short and intermediate distances. The practical importance has, however, never been proven.

There are also a number of monocular clues for judging depth. Among these are the fact that nearer objects cover more distant ones, the known dimension of certain objects, parallaxic movements and an apparent colour desaturation at great distances. These monocular clues are most important at greater distances and do not depend on cooperation between the two eyes.

9.2 Heterophoria

The direction of gaze of the two eyes against the same point is made possible by fusion of the images. When fusion is artificially broken, e.g. by covering one eye, the non-seeing eye takes up its resting position. In a few cases, the covered eye remains aligned with the other eye; the subject is said to be orthophoric. In most cases, the covered eye deviates before taking up the resting position. If fusion is readily accomplished when the eye is uncovered, the subject is said to have a heterophoria. Heterophoria, or latent squint, thus means that the two eyes cooperate normally most of the time because the fusional strength is greater than the tendency to squint. Most heterophorias are small, and the fusional effort necessary to compensate for it, is modest.

There are several forms of latent squint:

- a esophoria – tendency to deviation inwards
- b exophoria – tendency to deviation outwards
- c hyperphoria or hypophoria – tendency to vertical deviation
- d cyclophoria – tendency to rotational deviation.

Heterophoria can give rise to eye-strain due to the constant fusional effort necessary. Although large heterophorias are more prone to give symptoms, there is no direct correlation between the magnitude of latent squint and the subjective troubles. If an applicant complains of asthenopia or headache and is corrected for a possible refractive error but has a heterophoria, the latter may be the cause. []The addition of (small-angle) prisms to spectacles is [not acceptable for aviation purposes, because of the pathology and the side effects of the glasses].

If the fusional strength is weak or further weakened by fatigue or the influence of drugs, the balance between fusion and tendency to squint may be upset. One eye then deviates: the heterophoria is said to be decompensated giving an intermittent squint. If diplopia follows the misalignment, it is a potentially dangerous situation. Again the evaluation of the condition is complicated for several reasons. First, suppression (see below) may prevent double vision in spite of the ocular deviation. Secondly, it is very difficult to establish whether a heterophoria at times will be decompensated. The magnitude of the heterophoria in itself is not conclusive because the fusional strength varies between individuals (maximum values for heterophorias as stated in visual requirements JAR–FCL 3.220([e]) – *vide infra* – are only for guidance as to when fusional reserves should be assessed). The fusional range or an estimate of the fusional strength are supportive measures but they are difficult for a non-expert to determine. In cases of large heterophorias or suspected decompensation with double vision, as in cases with suspected 'jump of localisation', the applicant should be referred to an ophthalmologist acceptable to the AMS.

9.3 **Strabismus**

Strabismus or squint infers that the two visual axes constantly point in different directions. The condition may arise at any age, but most cases develop in childhood. The reason may be defective fusional strength, abnormal vision of one eye (or both), or an oculomotor disorder. Different forms of strabismus are named corresponding to the heterophorias: esotropia, exotropia, hypertropia, hypotropia, cyclotropia.

If strabismus develops in childhood, double vision is prevented by suppression of one eye or both eyes. Those areas of the visual field that are most disturbing are quite simply 'uncoupled' and the sensitivity of other areas altered. In esotropia, e.g. the fovea and the area corresponding to the fovea of the other eye are deeply suppressed. This way, the visual acuity of the squinting eye is permanently reduced unless treatment is given. When the squinting eye is forced to see, e.g. by covering the other eye, suppression is more or less completely released. The squinting eye may be 'locked' in the abnormal position by developing an altered directional sensitivity, an anomalous correspondence. If such a case is operated so that the eyes are aligned, double vision may ensue.

In the case of strabismus present since childhood, the patient is usually trouble-free. One eye is as a rule preferred and the other is suppressed so that double vision is eliminated. Vision in the larger part of the squinting eye's visual field is almost normal; it follows that the binocular visual field is affected only to a minor degree unless there is a large angle of esotropia (when one eye is looking towards the nose, vision to the side is restricted). Some patients alternate eyes; the eye 'turned on' works normally (with normal visual acuity) and the other is suppressed, particularly in the central visual field. By alternation, the first eye is 'turned off' and the suppression in the other eye released etc.

In a strabismus that develops after childhood, diplopia can not be eliminated by suppression. Most of these cases are decompensated exophorias which turn into an exotropia. These patients acquire double vision which is extremely annoying. Since some fusional strength usually remains, treatment by alignment (orthoptic, optical or operative) may be successful and should be started early.

A paralytic strabismus is due to a paralysis of one or several ocular muscles. If it occurs in childhood, suppression sets in. Most patients are, however, adult, and they generally first notice their disease by double vision. The misalignment and the degree of diplopia increases when the eye is moved in the direction of the paralytic muscle.

9.4 **Convergence**

Vergences, or disjunctive eye movements, provide us with the ability to fixate points at various distances in visual space. In convergence the visual axes of both eyes are rotated inward whereas in divergence the movement of the eyes is outward. Vergence movements play an important role in the maintenance of binocular vision and oculo-motoric fusion. Insufficiency of convergence is one of the most common causes of ocular discomfort and asthenopia.

Under normal conditions the act of convergence is associated with accommodation and miosis (forming together the triad of the near reflex). The balance between convergence and accommodation is affected by optical correction of refractive errors, a fact that has to be considered when spectacles are prescribed.

Convergence is assessed in relation to the other eye movements, to the presence of heterophoria, and to the oculo-motor system.

9.5 Examination techniques

Examination starts with a thorough case history. Eyestrain, ocular or frontal headache and double vision should especially be asked for. In the case of strabismus, it is of value to clarify its debut and the treatment given.

Abnormal head position should be looked for. In some types of strabismus, diplopia is compensated by head rotation or tilting.

At the examination, the oculomotor function and the binocular cooperation are studied.

A strabismus of some magnitude is overt. Small-angle strabismus and heterophoria are best revealed by the cover-test. In the simple cover-test, one eye is occluded with the aid of a hand, a spoon or the like. The non-covered eye is watched. If it takes up fixation after a corrective movement, it was misaligned and a strabismus is proven. The simple cover-test is done first by occluding one eye, then after a short pause the other (fig. 20).

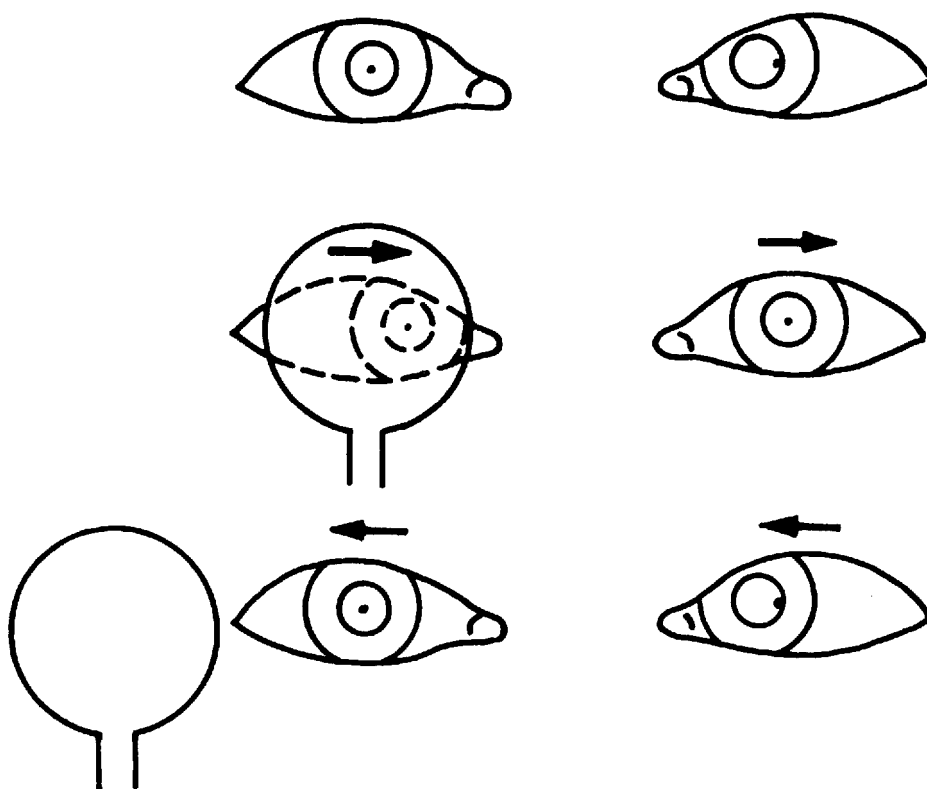


Figure 20 In the simple cover test, one eye is occluded and the other eye is watched. If it moves, it was not aligned before covering. (A case of esotropia of the left eye is shown.)

To disclose a heterophoria, the alternating cover-test is used. One eye is covered and after a few seconds the occluder is quickly moved to the other side, then after a while back again (fig. 21). This way, fusion is blocked and the eyes take up their resting positions. The uncovered eye is watched. If it moves, the eyes are not parallel and a heterophoria is proven. Strabismus gives rise to corrective movements with the simple and the alternating cover-tests, heterophoria only with the latter.

Further information is gained by watching the eye movements. The applicant is asked to fixate an object which is moved in different directions. These are, from the primary position, upwards and downwards, to the right and to the left, and upwards and downwards at gaze to the right and the

left. A gaze paralysis reveals itself by restricted movements of both eyes in certain directions. A peripheral oculomotor paralysis is shown by limited movements of one eye. The patient is asked for double vision in any direction of gaze. To disclose a misalignment, the cover-test can be used in all gaze directions. To establish which muscle is affected, a coloured filter can be used in front of one eye in combination with a small luminous object.

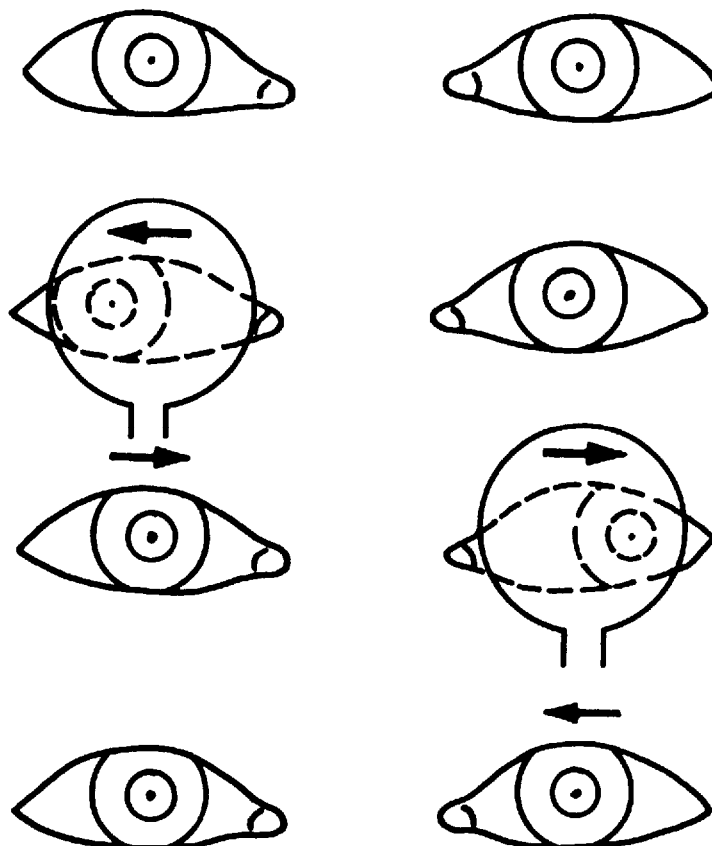


Figure 21 In the alternating cover test, the occluder is moved between the two eyes. This way fusion is blocked and a heterophoria revealed. The non-covered eye is watched. (A case of simple exophoria is shown.)

To measure the magnitude of heterophoria or strabismus several methods exist. The best one is to combine the cover-test with prisms placed before one eye. In esophoria and esotropia base-out prisms are used. Their power is increased until the corrective movement is eliminated. In exophoria and exotropia the base is placed nasally. This method does not depend on the applicant's cooperation in any other way than steady fixation. It can be performed with fixation at near or at a distance.

The degree of strabismus can also be roughly estimated by looking at the corneal reflexes of a point light source.

Heterophoria can also be measured with a so-called Maddox rod. Through this rod, a bright light source is seen as a line and fusion is therefore broken. Measurement is made with the aid of a ruler attached to the wall or, simpler, with a graduated device with a built-in Maddox rod and a rotary prism. Heterophoria at near is easily measured with the Maddox wing test (the detailed use of these tests is best learnt with the instrument at hand).

The fusional range is measured with prisms placed in front of one eye. Prism power is successively increased until fusion is no longer possible and double vision ensues. Testing is done with fixation at near or at a distance.

Squint angles can also be measured with an apparatus called the synoptophore. With this complicated instrument, a somewhat artificial situation is created and testing is considered less valid than that done in free space.

To reveal possible suppression of one eye the Worth four-dot test can be used. Four objects, white, red and green, are watched with a red filter before one eye and a green before the other. The subject only perceives the dots visible to the non-suppressed eye(s) – their colour determines which eye it is. If all four dots are seen, the eyes cooperate. If more than four dots are seen, a squint without suppression is proven.

Convergence is measured and expressed as the near point of convergence (not to be confused with the near point of accommodation).

The near point of convergence is determined by placing a fixation object – as for example the black line on the RAF Near-Point-Rule – in front of the eyes of the examinee. The visual object is then slowly moved towards the eyes until one eye loses fixation and turns outward. The distance (in centimetres) at which this occurs is the near point of convergence. Normal values are usually between 6 and 8 cms. If the near point is 10 cms or more the convergence is insufficient.

9.6 **Stereoscopic Vision**

No specific stereoscopic requirements have been established, albeit stereoscopic visual ability does express the standard of the binocular function. Thus testing of the stereoscopic visual acuity may be used as a valid screening measure of the central binocular function. The usual tests (e.g. Titmus and TNO or similar) measure the smallest disparity, expressed in seconds of arc, that can be recognised (disparity: difference between the images from the two eyes). A test result better than 60" is usually regarded as normal.

10 **COLOUR VISION**

Colour contrast aids in detection and identification of objects in the visual scene. Colour is a quality of the mind given to light of a certain spectral composition in a certain state of ocular adaptation. Psychologically, colour can be described by the three qualities hue, saturation and lightness. These have psychophysical counterparts which can be given colorimetric figures in order to characterise the colour in question.

The early use of colour in sea and land traffic was limited by the techniques available to produce light of sufficient saturation and brightness. Therefore only red, yellow (white) and green signals were adopted and their significance is today so deeply rooted in us all that they cannot be exchanged. This is unfortunate, since all people do not perceive colour in the same way and exactly these hues give rise to separation difficulties. Although attempts have been made to minimise the use of colour contrast as the sole characteristic of a stimulus, colours are still used to such an extent that some applicants have to be rejected for safety reasons.

10.1 **Colour vision physiology**

The person with a normal colour sense is called a normal trichromat. This person perceives as light electromagnetic radiation of wavelengths between about 400 nm (violet) and 700 nm (deep red). Maximum spectral sensitivity is at 555 nm (yellow-green). A normal trichromat can discriminate between more than 100 hues in the spectrum; the wavelength discrimination varies somewhat in the spectrum. By adding saturation and lightness differences, several hundred thousand different colours can be discriminated. Stimulus variables which affect colour perception are the angular subtense, duration and brightness.

Normal colour vision is made possible by the presence of three different kinds of cones with each one light absorbing pigment.

10.2 Colour vision deficiencies

The congenital, hereditary colour vision deficiencies are of different quality and severity. More than 99.9% of them affect the perception of red, red-purple, green and blue-green.

Monochromacy or achromatopsia means total absence of colour perception. These rare disorders exist in several forms; the most common is combined with low visual acuity, nystagmus and photophobia.

For a person with dichromacy, some hues are completely desaturated and impossible to distinguish from each other and from neutral grey. Wavelength discrimination is severely disturbed.

Anomalous trichromacy is a less pronounced defect. Subjects with such an anomaly show, compared to normal, increased thresholds for saturation and wavelength discrimination in certain spectral regions.

Congenital dichromacies and anomalous trichromacies exist in the following forms:

	Dichromacy	Anomalous trichromacy
Red-Green defects	Protanopia Deuteranopia	Protanomaly Deuteranomaly
Yellow-blue defects	Tritanopia	Tritanomaly (?)

The red-green defects are inherited as X-linked recessive disorders and are fairly common: 8–10% in caucasian men, in women about 0.5%. In men, deuteranomaly is most frequent: about 5%; the other three red-green defects affect approximately 1%. The yellow-blue defects are rare, about 1 in 50 000.

Protanopia and deuteranopia have been shown to be caused by the absence of one of the retinal cone pigments; the presence of not more than two pigments only makes possible the perception of two hues. The lack of the long wavelength sensitive pigment in protanopes results in lost sensitivity to deep red light which is perceived as black. In protanomaly and deuteranomaly, an abnormal pigment has replaced a normal one. Also the protanomalous subjects have reduced sensitivity to long wavelength light. The reason for the tritan defects is supposed to be alterations in the short wavelength sensitive pigment.

Protanopes confuse red and blue-green, deuteranopes green and red-purple. In protanomaly and deuteranomaly, separation difficulties arise with the same hues, although only those of low saturation, low brightness or small angular subtense. The anomalous trichromacies vary in severity and some are almost as pronounced as the dichromacies: extreme anomalous trichromacy.

Borderline cases between normal trichromacy and anomalous trichromacy are pigment amblyopia and colour asthenopia. The former confuse pigment colours, e.g. those on pseudo-isochromatic charts but pass other colour vision tests. Colour asthenopia is essentially an increased 'fatigue' to spectral lights. These and other borderline cases are usually considered as normals in practice.

The rare congenital tritan deficiencies cause confusion between violet and yellow colours.

Congenital defects are unaltered with age and cannot, contrary to what is sometimes claimed, be treated in any way. Tinted filters, e.g. the so-called X-chrom lens, make possible a better discrimination of some confusion colours but do not improve colour perception. Applicants passing a colour test by the use of such a device are not 'colour safe'.

Acquired colour vision deficiencies arise from diseases in the eye or the visual pathways. An ocular disorder most often gives rise to a yellow-blue defect. It is generally combined with other visual disturbances like reduced visual acuity or visual field defects and the ocular damage is thus overt. Of greater practical interest is the red-green deficiency caused by an optic nerve lesion. Such a problem invariably accompanies an optic neuritis and may result in difficulties in identifying colour signals although the visual acuity is normal.

With increasing age and density of the yellow lens pigment, a slight degree of tritanomaly follows.

10.3 Practical considerations

In aviation, colour is used in signals, instruments, signs, and print. The coloured object can be self-luminous (lamp + filter, LED or colour phosphor) or can be produced with pigment colours. In the latter case, the colour appearance depends on the character of the illumination. In some cases, a luminous contrast to the background is also present, and the identification of the colour is of assistance but not necessary to read the information. In other cases, e.g. navigation lights, the hue is the only clue to the correct identification. With the technical evolution, some colour signals have lost much of their significance because the message they convey has been taken over by other instruments. At the same time, a number of new colour applications have been introduced. The most recent is the colour display which presents data in a number of different hues and saturation steps. Luminous contrast is not always present and it seems most possible that the displays can give rise to practical difficulties for colour defectives. The evolution is very rapid, and the colour characteristics of the displays largely unknown. These instruments have created a serious problem which, until more knowledge is attained, necessitates a much less liberal attitude to colour vision abnormality.

As regards to the use of colour in civil aviation, some information is used only at night and other only in more advanced aviation. It is not self-evident that normal trichromacy is a necessity in all situations. By setting standards for the chromaticity of various colours, an attempt has been made to make their identification easier for air personnel with a colour deficiency.

The mere qualitative diagnosis of the colour vision deficiency is not sufficient, because the colour discrimination varies considerably between individuals with the same type of defect.

A practical colour vision test certainly has the highest validity but only for the conditions present at the test. It has been the practice of some countries to waive applicants with simple deuteranomaly who readily pass lantern tests. In some cases, a practical test with a signal gun has been decisive. Even individuals with rather outspoken defects may pass this test which does not signify whether the applicant normally perceives other less conspicuous signals.

In order to assess the fitness of an applicant with a colour vision deficiency with regard to a possible waiver, it is necessary to have at hand the results of a battery of colour vision tests. As many different aspects of colour vision as possible should be examined.

10.4 Tests of colour vision

Colour vision tests are produced to identify individuals with colour vision deficiencies, to classify them, and to screen those with a mild defect from those with a more severe defect.

The most readily available tests for screening are the pseudo-isochromatic plates. Most of them are made only for detection of red-green deficiencies; some series have plates which enable a

classification and graduation of severity. The different series perform the screening task more or less well; among well-known series are those of Ishihara, Dvorine, Stilling-Velhagen, and Boström-Kugelberg. These tests effectively separate normal from colour defectives. There are, however, subjects who fail only a few plates and in these cases a definite diagnosis is only possible with the aid of an anomaloscope.

There is a weak correlation between the number of failed charts and the severity of the defect; dichromats usually fail more plates than do anomalous trichromats. The classification of protans and deutans is not always possible with the charts. The American Optical Hardy-Rand-Rittler plates are especially designed for qualitative and quantitative diagnosis. These tasks are better fulfilled with this series than with any other plates. Unfortunately, this test, which is also excellent for testing acquired defects, is no longer available.

Testing with pseudo-isochromatic plates should be performed according to the instructions given by each test. It is important that the quality of the illumination is correct: either northern daylight or an artificial daylight source should be used. Ordinary incandescent lamps or fluorescent tubes make these tests easier to pass, especially to deuteranomals. The daylight source should give an illumination equivalent to the standard illuminants 'C' or 'D' of CIE (Commission Internationale de l'Éclairage). The plates should be shown at right angles to the visual axis of the applicant, at the correct distance and for the time specified in the test. The applicant should not wear tinted glasses. The number of failed plates serves to classify the subject as normal, defective or 'doubtful' according to the specifications of the test.

In the assortment tests, the subject is asked to arrange a number of coloured chips or to separate them into coloured or neutrally tinted. Of these tests, the Farnsworth Panel D-15 effectively parts subjects with minor defects from those with more severe defects. The test is easily performed and evaluated and, when failed, gives a qualitative diagnosis. It may be used as a valuable adjunct to other tests.

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The lantern tests are produced to test the ability to identify the hue of signal colours; they are meant to simulate the practical situation. There are a number of different lantern tests. In some of them, fixed red, white and green stimuli are presented. In others, there are extensive possibilities to vary the hue and saturation of the stimuli as well as the aperture size and presentation time. The possible advantage of being able to vary the stimuli is counteracted by the lack of knowledge of what these differences signify. Well known lantern tests are those of Edridge-Green, Giles-Archer, Beyne, Farnsworth, and Holmes-Wright. At present, however, only the lanterns of Holmes-Wright, []Beyne [and Spectrolux] have been approved for assessing colour deficient pilots as to whether they can be considered colour safe or not.

The correlation between lanterns and practical colour recognition is weak and has never been properly examined. It is not established how the performance on these lantern tests is related to the 'ready perception of colours necessary for safe duty performance'. Without this knowledge, it is safest to follow the norms given for each test.

The Holmes-Wright lantern [test] has an aperture size of [1,6] mm, corresponding to a visual angle of [0,9] minutes of arc. The light intensity is 2 000 μ -candelas for demonstration, 200 μ -candelas for daylight testing and 20 μ -candelas for testing in complete darkness. The lantern is easy to use.

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[a) Holmes Wright Type A - protocol

Ambient lighting:

Mesopic

Adaptation period:

Three minutes

Visual correction:

Normal (for distance - non tinted)

Subject-lantern distance:

Six metres (subject is seated); lantern is at eye level

Lantern setting:

'HIGH' brightness

Exposure time for each pair of lights:

Five seconds

Permitted response time:

Five seconds (from the time the lights are initially exposed)

Pre-test demonstration:

- 1) Turn the filter to 'DEM' (demonstration) and the colour setting to '1'.
- 2) To the applicant: 'This test is to find out if you can distinguish red, green and white lights. The lights are shown to you in pairs, one above the other, in any combination of red, green or white. For each pair name both lights, stating the top one first. The top light which you now see is red'.
- 3) Turn the colour setting to '2', saying to the applicant 'The top light you now see is green'.
- 4) Turn the colour setting to '3', saying to the applicant 'The top light you now see is white'.
- 5) Turn the filter from 'DEM' to 'HIGH' brightness, saying to the applicant "I am now going to show the lights at this brightness' (which is lower than 'DEM').

Test procedure:

- 1) Turn the colour setting to '2, 4, 6 or 8' (i.e. any red/green combination). Say to the applicant 'Name first the top and then the bottom light. Do not use any words other than red, green or white and you will be given five seconds to name each pair of lights. Any questions? Start now'.
- 2) If the applicant uses any other colour name, he is to be reminded that only these words will be used, and the examiner should make no other comments.
- 3) Show each of the nine pairs of lights to the applicant in random order, the responses being recorded on the examination form.

Assessment:

If any error is made naming green as red, or red as green, the applicant will be assessed as 'colour vision unsafe' without further testing.

If any other error is made, two further runs (i.e. 2 x 9 pairs of lights) on 'HIGH' brightness will be carried out. If no error in either run is made, the applicant will be assessed as 'colour vision safe'.

If one or more errors are made, the applicant will be assessed as 'colour vision unsafe' unless dark room facilities are available.

If dark room facilities are available, the applicant will be dark adapted for 15 minutes and one final run of the nine pairs of lights in dark room conditions at 'HIGH' brightness is carried out.

If no error is made, the applicant will be assessed as 'colour vision safe'. If one or more errors are made, the applicant will be assessed as 'colour vision unsafe'.

b) Spectrolux protocol

Ambient lighting:
Mesopic

Adaptation period:
Three minutes

Visual correction:
Normal (distant - non-tinted)

Subject-lantern distance:
5 metres (subject is seated); lantern is at eye level

Lantern setting:
Not applicable

Exposure time for each pair:
Three seconds

Permitted response time:
Three seconds (from the time the lights are exposed)

Pre-test demonstration:

To the applicant : 'This test is to find out if you can distinguish red, green and white lights. The lights are shown to you in 12 pairs, one above the other, in any combination of red, green or white and the intensities of the colours will vary. For each pair, name both lights, stating the top one first.

The operator then demonstrates two different pairs of lights, selected at random, indicating to the applicant the colours he should be observing.

Test procedure :

Say to the applicant 'Name first the top and then the bottom light. Do not use any words other than red, green or white and you will be given three seconds to name each pair of lights. Any questions? Start now'.

If the applicant uses any other colour name, he is to be reminded that only these words will be used, and the examiner should make no other comments.

Assessment :

No errors are permitted. Should the subject make any error, the test is failed and the subject classed as 'colour vision unsafe'. No additional runs are permitted.

The Beyne's lantern (lanterne chromoptométrique de Beyne) presents the colours green, red, blue, white, and yellow-orange with an aperture size corresponding to a visual angle of 3 minutes of arc. Each colour is shown for one second. The examinee is placed in front of the lantern at a distance of 5 metres. No errors are accepted.

[c] Beyne's protocol

Ambient lighting:

Darkness

Adaptation period:

Three minutes

Visual correction:

Normal distance - (non-tinted)

Subject-lantern distance:

Five metres (subject is seated); lantern is at eye level

Lantern setting:

Three minutes of arc

Exposure time for each light:

One second

Permitted response time:

Three seconds (from the termination of light exposure)

Pre-test instructions:

'This test is to find out if you can distinguish red, green, white, blue and orange lights. The lights will be shown to you one at a time. You will see red, green, white, orange and blue and no other colours. You will be shown each light for one second and will have three seconds to respond. If you take longer than three seconds, this will be regarded as a mistake. Any questions? Start now'

The lights are not demonstrated prior to the test.

Order of presentation of the lights:

First and last presentation is blue. Between the two blue presentations three white, three green, three red and one orange light are shown, in a random order i.e. 12 lights are presented.

Number of runs:

One (two if one mistake is made in the first run)

Pass criteria:

No mistakes - the subject is passed as 'colour vision safe'.

Two or more mistakes - the subject is failed as 'colour vision unsafe'.

Only one mistake - a second run of 12 lights is permitted. If no mistakes are made on the second run, the subject is passed as 'colour vision safe'.

The lantern-tests may be retaken after 6 months.

d) Nagel Anomaloscope

The Nagel anomaloscope is a spectroscopic device designed to evaluate the Rayleigh equation. It presents a circular split field viewed through a telescope-like device. The upper half field is a spectral yellow-green (545 nm) and spectral red (670 nm). The luminance of the pure yellow lower half field may be adjusted from dark to bright.

Measurement requires a trained and experienced examiner. The instrument is adjusted by means of two knobs on the sides of the device for a normal match. (yellow=15, red-green=40). The examination starts with a three-minute adaptation period where the evaluatee looks at the screen in front. The evaluatee is asked to describe the appearance of the colours seen in the instrument. Different matches are offered to the evaluatee and he or she is asked to describe the appearance of the colours seen. The matches are: 73/15; 73/6, 60/6, 20/15.

If the normal match and only the normal one is accepted, the range is evaluated. The examiner changes the red-green ratio in small increments around the match point asking each time: Is this a match. The evaluatee is asked to adjust the knob controlling the luminance of the test field. In this fashion the match centre and matching range are determined and recorded.

If the normal match is not accepted and after the special matches are offered, the yellow-green knob is set in increments of ten until the full range of possible matches is evaluated and the matching range is evaluated as described above.

Between each trial the evaluatee must readapt at the screen in front.

An applicant is considered to be colour safe if he/she has shown to be a normal trichromat.]

In summary, a vast amount of work still has to be done in order to establish which colour vision deficiencies can be accepted without loss of safety. Firstly, the colorimetric properties of all colours in use have to be determined, a task recently made even more difficult by the introduction of the colour displays. Secondly, one has to analyse how the identification and discrimination of these colours is influenced by the different types of deficiencies and, finally, it must be decided if an existing or future colour vision test can effectively divide applicants into 'colour safe' and 'colour unsafe' groups.

11 PATHOLOGICAL EYE CONDITIONS

In this chapter eye conditions are listed which can or will influence visual performance. Some of them are so grave and their symptoms so pronounced that applicants possessing them will be assessed as medically unfit for licensing without further ado. In other cases, the applicant may be assessed as medically fit after a thorough ophthalmic examination and based on an accredited medical conclusion.

Some of the conditions listed below are of a progressive nature. Applicants with such a disorder which fulfil the visual requirements should be advised that acceptance may be limited and regular examinations be instituted depending on the nature of the condition.

The following conditions are usually associated with reduced visual performance and may therefore entail medical unfitness for licensing purposes.

11.1 Eyelids

Disorders of relevance influence the position or motility of the lids or cause ocular irritation.

- a Ptosis interfering with the extent of the visual field
- b Lagophthalmos (inability to close the eyelids) which causes corneal desiccation
- c Scars and adhesions which affect normal eye movements
- d Tumours and lesions which interfere with the protective functions of the lids

Aviation ophthalmology (continued)

- e Abnormalities of the lid margins causing trichiasis or chronic irritation of the lids.

11.2 **Lacrimal system**

- a Any disorder which gives rise to the dry eye syndrome with ensuing ocular irritation and visual impairment
- b Obstructions of the lacrimal outflow system with significant epiphora or recurrent inflammations.

11.3 **Conjunctiva**

- a Diseases which limit lid or ocular mobility and thereby cause deficient eyelid closure or double vision
- b Affections of the conjunctival glands interfering with proper tear film production (dry eye).

11.4 **Cornea**

- a History of recurrent keratitis or corneal ulcers
- b Corneal scars which influence visual function
- c Keratoconus or corneal dystrophy. These diseases usually lead to reduced visual acuity in the long run.

11.5 **Uveal tract**

- a History of recurrent anterior uveitis (iridocyclitis)
- b Sequelae after anterior uveitis causing increased glare sensitivity or similar problems; secondary glaucoma
- c Posterior uveitis giving rise to reduced visual acuity or visual field defects
- d Congenital malformations with visual impairment.

11.6 **Retina**

- a Hereditary degenerations with progressive influence on visual acuity and visual fields (e.g. retinitis pigmentosa)
- b Any macular degeneration which interferes with visual function
- c Retinal detachment
- d Vascular disorders with exsudates, bleedings or ischemic retinal damage.

11.7 **Optic nerve**

- a Optic neuritis
- b Optic atrophy
- c Both these disorders cause visual impairment by reduced visual acuity, defective red-green colour sense and central-paracentral visual field defects
- d Optic nerve head *drusen* or senile plaques.

11.8 **Lens**

- a Lens opacities (cataract) affecting visual acuity or glare tolerance
- b Aphakia not corrected with an intraocular lens: hyperopia of high degree

- c Dislocation of a lens, partial or complete.

11.9 **Miscellaneous defects and diseases**

- a Glaucoma (dealt with in detail below)
- b Tumour of the eye or the orbit
- c Inflammatory orbital condition
- d Disorders affecting ocular motility, e.g. orbital trauma, extraocular muscle paralysis, endocrine myopathy
- e Nystagmus with reduced visual acuity
- f Impaired pupillary light reflexes (drugs, trauma, inflammations)
- g Night blindness (nyctalopia, hemeralopia).

11.10 **Practical Considerations**

a *Optic Neuritis*

30–60% of patients with optic neuritis will later develop multiple sclerosis. The risk of developing multiple sclerosis is reduced in patients above the age of 45 years. [An assessment] may be considered in pilots older than 45 years of age if visual functions are restored and a specialist neurological examination demonstrates no pathology.

b *Central Serous Retinopathy*

The clinical course of this disease is very unpredictable. Usually visual functions are almost fully restored, leaving only a slight reduction in contrast sensitivity. [An assessment] may be considered if visual functions are restored and retinal oedema cannot be demonstrated by clinical nor by angiographic examinations.

c *Vascular occlusions*

Previous or present occlusion of the central retinal arteries and veins is not acceptable in pilots. Following branch occlusion, [an assessment] may be considered [for revalidation or renewal] if visual functions are restored and the presence of disqualifying pathology cannot be demonstrated by ophthalmic and medical examinations by accredited specialists.

d *Retinal detachment*

A retinal detachment will result in visual field defects and, in most cases, in reduced visual acuity as well. Even though vision may be restored by surgery, refractive errors and changes in eye motility may be significant side effects of the treatment. [An assessment for revalidation or renewal] may be considered six months after successful surgery provided visual requirements are fulfilled.

e *Keratoconus*

This is a progressive corneal disease leading to severe astigmatism, corneal oedema and, in some cases, even to spontaneous corneal perforation. In its early stages, keratoconus may be treated with spectacles, later with contact lenses and, in the final stage, with corneal transplantation. [A fit assessment may be possible for class 2 and at revalidation or renewal examination for class 1 if the visual requirements are met with contact lenses.] After surgery, [see below].

f *Corneal transplants*

Following a corneal transplantation, the refraction remains very unstable for a period of six to 12 months. [Fit assessment for revalidation or renewal class 1] may be considered one

year after surgery if the visual requirements are fulfilled with use of correction suitable for aviation purposes, if the refraction is deemed stable and if there is no significant reduction of contrast sensitivity. The pilot should be re-examined by an ophthalmologist semi-annually.

12 GLAUCOMA

Glaucoma is the common name of several disorders, the most frequent being chronic open-angle glaucoma (COAG), angle-closure glaucoma (ACG), and secondary glaucomas.

COAG is an insidious disease with progressive optic nerve damage and visual field defects. It is usually combined with and possibly caused by increased intraocular pressure (IOP). Optic nerve fibres are supposedly destroyed by the combined action of raised IOP and impaired blood flow in the optic disc.

The mere presence of raised IOP is called ocular hypertension, and it involves an increased risk of developing COAG. This latter diagnosis is not ascertained by raised IOP alone, it demands the occurrence of either disc cupping or visual field defects.

The ACG is caused by the blockade of a narrow chamber angle. The IOP quickly rises to a high degree, there is reduced vision due to corneal oedema and severe pain, headache and nausea. If not treated, the condition gives rise to optic nerve damage as in COAG. The only way to anticipate an attack is by examination of the chamber angle, since the IOP is normal in the free intervals.

Secondary glaucomas are caused by conditions which interfere with the normal passage of the aqueous in the pupil or the chamber angle (e.g. anterior uveitis).

The first objective signs in the fundus are atrophy of nerve fibre bundles and cupping of the optic disc. The earliest changes are subtle and the diagnosis necessitates either progression or alterations of a certain magnitude. A rather substantial axon atrophy is present when visual field defects are first measurable. In most cases these are small paracentral scotomas within the central 15–25° of the field (Fig 16). Another early defect is the so-called nasal step, ie, a constriction of the upper or lower part of the paracentral nasal field (Fig 16). With progressive optic nerve damage, the cupping of the optic disc increases. Of help to record cup changes are the C/D ratio (a measure of the diameter of the cup in relation to that of the whole disc) and the rim area (the area of the outer rim of the disc with nerve fibres). If the disease process goes on, the cup usually first reaches the rim of the disc in either the lower or the upper pole. In severe cases, no rim of nerve fibres is seen at all, and the cup is deep or undermines the disc edges.

With progression of the disease, the scotomas increase in size and coalesce. One typical visual field defect in intermediate stages is the Bjerrum arcuate scotoma which stretches from the blind spot to the nasal field (Fig 16). The central part of the field is affected late in the disease as is the temporal peripheral field.

12.1 Methods of examination

The IOP is measured by tonometry. A simple but not so precise method is indentation tonometry (Schiotz). The deformation brought about by a certain weight on the cornea is measured and the result converted to IOP. In practice, the instrument is carefully placed on the anaesthetised eye of the supine subject. [This kind of tonometry is not in wide use anymore, because it is uncomfortable for the applicant and because there are better methods available.]

A more precise measure of the IOP is given by applanation tonometry. Here, a certain minor deformation of the cornea is created and the pressure necessary directly converted to IOP. The apparatus is expensive and the examination demands some training.

An increased IOP, i.e. above about 25 mm Hg (policy on what is considered an 'alarm value' varies), or a difference between the eyes of 4 mm Hg or more should cause a suspicion of glaucoma. The applicant should then be referred to an ophthalmologist for repeated tonometry, assessment of visual fields and ophthalmoscopy.

Gonioscopy is the examination of the chamber angle with the aid of a corneal microscope and a special contact lens. The correct judgement of the chamber angle demands experience. If a narrow angle is found or the subject has had an attack of ACG, an iridectomy is done. After this minor procedure (today easily performed with a laser), there will be no (further) attack of high IOP and if the visual functions are intact, there is no reason for disqualification of service.

Visual field testing is essential to prove functional impairment. The examination should be done carefully with special emphasis on the defects typical of early glaucoma; it can be done manually by perimetry or campimetry or with an automated perimeter.

Provocative tests and tonography are not in current use.

12.2 Treatment

The treatment of glaucoma serves to reduce the IOP to a level at which no (further) damage to the optic nerve occurs.

Epinephrine (usually 1%; available also in a better penetrating composition of lower concentration) effectively reduces the IOP. It does not influence accommodation, but may increase the pupillary diameter and thereby provoke an attack of ACG. Short-term side-effects are rare, but after some years of treatment hyperaemia of the eyeball and irritation at instillation are usual.

Miotics increase the facility of outflow and by their parasympathetic action they also cause miosis and an accommodative spasm. Their pressure-reducing effect is good and reliable. The most frequently prescribed agent is pilocarpine (1–4%). It should be avoided in young patients with retained accommodation. In such cases it is better tolerated in the form of slowly releasing lamellas. Other miotic agents have long duration but are not much used since they increase the risk of cataract. Any type of miotic agent reduces retinal illumination whereby night vision is impaired.

Beta-blockers have rapidly become valuable aids in glaucoma treatment; their pressure-reducing effect is good and the side-effects are few. Because of their general effect on the autonomic nervous system, they are not to be used in cases of asthma or cardiac arrhythmias.

Carbonic anhydrase inhibitors such as acetazolamide reduce the aqueous production. They are given orally and are effective pressure reducers. Side-effects are tingling in the extremities, gastro-intestinal disturbances and a tendency to provoke the formation of renal calculi. Their main indication is short-term pressure reduction.

[Alpha agonists (nonselective) such as epinephrine and dipivefrin (pro-drug) decrease the aqueous fluid production and increase the trabecular outflow. The major side effects are pupil dilation, macular edema and tachycardia. But also increased blood pressure, arrhythmias and tremor can occur.

Alpha agonists (selective) such as apraclonidine and brimonidine decrease the aqueous fluid production and increase the uveoscleral outflow. Major side effects are contact allergy. Other systemic side effects can be headache, drowsiness, fatigue and variable blood pressure response.

Prostaglandin agonists such as latanoprost, travoprost and bimatoprost improve uveoscleral outflow. Major ocular side effects are iris colour change, lash growth and trichiasis, but also

headache, symptoms of upper respiratory infection, chest pain (rare) and myalgias (rare) can occur. It should not be given in cases of narrow-angle closure, ocular infection or inflammation.]

12.3 Practical considerations

The diagnosis glaucoma does not per se disqualify from continued service. Even small paracentral scotomas do, however, constitute a safety risk in aviation personnel. The applicant with glaucoma should fulfil the following requirements:

- a All visual requirements.
- b No side-effects from the treatment given. Of the side-effects, the most important is the accommodative reduction of the visual acuity. This possible impairment can easily be tested by measurement of the visual acuity for one hour every 10 minutes after instillation of eye-drops.
- c Periodic follow-up examination of the visual function under the treatment given at the discretion of the AMS.

Subjects with ocular hypertension should be regularly examined at an individual basis in order to disclose the possible debut of COAG.

13 MONOCULARITY

In persons with only one eye, the perception of depth and distance is reduced, the visual field is smaller, and the risk of acute visual incapacitation is significantly increased. For those reasons, a one-eyed person cannot be [assessed as fit for a class 1 medical certificate]. If the visual acuity in one eye is reduced to 6/24 [(0,2)] or below, the person is functionally one-eyed except for the visual fields. One-eyed persons may to some degree adapt to their condition and may thus perform quite well in everyday life.

[Private] pilots may be [assessed as fit Class 2] after total loss of one eye (or loss of vision in one eye or reduction of visual acuity to a significant degree in one eye) provided the condition has been stable for a period of more than six months. [The] underlying pathology must be assessed as acceptable following examination by []specialist in ophthalmology. []Furthermore, the pilot should demonstrate his flying ability by a medical flight test prior to final assessment. [In case of initial applicants the good eye should fully meet all requirements (i.e. visual acuity 1,0; no refractive error; no history of refractive surgery; no significant pathology) and the monocularity should have occurred after the age of 5 years (If monocularity occurred prior to age 5 the concept of a 3 dimensions has not yet been acquired].

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CHAPTER 14 - AVIATION OTORHINOLARYNGOLOGY

1 INTRODUCTION

Oto-rhino-laryngology is an important medical specialty in aviation medicine. It concerns organs involved in verbal communication and physical orientation. Further, the middle ears and paranasal sinuses are semi-closed cavities sensitive to pressure variations. Verbal communication between air traffic controllers and pilots is essential for flight safety. Disorientation is one of the important causes of major accidents and barotraumas of the middle ears and sinuses can cause considerable discomfort and distraction during aircraft descent and approach.

2 KEY TO THE EAR-NOSE-THROAT EXAMINATION PROCEDURES

CLASS 1	EXAMINATION			MANUAL REFERENCE
	A	B	C	
[Pure tone audiometry (subsequently 5 yearly, after 40 th birthday 2 yearly)]	+	-	--	
Impedance tympanometry [or equivalent] including valsalva manoeuvre	+	-	-	3.5
Pure tone audiometry	+	+	-	4.3
Anterior rhinoscopy	+	+	+	6.3
Spoken voice test	+	+	+	4.6
On indication tests may include				
[Pneumatic otoscopy]				[3.3]
Speech audiometry				
Eog spontaneous & positional nystagmus				
Differential caloric test Or vestibular autorotation				
Posterior rhinoscopy				
Mirror or				
Fibre laryngoscopy				
[Periodic examinations]				
[Pure tone audiometry (subsequently 5 yearly, after 40 th birthday 2 yearly)]				[4.3]

- A Comprehensive **initial** examination at initial examination by AMC or a specialist in aviation otorhinolaryngology acceptable to the AMS
- B Comprehensive **[examination at revalidation or]** renewal examination on clinical indication by AME, **[AMC]** or a specialist in aviation otorhinolaryngology acceptable to the AMS
- C Routine **[examination at revalidation or]** renewal examination (JAR-FCL 3.230 and 3.235 refer)

CLASS 2	EXAMINATION		MANUAL REFERENCE
	A	B	
Spoken voice test	+	+	4.6
Pure tone audiometry [(When an instrument rating is to be added, subsequently 5 yearly, after 40 th birthday 2 yearly)]*	+	+	
On indication tests may include			
Pneumatic otoscopy			[3.3]
Impedance tympanometry Including valsalva manoeuvre			
Speech audiometry			
Barany chair test			
[Periodic examinations]			
Pure tone audiometry [(When an instrument rating is to be added, subsequently 5 yearly, after 40 th birthday 2 yearly)]			[4.3]

- A At first issuance [Routine examination at initial examination] by an authorised medical examiner [AME]
 B Subsequent [Routine examination at subsequent revalidation or] renewal examinations [by AME]

3 THE EAR

3.1 General

Anatomically, the ear is divided into three parts, the external ear, the middle ear and the inner ear (the inner ear will be discussed in the hearing and vestibular function sections).

3.2 The external ear

The external ear includes the pinna, the external ear canal and the tympanic membrane.

a *The [external] ear canal*

In the adult, the external ear canal is an approximately [3,5] cm long and 1 cm wide tube, usually slightly curved forwards-downwards. The inner [1,5] cm of the canal is surrounded by bone and extremely sensitive to touch. Ear wax, produced by modified salivary glands in the inner part of the canal, is extruded as a tube and tends to accumulate if this extrusion is impeded.

Usually, diseases of the external ear canal will not disqualify a pilot from his duties. Nevertheless, it is important that the ear canal permits the inspection of the tympanic membrane. If meatal exostotic growths or other abnormalities of the ear canal interfere with a thorough examination of the tympanic membrane during otoscopy (see below), the applicant can be considered [unfit during] a physical examination, even though he might be physically fit for duty. The decision to reject a pilot candidate for that reason must be made with caution and presupposes a careful examination including an oto-microscopy performed by a specialist. The physician should be able to inspect at least 2/3 of the surface of the tympanic membrane to be able to state that no gross pathology of the tympanic membrane is present. In cases of a history of recurrent middle ear infections, insertions of grommets into the ear drum, or the presence of even a slight conductive hearing loss indicating the risk of an atrophic degeneration or perforation of the tympanic membrane, a full examination of the

tympanic membrane must be performed. The physician's possibility to assess, whether a pilot is fit for duty, should not under these conditions be limited by abnormalities of the canal.

b *The tympanic membrane*

The normal tympanic membrane is a cone-shaped, semi-transparent, pearly grey structure at the end of the ear canal. It is orientated like the cheek, not exactly in the sagittal plane, but facing slightly anteriorly and inferiorly. The handle of the *malleus* is embedded in the membrane with its lower end close to the centre of the membrane, indicating the deepest point of the membrane, the *umbo*. From the upper end of the handle, the short process of the malleus protrudes into the canal. The anterior and posterior hammer folds, projecting almost horizontally from the short process toward the border of the membrane, divide the tympanic membrane in its upper flaccid part (*pars flaccida*) and the much larger lower tense part (*pars tensa*). Under illumination during inspection, a cone of light appears in the antero-inferior quadrant where the light reflects from the part of the tympanic membrane perpendicular to the light beam.

The tympanic membrane separates the ear canal from the middle ear and is essential for a normal sound transmission.

Atrophic areas of the membrane will rupture when they are exposed to even small differential pressures. They are characterized by their lack of elasticity due to the disappearance of the normal *lamina propria* of the tympanic membrane, which results in a flaccid and thin appearance at normal middle ear pressures. At negative middle ear pressures, atrophic areas can adhere to the promontory of the medial wall of the tympanic cavity or can look like a thin tapestry over the long process of the incus and the stapes. In its uttermost consequence, an atrophy of the ear drum is associated with an *atelectasis* of the middle ear. In this case, the medial wall of the middle ear is entirely lined by the adherent atrophic tympanic membrane.

Owing to their fragility, atrophic areas, seen from an aviation medical point of view, should be treated as if they were true perforations. Historically, they may represent insufficiently healed perforations, even though more likely they represent parts of the membrane disintegrated by a sustained negative pressure.

Perforations of the *pars tensa* of the membrane are grouped as either *marginal* or *central*. Both marginal perforations and perforations of the *pars flaccida* indicate that a *cholesteatoma* may be present in the middle ear. The mechanism behind the development of cholesteatomas is still under debate. From a marginal perforation, keratinized epithelium is able to migrate into the tympanic cavity or the cholesteatoma may originate from a pocket of the tympanic membrane sucked into the middle ear by a negative pressure. During their growth, cholesteatomas destroy the surrounding bony tissue. They should be recognised as early as possible. Central perforations are less dangerous. Usually, they result in recurrent or chronic mucosal infections. In all types of perforations, conductive hearing impairments are to be expected.

Fibrosis of the tympanic membrane is usually associated with a history of tubo-tympanic dysfunction. It may indicate the presence of a similar pathology in the middle ear, *tympanosclerosis* (see below). *Per se*, fibrotic plaques or scar tissue in the tympanic membrane are insignificant for the function of the tympanic membrane, nevertheless, their presence should sharpen the attention of the examiner toward the possible presence of atrophic areas or perforations.

3.3 Inspection of the ear = otoscopy

a *Screening otoscopy*

Otoscopy is usually performed by means of an otoscope. Modern otoscopes use a fibre light source and are equipped with a magnifying glass, providing excellent illumination and magnification of the visual field. The removal of small amounts of ear wax or small foreign bodies from the ear canal is very often impossible through the otoscope. For that purpose,

an old-fashioned ear speculum, a suitable light source and a frontal mirror is much to be preferred.

Irrigation of the ear canal in order to remove ear wax should be performed only in examinees without any history of middle ear disease in order to avoid iatrogenic perforations of the tympanic membrane. The irrigation water must be held at body temperature in order to avoid caloric vestibular reactions. The water beam should not be directed toward the ear drum and the water must be allowed to wash the ear canal freely. An occlusion of the canal by the tip of the syringe will result in an iatrogenic traumatic perforation of the membrane.

Otoscopy should be performed by carefully inserting the tip of the otoscope into the ear canal with simultaneous inspection of the canal, following the canal lumen. In order to straighten the cartilaginous part of the canal, the pinna is pulled upwards-backwards by the free hand. It is essential to avoid touching the bony part of the canal with the tip of the speculum. The landmarks of the ear drum (i.e. *the handle of the malleus*, the *short process of the malleus* and the *cone of light*) are identified and the two parts of the membrane are carefully inspected.

With negative middle ear pressures, the tympanic membrane retracts into the tympanic cavity. Because of the oblique position of the tympanic membrane in relation to the view axis, the *umbo* appears to have moved upwards-backwards, and the handle of the malleus appears shortened and rotated in a more horizontal position.

In order to obtain a three-dimensional impression of the ear drum and in order to reveal atrophic and sclerotic areas, a *pneumatic otoscopy* may be indicated. For that purpose, the otoscope should be mounted with a balloon and a speculum capable of occluding the lumen of the cartilaginous part of the canal. The pressure of the air, trapped in this air-tight system, can be varied by gently squeezing the balloon. This results in discrete movements of the tympanic membrane, which can be observed through the otoscope. If the membrane does not move, it may be for one of the following five reasons:

- i) the system is not air tight,
- ii) there is a perforation,
- iii) there is a negative pressure in the middle ear,
- iv) the middle ear is fluid filled or
- v) the middle ear is atelectatic.

Characteristically, an atrophic area of the membrane, owing to its lack of elasticity, is only capable of presenting itself in two positions by pneumatic otoscopy: intruded into the tympanic cavity or extruded into the canal, depending on the pressure applied to the ear canal. Intermediate positions are not seen.

In the case of a partially fluid filled middle ear space, the meniscus indicating the air-fluid transition, will simulate a small hair on the membrane. By pneumatic otoscopy or by rotation of the head, the meniscus will move.

b *Oto-microscopy*

At any suspicion of tympanic membrane pathology, most otologists will perform an examination with an operation microscope which allows description of pathology not revealed by otoscopy.

(*Impedance tympanometry*: See below.)

3.4 The middle ear and the Eustachian tube

Functionally, the middle ear and the *Eustachian tube* are an entity. The sound transmission from the tympanic membrane to the inner ear depends on the normal movements of the membrane-

ossicular system, which depends on an equivalence between the pressures of the middle ear and the ear canal.

The tympanic cavity communicates with the naso-pharynx by way of the Eustachian tube, which is an approximately 4 cm long tube lined with ciliary epithelium, capable of transporting mucus from the middle ear into the naso-pharyngeal space. The lateral third of the tube is rigid and surrounded by bone. The medial two thirds are surrounded by the V-shaped tubal cartilage. Normally, the medial part is collapsed. By swallowing, yawning or chewing, the *tensor veli palati* and *sapingopharyngea* muscles open the tube, allowing an equalisation of the middle ear pressure in relation to the naso-pharyngeal air pressure. The muscles are innervated by the *trigeminal* nerve. A voluntary activation of the trigeminal muscles can be achieved by a voluntary, isometric contraction of the masticatory muscles. Very often this act results in an audible click. This click does not indicate an opening of the tube, but is the result of an activation of the *tensor tympani* muscle, which is also trigeminally innervated.

The Eustachian tube behaves as a one-way-valve allowing air to escape from the middle ear if the middle ear pressure for some reason exceeds the nasopharyngeal pressure by more than approximately 40 hPa in a normal person. (Originally in tympanometry, the unit of mm H₂O was used. It has been replaced by the corresponding SI-unit of dekaPascal (daPa). 10 daPa = 1 hPa = 1 mbar). This phenomenon is responsible for the 'popping' sensation sometimes felt in the naso-pharynx during aircraft ascent.

If, for some reason, the middle ear pressure is not equalised with the external pressure for some time, a negative pressure will build up in the middle ear. This is caused partly by the resorption of the gasses from the middle ear space through the mucosa to the blood stream, but active pressure balancing processes are involved too. The procedure will result in a middle ear pressure at approximately -200 daPa. Under normal middle ear pressure conditions, a delicate balance seems to exist between the intracapillary blood pressure and the middle ear air space pressure. As soon as a negative pressure of this degree is established in the tympanic cavity, a swelling of the mucosa will appear followed by a transudation of plasma from the blood stream to the middle ear. When this condition has existed for more than a few days, the transudate will change into a more and more viscous fluid because of the formation of mucous glands in the middle ear mucosa. This condition, the *secretory otitis media*, is the simple consequence of tubal dysfunction.

Another result of the development of negative middle ear pressures is that the pressure equalisation between the naso-pharynx and the middle ear becomes more difficult at increasing differential pressures. At approximately 120 hPa differential pressure, the Eustachian tube *locks and blocks*. If a person suffers from a common cold, this critical value is lower due to the swelling of the naso-pharyngeal mucosa. If this '*locked-and-blocked*' threshold approaches zero, normal swallowing, yawning or chewing will not cause a pressure equalisation and the tubal dysfunction will, eventually, result in a secretory otitis media.

3.5 Examination of the tubal function

For screening purposes the tubal function can be judged by making the examinee perform a **Valsalva's manoeuvre**. With his nostril closed by digital compression, the examinee performs a forceful expiration against his closed nostrils. Very often the examiner is able to see the tympanic membrane change its position during or after the manoeuvre. If this effect is not visible, it does not exclude that the manoeuvre has been successful.

Toynbee's manoeuvre is performed by letting the examinee swallow while he closes his nostrils and mouth. Very often, the ear drum will become displaced inwards due to the suction effect on the Eustachian tube. A negative result of this test does not always indicate a tubal dysfunction. If these two tests are implemented in the physical examination, one has to accept that a negative result is not interpretable. *A pragmatic solution of this problem is to accept all Class 1 applicants with no history of chronic or recurrent tubo-tympanic disease if they present themselves with a normal impedance tympanometry (see below).* Class 2 applicants do not require impedance tympanometry to be undertaken.

Impedance tympanometry: During the last decades, this method has become an international standard in the routine specialist otologic examination. It is based on the fact that acoustic energy, not transmitted by the sound transmission system, is reflected from the tympanic membrane. By measuring of the relation between an acoustic energy presented in the ear canal and that reflected from the ear drum, the acoustic impedance of the sound transmission system can be estimated. If the pressures in the ear canal and the middle ear are identical, the acoustic impedance will be at a minimum. With a systematic variation of the ear canal pressure (e.g., from +200 to -300 daPa) accompanied by a simultaneous impedance measurement, a curve can be produced, indicating the actual middle ear pressure at the point of the impedance minimum. Furthermore, an estimate of the compliance of the sound transmission system can be made, based on the amplitude of the impedance variation caused by a standard ear canal pressure variation.

An objective Valsalva's test can be performed by means of impedance tympanometry. Applicants not controlling or understanding the Valsalva technique, when explained to them may still have a normal tubal function. The final judgement of the tubal function should not be based on the momentary performance by the Valsalva's test alone, but on evidence of chronic or recurrent tubal dysfunction obtained by a positive history. Impedance tympanometry or pneumatic otoscopy may be indicated.

High sound pressures (above 65–75 dB) result in reflex contractions of the *stapedial muscles*. This contraction raises the acoustic impedance, which can be measured by means of an impedance-meter. The impedance tympanometry should be accompanied by a stapedial reflex test to confirm the presence of a normal ossicular chain and a normal stapedial reflex pathway.

3.6 Guidance regarding assessment

a [Applicants] at initial examination

A history of recurrent acute otitis media in childhood should not entail disqualification unless the applicant still has a perforation or atrophic areas of the tympanic membrane. A history of a single grommet insertion or multiple insertions before the age of ten should be considered acceptable, unless the applicant has a chronic perforation of the tympanic membrane, atrophic areas or partial or total atelectasis of the middle ear. If the applicant has no history of chronic or acute middle ear disease after the age of ten, the risk of a recurrence at higher age is negligible.

A history of recent barotitis caused by flying or diving should result in a thorough evaluation of possible medical causes of the event (sino-nasal or naso-pharyngeal disorders) and be judged on this evaluation.

The presence of perforations (independent of their location or aetiology) and the presence of atrophic areas require a careful evaluation.

A history of middle ear surgery for infective middle ear disease should be [disqualifying], except for a simple mastoidectomy in childhood and grommet insertions.

b [Applicants at revalidation / renewal examinations]

During a pilot's career, the risk of middle ear disorders is presumed higher than average owing to exposures to pressure alterations during flight. If a pilot suffers from frequent episodes of barotitis during training or in his early career without an obvious explanation, he will normally understand that he is not suited for this profession and should be advised to withdraw from his flying activities.

Cases of acute barotitis should be treated as soon as possible and [- after a period of temporary infitness -] the pilot [assessed as fit] as soon as he is able to demonstrate normal middle ear pressure and normal ability to clear his middle ears by Valsalva's manoeuvre. Acute suppurative middle ear disease should be cured and [- after a period of temporary

infitness -] the pilot [assessed as fit] as soon as pneumatic otoscopy is normal and he is able to demonstrate normal middle ear pressure at impedance tympanometry and normal ability to clear his middle ears, provided that his hearing is still within the hearing requirement.

3.7 Other middle ear conditions

3.7.1 Petrosal fracture

Applicants [] with a history of petrosal fracture or with a proven or suspected *perilymphatic fistula* present a problem concerning aeromedical assessment. Owing to a unique structure and bone biology of the otic capsule, fistulae and fractures of the capsule do not heal with bone formation. A thin bony layer surrounding the perilymphatic space does not undergo the usual re-modelling processes of other bone, but remains unmodified from early foetal life. This secures the lifelong stability of the physical dimensions of the membranous labyrinth (and hence the frequency characteristics of the sensory organs). The insufficient healing process is believed to be the result of this biologic inertness of the otic capsule. If an otic capsule fracture or a perilymphatic fistula is present, sudden deterioration of the hearing and vestibular function could result from sudden pressure gradients in the middle ear. Strictly speaking, the final proof of resistance against pressure gradients in these cases can be made only by exposing the applicant to this physical stress, jeopardising his hearing and vestibular function, which is unethical. This is further complicated by research results showing that a large percentage of patients suffering from post-concussion syndrome actually suffer from a perilymphatic fistula. The final assessment of these cases must be left to a specialist familiar with both the diagnostic problems and the treatment of perilymphatic fistulae and with aviation medicine.

3.7.2 Otosclerosis

Otosclerosis gradually impedes the natural mobility of the stapes footplate resulting in a progressive conductive hearing loss caused by the increased stiffness of the sound transmission system. Usually, the disease is bilateral and develops slowly. If [an] applicant [] is suspected of this disease, he should be warned of the high risk of being [assessed] as unfit for duty because of the resulting hearing loss, or in case of surgery because of surgery itself (see below) or because of surgical complications. If surgery is performed in a pilot suffering from otosclerosis, a so-called 'closed-window-technique' must be employed. During surgery, a perilymphatic fistula is created in the stapes footplate; then, a small piston prosthesis replacing the supra-structure of the stapes is attached to the long process of the incus and inserted into the fistula. The closed-window-technique involves a sealing of this fistula by means of a vein or fascia graft. If the fistula is not sealed, the lateral displacement of the piston during a decompression could result in an opening of the fistula which would cause a severe attack of vestibular vertigo and a sudden loss of hearing. In order to ensure healing, pilots who have undergone stapes surgery should not fly for the next three months. Approval following surgery should be based on a non-complicated post-surgical course, the absence of dizziness, spontaneous or positional nystagmus and a satisfactory hearing result.

3.7.3 Post-surgical assessment in general

Except for applicants and certificate holders, who have undergone minor surgery such as simple mastoidectomies or grommet insertions during childhood (see above), the assessment of ear surgery as a cause for exclusion from flight duties must be based on an individual evaluation founded on particulars concerning the underlying pathology, surgical procedures and results and the post-surgical condition of the ear. Emphasis must be put on the risk of opening a potential perilymphatic fistula when the ear is subjected to sudden pressure variations. If the pilot is going to fly pressurised-cabin-airplanes, events resulting from a sudden decompression must be anticipated. If the decompression results in a sudden vigorous spell of vestibular vertigo and a sudden loss of hearing, the pilot instantaneously becomes incapacitated (in a situation where there is an urgent need for his pilot skills). Information concerning the individual case of ear surgery must be evaluated, primarily with this risk in mind. The risk of a fracture of the continuity of a reconstructed ossicular chain caused by sudden change of the middle ear pressure must be

considered. Lastly, it is reasonable to evaluate the risk of a rupture of weak areas of the tympanic membrane. At least a three months healing period should be [required] before approval. In cases involving a potential, but not obvious risk of a perilymphatic leak (stapes surgery, including type III tympanoplasties, and intra-operative observations of an otic capsule weakness) [a multi-pilot (Class 1 'OML') or safety pilot (Class 2 'OSL') limitation may be required for two years].

Note: *In all cases of ear canal, tympanic membrane or middle ear disease and in all post-surgical cases, the hearing and vestibular requirements must be fulfilled [for a fit assessment].*

4 HEARING REQUIREMENTS

Definition: *Hearing is the conscious, sub- or pre-conscious perception of any sound.*

4.1 General

A pilot must be able to decipher verbal messages from the ATC. Further, the pilot must be able to perceive sound warning signals from the aircraft. These warning signals can be either an integrated part of the aircraft safety system, such as a stall warning signal, or the result of a mechanical or electrical malfunction of the aircraft.

Physically, sound is defined as progressive longitudinal oscillations in a physical medium, in the present context, air. A sound is characterized by its pitch (or frequency) composition (expressed in Hz [Hertz = cycles per second]) and its amplitude, which determines the intensity (expressed in dB [decibel]). The normal ear is capable of perceiving a frequency band from 18 to 20 000 Hz and a 1 012-fold (120 dB) intensity variation. Physically, 0 dB refers to the established perception threshold of a normal human ear at a given frequency.

A pure tone has a sinusoidal waveform. Physically, noise is a random composition of a large spectrum of pure tones, psycho-physically noise can be defined as an unintended, ungraceful or unwanted sound, independent of its frequency composition. Physically, the acoustic environment in a motorised aircraft is characterised by a high noise level, caused mainly by the engines. A person exposed to high sound intensities, such as aircraft noise, will experience a temporary threshold shift (TTS). The duration and magnitude of this threshold shift will depend upon the sound intensity, the exposure duration and an individual sensitivity factor. Frequent exposures to high sound intensities will result in permanent threshold shifts (PTS) – still influenced by noise characteristics and individual factors. Very often, the pilot's exposure to high noise level during his career will result in a significant PTS. The ability of a pilot to perceive, decode and take advantage of an acoustic signal, verbal or non-verbal, depends not only on his hearing abilities, but just as well on his experience with the signal in question. A skilled and experienced pilot is able to screen an ATC-message and consciously only perceive the information he needs. A pilot student, in contrast, listens carefully to each word, considers the true meaning of each word, extracts what he believes he needs to know and tries to memorise the meaning of the message. The two procedures sketched, require different hearing abilities (and strategies). [].

4.2 Hearing tests

Before interpreting the results of a hearing test or prior to deciding which test should be used, it is important to consider the different dimensions of hearing as a psycho-sensory process involved in different test modalities.

a *Threshold determination tests*

The tests determine the limit between non-perceived and perceived sound signals. Stimuli are pure tones or standard speech signals. Only a very few real life hearing tasks are concerned with sound intensities at hearing threshold levels. Threshold tests provide no safe information about hearing dynamics or discrimination abilities. During the test, the examinee will pay all his attention to hearing and detecting possible sound signals and ignoring all other

sensory signals in the environment. Tests are performed in sound proof rooms or using noise-protecting head-sets in order to optimise the signal-to-noise ratio. Circumstances are very far from practical flying hearing requirements. Originally, these methods were designed for diagnostic purposes only and not for the purpose of demonstrating that a person is fit for certain professions.

b *Discrimination tests*

The tests utilise the spoken word. The examinee must master the language used. In speech audiometry, words (or sentences) are standardised from a phonetic point of view and relate to semantically different, unexpected spheres. The tests can be performed in different noise environments; nevertheless, a 'standardised flight noise environment' cannot be defined. Audiometric speech discrimination tests are intensity standardised according to threshold estimates in normally hearing subjects. In the clinical tests (the whispered and spoken voice tests), intensity standardisation is crude and examiner dependent. Most conditions however are far from the real life pilot acoustic environment (e.g. 'say again' appeals are usually not responded to) and all the attention of the examinee is aimed at the acoustic part of the total sensory environment.

4.3 Pure tone audiometry

Properly calibrated audiometers must be used and the calibration must be checked at regular intervals. The results are recorded in a standard audiogram; the standards requiring that the horizontal octave (frequency doubling) interval measure is identical with the vertical 20 dB interval. The audiometry and the audiogram should cover at least the six octave bands from 250 to 8 000 Hz. In this frequency band, thresholds should be determined at the following frequencies: 250, 500, 1 000, 2 000, 3 000, 4 000 and 8 000 Hz. [For aeromedical assessment only the frequencies 500, 1000, 2000 and 3000 Hz are required.] The threshold is defined as the lowest intensity at which the tone is heard at least 50% of the times tested. Usually, a 5 dB intensity interval is used; higher intervals are not [acceptable]. It is important to prevent the examinee from observing the examiner operating the tone button. Screening audiometry at 20 or 30 dB(HL) might secure the fulfilment of the hearing requirements, but would jeopardise the diagnostic opportunities of series of audiometries at the required intervals.

If the pure tone threshold difference between the two ears exceeds 50 dB at a given frequency in an air-conduction test (using a head-set), the sound signal presented to the worst ear will be heard in the best ear. To avoid this effect (resulting in a 'shadow-audiogram'), a 50 dB masking noise must be presented to the contra-lateral ear.

Bone-conduction tests are not required by the requirements. If performed, the examiner must be aware of the sharpened masking demands of this test. The trans-cranial attenuation of a bone-conducted tone is 5–10 dB, making masking (by means of air conducted noise) compulsory to be able to distinguish safely between bone-conduction thresholds of the two ears. The purpose of a bone-conduction test is to establish the nature of a hearing loss. A true conductive hearing loss will present with normal bone-conduction thresholds, whereas a sensory-neural hearing loss will show identical bone- and air-conduction thresholds.

In audiometry, the following notification rules must be regarded. Air-conduction: right ear: O; left ear: X. Masked air-conduction: right ear: •; left ear: _ . Bone-conduction without masking: right ear: [; left ear:] . Masked bone-conduction: right ear: <; left ear: >. If colours are used, red indicates the right ear, blue indicates the left ear.

4.4 Speech audiometry

The degree of the development of speech audiometry tests in a certain language depends on both the extent of the language area involved and on the general development of the medical services in that particular area. Since English has become the official international ATC-language, one could [assume] that internationally all pilots should undergo a test conducted in English. Basically, speech audiometry is a speech intelligibility test, this implies that the examinee should master the

language used. To do justice to non-Anglo-Saxon pilots, one would have to use ATC-communication-type speech material only. But then the speech audiometry would become an ATC-communication-skill-and-experience test which is not intended. Therefore, the recommendation is that, when examining a pilot according to the requirements, the following two-step test procedure should be used:

- a Perform a speech audiometry test according to the national standards of the language preferred (or spoken daily) by the pilot. Make sure that both the threshold of speech intelligibility (TI) and discrimination loss (DL) are determined. Further, if a standard exists, a discrimination test in noise should be performed. Then compare the results of the tests with the documented normal limits of that particular test. Even though the test results are within the normal limits, the aetiology of the hearing loss should be further investigated. If the aetiology is non- or only slowly progressive, approve the hearing, but consider [shorter] audiometry intervals. If the results are abnormal or border-line normal, consider the aetiology and make sure that a safe diagnosis is established. In cases of border-line results and non-progressive aetiology, the following test should be executed:
- b [Collect] authorised information about the noise spectrum and spectral intensities experienced on the flight deck of the particular aircraft flown by the applicant. If inaccessible as authorised figures or reliable manufacturer information, a measurement using a sound-level-metre is performed and, if convenient, recorded by means of a high-fidelity tape-recorder. Then, in a sound proof room, the flight deck noise level is reconstructed according to the frequency and intensity measurements and checked by means of a sound-level-metre. A tape-recording of selected ATC-communication is presented to the pilot with a realistic volume control. The pilot should be allowed to wear his own head-set or listen to a loudspeaker placed according to the flight deck design. Preferably, the noise source is placed behind the pilot, as in the aircraft. The pilot is given 25 ATC-messages, he is allowed to make notes and told to read back the essential cues of the ATC-communication. The result is considered satisfactory if all essential information is read back correctly. In this case acceptance of the pilot's hearing ability should be restricted to the aircraft from which the noise information was acquired.

[A medical flight test is an appropriate alternative.]

Speech audiometry must always be performed by an audiometrist familiar with aeromedical problems or by a specialist in oto-rhino-laryngology acceptable to the AMS.

4.5 Guidance regarding [aeromedical assessment]

The requirements (JAR-FCL 3.235 & 3.355) and the interpretation above describing additional speech audiometry tests offer sufficient guidance concerning [] the hearing requirements. It is essential to realise that any hearing loss caused by a disease [] should undergo a diagnostic evaluation. This means that all abnormal hearing results must be accompanied by a diagnosis. Too often it has been claimed that a pilot with a hearing loss, but fulfilling the hearing requirements should be allowed to fly without further ado. However, a deterioration of the hearing is always a sign of disease [].

4.6 Other hearing tests for diagnostic purposes

For diagnostic purposes two groups of simple audiometer independent tests can be used, the tuning fork tests and the whispered and spoken voice tests. More advanced diagnostic tests, the acoustic brain-stem response (ABR) and electro-cochleography (ECoG), should be used for advanced diagnostic purposes, but will achieve no further attention in this context as their use must be considered a specialist task. Objective information can be obtained by a determination of the stapedial reflex thresholds, but this information must be interpreted in context with clinical and audiometric information, which is outside the scope of this text.

a **Tuning fork tests**

Use an A1 (= 440 Hz) or a C2 (= 512 Hz) tuning fork. When you strike it, snap it between your thumb and index finger or tap it gently on your knuckle or knee.

Rinne's test: Compare air- and bone-conduction by pressing the hilt of the struck tuning fork against the mastoid process. When the examinee indicates that the tone is no longer heard, move it so the vibrating tines are held 1–2 cm from the ear canal. Ask the examinee if he hears the tone now. If the answer is positive, the test result is indicated *positive*. If it is not audible by air-conduction, the test is repeated in the reverse order. If the tone is heard by bone-conduction after having faded out by air-conduction, the test result is said to be *negative*. A shorter version of the test is to let the examinee compare air- and bone-conduction by alternately placing the tuning fork on the mastoid process and 1–2 cm from the ear canal and making him indicate where the tone seems loudest. A *negative Rinne's test indicates a conductive hearing loss of more than 20 dB*.

Weber's test: When a sounded tuning fork is placed in the mid-line of the forehead, it is normally heard equally in both ears. In the case of a simple unilateral sensory-neural hearing loss, the sound will lateralise to the normal (or better) ear. If a unilateral conductive hearing loss is present, the tone will refer to that ear. This phenomenon is difficult to explain, but easy to produce in a normal person, creating a temporary unilateral conductive hearing loss by occluding the ear canal with a finger. For good reasons, the phenomenon surprises the patient. In order to avoid confusion it is wise to ask a patient with a known unilateral hearing loss if the tone 'is heard in the better or the worse ear'. Lateralisation is produced at a hearing loss of just 5 dB. The outcome of the test can be capricious if central hearing mechanisms have compensated for the directional hearing impairment caused by a chronic hearing loss.

Gellé's test: If the footplate of the stapes is bone fixed, as in otosclerosis, no intensity variation can be produced when the ear canal is occluded. The test result is indicated positive in the case of an intensity variation by occlusion of the ear canal.

b **The spoken voice tests**

It is difficult to standardise these tests because of large variations between examiners and different national traditions. The following may serve as a guideline:

- i *Prevent lip-reading* by having the examinee turn his back to the examiner.
- ii *The whispered voice test* should be performed by a whispering produced using the expiratory reserve (after completing a normal expiration). A unilateral test can be performed, when occluding the contra-lateral ear.
- iii *The spoken voice test.* Use an average conversational voice. Both ears are tested simultaneously unless a sufficient masking noise is presented to the contra-lateral ear.
- iv Use *numerals* between 21 and 99. Let the examinee repeat, what he has heard.
- v Use the *threshold distance* between the examinee and the examiner to indicate the outcome of the test.
- vi The tests should be performed in a *relatively silent room*.

4.7 Comments

a *Noise induced hearing losses*

Permanent threshold shifts are characterised by the so-called 'noise-dip' maximal, at 4 000 or 6 000 Hz. If present [in initial applicants], the prognosis of the hearing loss should be

considered. A noise induced hearing loss is the result of noise exposures influenced by a hereditary predisposition. The physical examination should, if possible, prevent selection of very noise sensitive individuals for the pilot profession – or at least such individuals should be warned that the noisy flying environment could harm their hearing to a degree that would cause a loss of licence at a later stage of their career. At any sign of a noise induced hearing loss, the applicant should be questioned carefully about his past noise exposures. If this exposure is negligible, the applicant should be considered very noise sensitive. If the hearing loss is pronounced, but the hearing (because of the high frequency configuration of noise induced hearing losses) is still within the required limits (JAR–FCL 3.235 (a), (c) & (d) and JAR–FCL 3.335 (a) & (b)), rejection or a waiver should be considered based on JAR–FCL 3.230. It is important to realise, that sensory-neural hearing losses have been proven super-additive – the pre-existence of a sensory-neural hearing loss of any origin makes that particular ear much more sensitive to a noise induced hearing deterioration. In all cases of noise induced hearing loss in young people, instructions and guidance should be given concerning the use of hearing protectors when exposed to noise of any origin, privately and professionally.

Most professional pilots exposed to aircraft noise for decades present themselves with a more or less pronounced high frequency hearing loss. [They have proven themselves sensitive to noise and the almost inevitable progression of their hearing loss can only be delayed by a proper protection.] These pilots should be instructed to wear external hearing protectors of the *ear-muff type* whenever moving outside the aircraft on the apron or close to other aircraft. [Active noise reduction headsets should be used in the cockpit environment (sound levels of more than 85 dB have been measured in certain aircraft types, resulting in sensory-neural hearing-loss upon long-lasting exposure).] [] Further, they should be aware of the noise exposures in their private life and protect themselves under these conditions as well.

b *Presbycusis*

In all civilised societies, most individuals will develop a high frequency sensory-neural hearing loss with increasing age. The degree of this hearing loss is determined by hereditary factors. As mentioned above, sensory-neural hearing losses are super-additive. That increases the need for proper noise protection with increasing age.

c *Unilateral hearing loss and unilateral deafness*

In normal life, unilateral deafness is a minor handicap, usually only affecting the directional hearing, once the patient has become accustomed to the condition. Directional hearing is a rather unimportant function during flight. If the aetiology of the existing hearing loss does not indicate a higher than normal risk of a hearing deterioration in the normal ear, [a fit assessment may be considered, a multi-pilot (CLASS 1 'OML') limitation may be required], provided that an ATC-communication test in aircraft-noise (as described above) is flawless.

d *Hearing aids*

The development of small, technically advanced, functionally reliable hearing aids has more or less been disregarded by the aviation medical community. Compared to correcting lenses, hearing aids are much more complex and the risk of functional disturbances is considerably higher, but still relatively low. Whenever a pilot's hearing performance can be improved significantly by the use of a hearing aid, it should be considered a benefit for flight safety. If the hearing aid is fitted with a non-air-tight ear-mould and acoustically adjusted to the pilot's hearing loss and the speech intelligibility benefit tested and proven in noise comparable to aircraft noise, such hearing aid should be allowed for flying duty. The conditions should be analogous to those applied in pilots with correcting lenses. The aid must be approved by a specialist acceptable to the AMS and an extra aid and battery should be carried by the pilot on duty.

5 THE VESTIBULAR FUNCTION

5.1 Definition

The vestibular function is an integrated part of the balance system. The balance system can be defined as an integrated neural system which by means of several sensory functions serves the postural and oculomotor reflexes and provides the individual with pre-conscious or conscious orientational information.

5.2 The sensory input

Vision and vestibular function are far the most important sensory inputs to the balance system. The division of labour between the two sensory functions is defined by the frequency of the movements stimulating the balance system.

Below 1–2 Hz, vision provides sufficient information about movements, above this limit the visual picture of the object or surrounding visual world becomes blurred because of a disappearance of the eye movements stabilising the visual field in relation to the movement. Compensatory eye movements caused by low frequency vestibular stimuli, generated by active or passive head movements without supporting visual stimuli, are insufficient. Above 1–2 Hz, compensatory eye movements elicited by vestibular stimuli are sufficient to stabilise the visual field during subjective movements. Normal active motion covers a broad spectrum of frequencies including both low and high frequency stimuli.

Spatial orientation has been described as a pre-conscious/conscious sensory percept. Visual and vestibular stimuli have different priorities in spatial orientation. The frequency limit of visual orientation is identical with that of visual compensatory eye movements. Visual information has a broader access to consciousness than vestibular information – the phenomenon is described by the term *visual dominance*. If for some reason deprived of unambiguous visual information, the balance system turns to the vestibular system in order to utilise that information. The phenomenon is described as *vestibular opportunism*. If the vestibular information originates from a low frequency stimulus, it is insufficient and at the worst misleading, resulting in a state of *spatial disorientation* which can be disastrous in aviation.

In aviation, vision is the most important sensory input to the balance system because of the low frequency spectrum of most aircraft movements.

5.3 Visual reflexes

Seen from a balance system point of view, vision is clearly divided into two separate functions; firstly, *peripheral* or *ambient vision* and secondly, *central* or *foveal vision*.

a *Ambient vision*

Contrasting linear structures are interpreted as either horizontal or vertical. In the presence of unambiguous ambient visual information about the true or apparently true direction of the horizon or large objects with obvious vertical cues, vision provides information about the true or apparent direction of the horizon or the gravitational vertical. A moving ambient visual field is interpreted as the result of a subjective motion, resulting in compensatory *optokinetic eye movements*. The optokinetic reflex is an open loop reflex, not sufficiently controlled by feedback information. Optokinetic nystagmus is maintained after the disappearance of the stimulus by central mechanisms (cerebellar velocity storage). In humans, optokinetic movements are vestigial and inaccurate.

If a sufficiently contrasting object is localised by the ambient vision, it stimulates a fast *saccadic eye movement*, placing the object in the foveal region.

b *Foveal vision*

The vision identifies objects by their shape, colour and apparent size and contributes to identification by a distance estimate. In humans, the smooth pursuit reflex more or less has replaced the function of the optokinetic reflex. By means of this foveal reflex, small objects can be tracked very exactly. It is a closed loop reflex. The true stimulus is minor movements of the object (retinal slippage) fed back from the foveal sensory cells and zero-adjusted by small second-order compensatory eye movements. At optimal stimulus conditions, this reflex is extremely precise. The reflex is able to utilise pre-programmed eye motion patterns; preferably ballistic trajectories making it possible to perform eye movements which, under certain predictable circumstances, are ahead of the object and for instance makes it possible to predict the impact of a thrown ball.

5.4 **The vestibular input**

The three *semi-circular canals* placed about three orthogonal axes and the two otolith organs, *utricle* and *sacculus* of each labyrinth comprise the vestibular end-organs. The physical dimension of the stimuli acting on these organs is *acceleration*; *angular* accelerations in the case of the semi-circular canals, *linear* accelerations in the case of the otolith organs.

Certain anatomical and physiological aspects are important for the understanding of the function and malfunction of these organs. The sensory cells of both types of organs are *hair-cells*. When stimulated mechanically, a hair cell reacts according to the direction of the mechanical force with respect to the polarisation of the hairs of the cell. The position of one of the hairs, the *kinocilium*, determines the directional properties of the cell. If the hairs are bent in the direction of the kinocilium, the firing rate of its efferent neuron increases; forces acting in the opposite direction result in a decrease of the firing rate. If the hairs are in their resting position or influenced by forces perpendicular to the axis of the cell, a certain resting firing rate is maintained.

In the ***ampullae of the semicircular canals***, the sensory cells are organised in a homogenous pattern. The determination of the direction of the axis of rotation of a certain stimulus is a central procedure based on the vector contribution of each of the semi-circular canals. Because of the mirror-symmetry of the two labyrinths, a stimulus resulting in an increased firing in one group of sensory cells will cause a comparative decrease of the firing rate in its antipodal cell group of the opposite ear. In that way, the signal arriving in the central nervous system will always possess the characteristics of a *differential signal*. If the connection between one labyrinth and the CNS is interrupted or if the end-organs of one ear are destroyed, the normal peripheral resting potential information will not arrive centrally and this will be interpreted centrally as the result of an anti-kinocilium-directed stimulation of the organs involved. That explains why end-organ vestibular disease simulates a stimulation and results in rotatory sensations (= *vertigo*) and compensatory eye movements corresponding to a continuous rotatory movement (= *nystagmus*).

In the ***maculae of each otolith organ***, the sensory cells are organised in a more refined pattern, covering all possible stimulus directions. Directional information is already present at the sensory organ level. Destruction of the sensory organ or first sensory neuron will not signal any specific directional cues to the CNS. Consequently, failure of the otolith organ function will not result in any illusions of motion, nor in any meaningless 'compensatory' eye movements, but cause a feeling of a less specific unsteadiness, not accompanied by a nystagmus.

The otolith organs are stimulated by linear accelerations. The effect of gravity is identical with the effect of a sustained $[9,81] \text{ m/s}^2$ (= 1 G) upward acceleration. The vestibular perception of simple linear accelerations depends on the ability of the balance system to dissolve into its components the resultant of the gravitational and motional vector. This depends on the presence of other, non-vestibular, directional cues. In a flight simulator, a backward tilt ('G-tilt') combined with a visually stable horizon gives a perfect illusion of a forward acceleration. Contrary to this, the forceful acceleration of an aircraft under poor visual conditions with no clear horizon seen is felt like an increasing climb rate. These two erroneous orientational percepts are called *somatogravic illusions*.

When an aircraft performs a co-ordinated turn, the resultant of the gravitational and centripetal force vectors is aligned with the vertical axis of the aircraft. The bank of the aircraft is felt only when the horizon is seen – if not, a somatogravic illusion of being in level flight will be perceived. The somatogravic illusion is one of several causes of spatial disorientation during flight – one of the most powerful and important.

5.5 The vestibular reflexes

Usually, vestibular stimulation elicits compensatory eye movements. Since eye movements are rotatory, their amplitudes and timing are related to a central estimate of the rotatory amplitude and timing of the eliciting head movement. These two parameters are analytically expressed by the *gain* and *phase deviation* of the eye movement compared to the head movement. Usually, the evaluation is made by a frequency analysis, comparing the two signals. This is meaningful because, as mentioned above, the frequency responses are important characteristics of the balance system function. The low frequency domain (< 2 Hz) is the visual domain – even though the vestibular organs may contribute to the responses – the accuracy of the gain and phase in this domain is determined by the visual information. At high frequencies, the vestibular system has its monopoly, and high frequency vestibular stimuli result in accurate gain and phase responses.

Continuous rotatory stimuli (extremely low frequency) is compensated by a continuous rotatory eye movement in the same plane as the stimulus. Since the eyes cannot continue their rotation for more than a limited angular distance, the compensation becomes bi-phasic, i.e. composed of a compensatory phase based on a rotatory velocity estimate and a fast anti-compensatory, saccadic movement in the direction of the stimulus. This eye movement pattern is called *nystagmus*. At high frequency, low amplitude head movements, there is no need for the anti-compensatory phase and the compensatory movements simply mirror the stimulus.

5.6 Non-eye-movement efferent phenomena

The most dominant of these is the *spatial orientation*. It is based on the integrated sensory product, a spatial image created by the sum of sensory inputs arriving at the balance system centres of the CNS. Since it is possible to distinguish between active and passive movements, information about central motor commands are believed to be integrated with the sensory information.

5.6.1 Spatial disorientation

(see below)

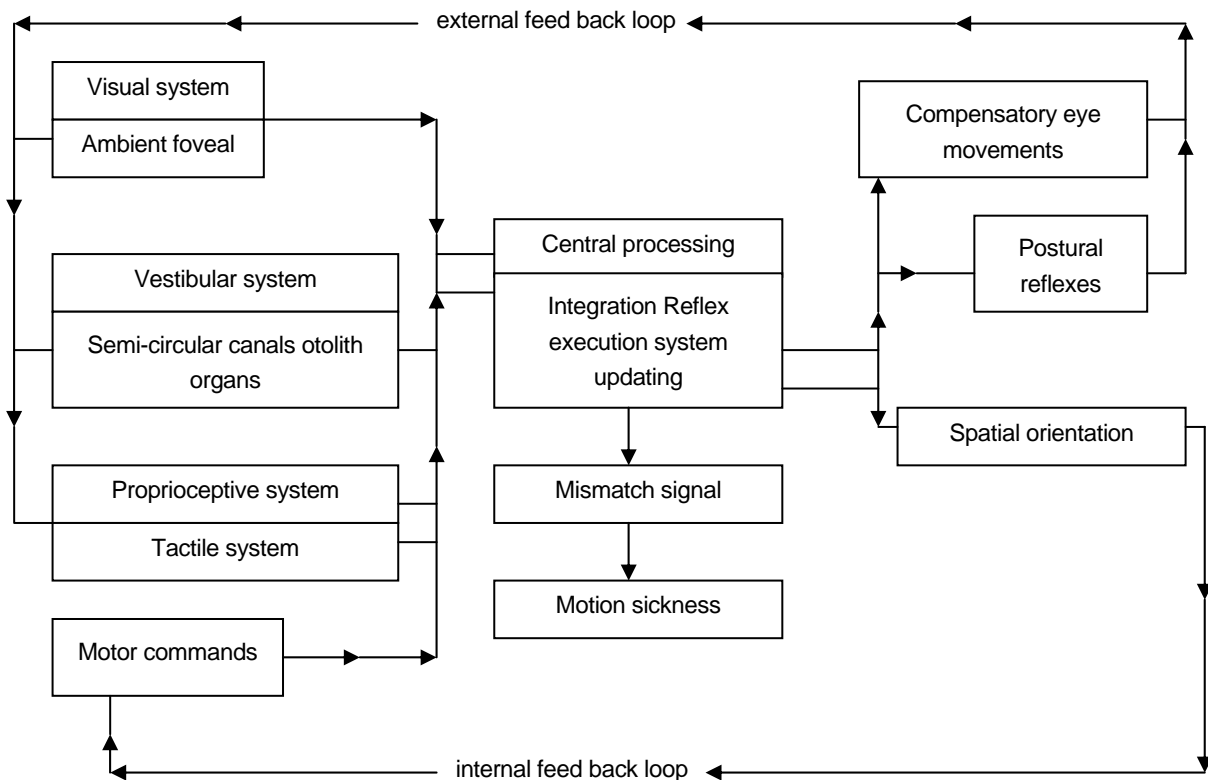
5.6.2 Postural reflexes

Postural reflexes are simple and primitive when they serve simple static purposes. In humans, locomotion by walking, running and jumping are physically complex tasks. These tasks serve as characteristic examples of learned, pre-programmed, complex behaviour. Running is an excellent example. It is based on the ability to predict the point of projection of the centre of gravity resulting from the next movement – this prediction can not be the result of sensory organ information alone. The sensory organ function in this context is to establish a feed-back from the motor activity making it possible to check a proper development of the current pre-programmed project.

5.6.3 Motion sickness

Motion sickness is an inexpedient, seemingly meaningless reaction to a balance system stimulation. The currently most widely accepted theory of the aetiology of motion sickness has been suggested by *Reason*. Semantically, it is contradictory that motion sickness under certain circumstances can be caused by the absence of motion. If a person has been adapted to a motion environment (like a ship) and returns to a normal non-moving environment, he may become sick (*mal de débarquement*). An experienced pilot flying a simulator easily feels sick due to the lack of the customary vestibular stimuli in the simulator and may feel embarrassed, when he realises that a much less experienced pilot, not habituated to the intimate correlation between certain visual and

inertial stimuli of flying, does not experience any simulator sickness symptoms at all.



A simple theory explaining motion sickness as the result of vestibular over-stimulation is insufficient to explain these phenomena. Reason claims a 'neural mismatch' theory, postulating that unusual or unknown combinations of simultaneous sensory stimuli will result in a mismatch signal evoking the symptoms of motion sickness. In fact, this theory contains most of our present knowledge of motion sickness provoking environments. It explains the coherence between the capability of a moving visual environment without inertial stimuli to cause disease, and the symptom-provocative effect of the removal of relevant visual information in an unusual inertial environment. In order to explain that an experienced fighter pilot flying as a back-seat passenger in a fighter aircraft may be sick if the pilot in control of the aircraft makes manoeuvres which would be non-provocative if he made them himself, it is necessary to include motor commands as a part of the balance system integration product. The mismatch theory firmly connects the motion sickness aetiology with the adaptational and learning processes of the balance system.

Motion sickness *symptomatology* can be described as an avalanche of symptoms, developing at various speeds, culminating in nausea and vomiting. The important initial symptoms are *drowsiness* (the first to yawn is the first to throw up) and *headache*. Then *hyper-salivation*, *bodily warmth*, *cold sweat*, *palleness* and various degrees of *mental depression* or *apathy* develop. This is accompanied by the development of an *awareness of the stomach* into *epigastric discomfort* and *retching*. At the same time, a feeling of *nausea* (located to the throat) develops culminating in *vomiting* followed by a return to an earlier step of the symptomatology – very often just to realise that a new development of symptoms is on its way.

Motion sickness research, the comprehension of other kinds of interaction between different sensory functions in the balance system and the experience with spatial disorientation during flight, have emphasised the need of a holistic view of the balance system physiology. The flow chart above is an attempt to give a simple survey of the cue points of the balance system physiology described above. It is based on a system concept which involves a high degree of integration and feed-back processes.

5.7 Spatial disorientation phenomena in flight

[Spatial disorientation can be defined as a false orientational [perception]. Since both, eye movements and orientation, are based on the integrated sensory product, there is an intimate correlation between inexpedient eye movement responses and spatial disorientation.]

Spatial disorientation can be defined as any incident occurring during flight where the pilot fails to sense correctly the position, motion or attitude of his aircraft or of himself in relation to the system of co-ordinates provided by the surface of the earth and the gravitational vertical. This does not include errors of navigation which can be defined as geographical disorientation. It is important to realise that the absence of a relevant orientational sensation is just as much a disorientation event as the experience of a false sensation.

Spatial disorientation is very often disregarded as a cause of aircraft accidents. The pilot's orientational experience can only occasionally be reconstructed after a major accident. Very seldom sensory physiology experts are involved in accident investigations. Very often pilots 'forget' to report spatial disorientation as a cause of minor incidents – possibly because they fear to be [assessed as unfit] due to a CNS- or vestibular system disease. They may not realise that the vast majority of cases of spatial disorientation are considered signs of a normally functioning sensory system in an abnormal environment, rather than the opposite.

Spatial disorientation can be divided into *peripheral* and *central errors*. Peripheral errors can be caused by both visual and vestibular insufficiencies, vestibular errors by both canal and otolith stimuli.

Very often, central errors are caused by an *error of expectancy* – a more or less clear visual picture of the surrounding world (or instrument reading) is misinterpreted. Below, some of the more pronounced or characteristic illusions will be expounded.

- [5.7.1] **Somatogravic illusions** are mentioned and exemplified above. They depend on an insufficient ability to dissolve the resultant linear acceleration vector into its constituent vectors. Primarily, the resultant vector is experienced as the true gravitational vertical unless clear (ambient) visual information provides a stronger cue. The illusions can appear during turns, accelerations or decelerations or when an aircraft levels out from a climb. Under the former circumstances, where the horizon may be below the pilot's visual field, the size and direction of the centrifugal forces interfere with the gravitational force vector resulting in a feeling of a nose-up pitch rotation of the aircraft. This can lure the pilot to exaggerate the manoeuvre, directing the aircraft into an unintended dive.
- [5.7.2] If, for some reason, the pilot is able to visually fixate a light source outside the aircraft when experiencing a somatogravic illusion it will appear to move according to the illusion; this phenomenon is called an **oculogravic illusion**.
- [5.7.3] The semi-circular canals are stimulated by accelerations only. At constant angular velocities the stimulus fades out after 15–30 seconds, depending on the stimulus characteristics. A pilot experiencing an aircraft spin will soon lose the spinning sensation if he has no outside visual reference. The lack of the spinning sensation is in this case a **somatogyral illusion**. When he recovers from the spin, his semi-circular canals are decelerated causing an erroneous feeling of spinning in the opposite direction, his second somatogyral illusion, which can be responded to by an attempt to recover from his illusory spin, leading him back into his original spiral (the so-called graveyard spiral). When affected by this stimulus, the oculomotor system will produce a nystagmus smearing the pilot's vision and making him unable to read the instruments and realise what is happening.
- [5.7.4] If the pilot for some reason moves his head up or down during the steady rotation phase of an unnoticed spin, he will perceive a tumbling sensation. During a spin, the horizontal semi-circular canals are in the plane of the rotation. When they are moved out of this plane, they will react as

during a deceleration. With a nose-down pitch head movement during a clock-wise spin, he will feel he is tumbling counterclockwise in the actual plane of the horizontal semi-circular canals. When he moves his head back to the normal position, he will feel he is tumbling in the opposite direction. This illusion is caused by a cross-coupled stimulation of the canals and is called a **Coriolis illusion**. This type of stimulus has been exploited for standardised tests of motion sickness sensitivity.

[5.7.5] **Flicker vertigo** is a visual illusion associated with the presence of flickering visual stimuli. A rotating anti-collision beacon or the down blast of a helicopter rotor making waves in the grass of the ground or on a water surface, easily induces a sensation of rotation in the opposite direction.

[5.7.6] A spell of transitory vertigo usually lasting 10–15 seconds may be experienced if the middle ears are exposed to different pressures due to the appearance of a sudden pressure transient in one middle ear. This condition is called **alternobaric vertigo**. It may be the response to a Valsalva manoeuvre performed during descent. The risk of experiencing alternobaric vertigo is increased considerably with the presence of a unilateral tympanic membrane perforation. The attack is accompanied by blurring of the vision because of the accompanying nystagmus and rotatory motion illusions. It is usually short lived (but may last for minutes); typically it is very intense and causes a state of disorientation which may be dangerous when appearing during the pressure variation caused by descent during approach and landing.

[5.7.7] A large number of visual illusions can be classified as **errors of expectancy**. Strong horizontal or near-horizontal ambient visual cues are interpreted as a true horizon. This may be dangerous during approach, if the street lights from a nearby highway are interpreted as the horizon. The pilot will perceive an erroneous nose-high attitude and if the visual cue is not horizontal, an unintended lean.

Pilots have certain expectancies concerning the dimension of a runway. If the runway has unusual dimensions or slopes, the pilot might misjudge his altitude and the distance to the runway threshold. A pilot flying over an oblique cloud top easily gets a 'lean', an illusion of flying wings level when his aircraft banks parallel to the cloud top.

Most pilot students have problems interpreting the artificial horizon. When looking at the instrument, he spontaneously interprets the inclination of the artificial horizon as an expression of the inclination of the aircraft. If he, in his mind, extends the plane of the artificial horizon into his ambient vision and so-to-say translates a foveal visual cue into an ambient visual cue, he will realise that he is wrong. This procedure is time consuming. A skilled and experienced pilot may become the victim of the same illusion if his flying abilities deteriorate due to panic.

5.8 Vestibular requirements

a *Vertigo and dizziness*

A pilot shall not suffer from spells of vertigo, dizziness or unsteadiness of any origin. Even the most thorough vestibular examination might not reveal any signs of vestibular disturbances in a patient suffering from an early stage Ménière's disease. A pilot's Ménière attack of vertigo during flight would be a disaster. An applicant not informing his examiner about symptoms of this type [jeopardises] flight safety. This imaginary, dishonest applicant might suffer from a minor sensory-neural hearing loss, safely within the hearing requirements. This is an example of, when judging vestibular function, even minor disturbances of hearing must be considered. Audiologic tests are much more sensitive to minor inner ear function deficiencies than vestibular tests.

b *Other vestibular conditions*

The presence of a *spontaneous or positional nystagmus* should be interpreted as evidence of a spontaneous drift of the balance system showing that a signal is generated somewhere in the system indicating a constant rotation in the plane of the nystagmus and in the direction of the fast anti-compensatory nystagmus phase. If generated in the vestibular part of the

system, nystagmus is always associated with rotational sensations; if generated in the CNS, it may or may not be accompanied by sensations; if originating from an ocular disease, it is never associated with sensations. Nystagmus is judged by its slow phase rotatory velocity. If a $6^\circ/\text{s}$ slow phase velocity horizontal spontaneous nystagmus is recorded, it compares to an error signal indicating that the aircraft is performing a horizontal turn at $6^\circ/\text{s} = 1 \text{ rpm}$. The slow phase velocity of nystagmus can be manipulated by closing or opening the eyes and by visual fixation and even by having the patient imagine a fixation point in darkness. If the nystagmus is vestibular of origin and its maximal slow phase velocity is recorded with the eyes closed – it decreases slightly when the eyes are opened in darkness and decreases further if a fixation point at a far distance is imagined and can be abolished in the presence of a real fixation point. If a nearby point is fixated or imagined, the slow phase nystagmus velocity will increase.

If this information is applied to the pilot's working conditions, instrument meteorological conditions (IFR) can be compared with the open eyes in darkness and the instrument reading task can be compared with the fixation of a real nearby point.

Vestibular asymmetrical threshold conditions involve a risk of not detecting and reacting to motions in one direction while detecting and reacting to comparative motions in the opposite direction. An aircraft exposed to even slight turbulence during flight will perform small, oscillating movements about any axis. The pilot's ability to maintain a stable aircraft attitude during turbulence depends on his symmetrical responses to these relatively high frequency motions.

The ratio of more or less conscious reactions to instrument reading versus reactions to vestibular information, depends on the pilot's skill and experience with instrument flight. A very low ratio is expected in IFR-trainees and VFR-pilots when unintentionally flying into IFR-conditions. An experienced pilot exposed to an unusual physical or mental stress during flight will mentally be moved to a point on a scale ranging from a condition of acute awareness at one end to panic at the other. This scale of increasing mental arousal is intimately associated with a progressive loss of recently acquired skills (= regression). This means that a pilot's skills should not be judged as a constant based on his number of flying hours, but should also be seen in the light of the risk of putting him into a state of reduced cerebral competence due to physical and mental stress. This means that a pilot's *instrument vestibular reaction ratio* is situation dependent and that signs or symptoms of vestibular insufficiency should not be accepted neither at the first issue of a licence nor at renewal, although skill and experience should be considered.

5.9 Accepted routine screening methods

[5.9.1 Electro-oculography (EOG) method]

The evaluation of the vestibular function is a specialist task and should be performed using methods ensuring objectivity, reproducibility and aviation relevance. Eye movements should be recorded by means of the electro-oculography (EOG) method. This method is based on the presence of a small electrical potential between the cornea and the fundus of the eye. When a person performs an eye movement in the direction of an electrode attached to the skin in the orbital region, this electrode will pick-up a positive electrical signal. Clinical EOG is performed by placing superficial electrodes in the temporal regions close to the outer canthi of both eyes for a horizontal lead and just above and below the orbital margins in the pupillary plane for vertical leads. The signals are amplified by means of a differential amplifier capable of giving a $25 \mu\text{V}$ input signal the deflection of the tracing of at least 1 cm. In order to reduce the disturbing influence of electrical noise, a body-worn pre-amplifier should be used. With an AC-amplification, a time constant of at least 5 s must be used. The corneo-fundal potential will vary depending on the light intensity. Its stability is highest when the subject is adapted to darkness. Calibration must be performed just prior to each recording by means of two small sharp light sources (LEDs) placed at least 2 m in front of the subject at a known horizontal angular distance, not more than 20° . If vertical recordings are done, the calibration should be performed in the vertical plane also.

Spontaneous nystagmus is defined as nystagmus present when a person's torso and head are in the anatomical normal position. If the nystagmus is provoked by a certain position, it is characterized as a *positional nystagmus*. Positional nystagmus is looked for in the supine position and with the examinee lying on his left and right sides. It is important to move the examinee slowly to the different positions; nystagmus provoked by the movement itself and not by the position is characterised as *positioning nystagmus*. EOG is recorded for at least 30 seconds in each position.

The EOG-recording is evaluated by a calculation of the slow phase eye velocity. The slopes of the slow phases of characteristic nystagmus beats are computed and evaluated in the unit of °/s by considering the calibration signal and time axis information. It can also be measured by the so-called *Ohm's energy-method*. By adding the amplitudes of each nystagmus beat in a 10 seconds period and then dividing the result by ten, a figure close to the average slow phase velocity of that particular period is obtained. Computerised programmes for slow phase velocity determinations are commercially available. If the recording is performed with the subject's eyes closed, spontaneous and positional nystagmus velocities below 6°/s are considered clinically insignificant – for aviation medical purposes, a 4–5°/s-limit seems more reasonable.

In order to detect vestibular threshold asymmetries at the [initial examination], vestibular reactions should be induced by either rotatory or caloric stimuli. Technically, *the caloric test* is the only clinical means of unilaterally testing responses from the vestibular end-organs. Seen from an aviation physiology point of view, the caloric stimulus is a rude, non-physiological stimulus. For clinical and diagnostic purposes, side or directional differences of as much as 25% are accepted as normal. The balance system reaction to the stimulus reflects fully the non-physiological properties of the stimulus, demonstrated by the induction of signs and symptoms of motion sickness in many normal persons exposed to a caloric stimulus. On the face of its clinical indispensability, the caloric test can be accepted as a means of excluding vestibular pathology in aviation medicine. Ideally, a much more physiological stimulus with a more intimate relation to aviation physiology should be applied. When implemented in the examination, a full differential caloric test should be performed, using 30° and 44°C water stimulation. The responses should be recorded by the means of EOG and evaluated as the maximum eye velocity response of each irrigation. The examination should be performed with the examinee in the supine position with his head elevated approximately 30° in order to place his lateral semi-circular canals in their optimal vertical position. The examinee should be told either to keep his eyes closed or keep them open in darkness, to keep his gaze in a straight forward direction and to maintain his level of arousal by means of *mental arithmetics* during the whole EOG-recording which should last for at least 100 seconds from the initiation of the ear canal irrigation. An interval of at least 5 minutes should be observed between each irrigation and calibration should be performed just prior to each EOG-recording. The maximum eye velocity results should be evaluated according to the Jongkees's formulae:

$$Isd = \frac{(L44+L30)-(R44+R30)}{L44+L30+R44+R30}$$

Isd is the index of side difference, L44, L30, R44 and R30 are maximal eye velocity responses from the left and right ears with 44° and 30° water stimuli, respectively.

$$Idp = \frac{(L30+R44)-(L44+R30)}{L44+L30+R44+R30}$$

Idp is the index of directional preponderance.

In both indices a positive sign is interpreted 'right' and a negative sign 'left' (Idp = +0.15 means a 15% directional preponderance to the right; Isd = -0.08 is a left side 8% unilateral weakness).

A unilateral weakness of less than 20% is considered normal; a directional preponderance of less than 25% is within accepted normal limits.

5.9.2 [Natural head motions]

A much more attractive way of inducing vestibular responses is by the means of natural head motions. If these are performed in the low frequency domain (< 2 Hz) an interference with visual oculomotor reflexes is expected, making it important to control visual fixation, which is difficult because a visual target fixation cannot be allowed. If performed in the high frequency domain, active head motion vestibular tests are easier to handle and interpret and are independent of the visual fixation state. A new standard termed the *Vestibular Autorotation Test*® (VAT) has been developed (by professor Dennis O'Leary of U.S.C., Los Angeles) and is recommended as an attractive, safe, easy-to-perform and aviation relevant replacement of the differential caloric test.

5.9.3 [Bárány rotating chair test]

A less sophisticated vestibular test method, the *Bárány rotating chair test*, may be used in Class 2 certificate applicants. A simple office swivel chair is used. The applicant is placed in the chair and mounted with Frenzel's glasses. With his eyes closed, the applicant is manually, but smoothly turned five rounds in twenty seconds. After a brisk stop, the applicant is told to open his eyes behind the glasses and the examiner notes the duration of resulting postrotational nystagmus. After a two to three-minute break, the procedure is repeated in the opposite direction. Following a clockwise rotation, the postrotational nystagmus is leftward and following a counter-clockwise rotation it is rightward. If the duration of the postrotational nystagmus in one direction is more than twice the duration of the nystagmus in the opposite direction, a *directional preponderance* is said to be present and the applicant should be submitted to a more sensitive and specific evaluation.

5.10 Other vestibular test for diagnostic purposes

[5.10.1 Romberg's test]

The *Romberg's test* is easy to perform and valuable for diagnostic purposes. The test can be sharpened by letting the examinee stand with his feet in a heel-to-toe position. The ability to walk a straight line can be tested using the *tandem-gait test*, making the examinee walk heel-to-toe with his eyes closed or blindfolded.

[5.10.2 Finger-to-nose test]

The *finger-to-nose test* is performed by letting the examinee place his finger on his own nose with his eyes closed.

[5.10.1 Bárány pointing test]

The *Bárány pointing test* is performed by having the examinee pointing at the examiner's finger and rapidly move his finger back and forth between his own nose and the examiner's finger with his eyes closed. Past-pointing will appear in acute vestibular disease and make any latent ataxia apparent.

[5.11 Guidance regarding aeromedical assessment]

As emphasised initially, evaluation of the hearing function is an important supplementary aspect of the evaluation of inner-ear balance function. Even small sensory-neural hearing losses must sharpen the examiners's attention to the vestibular function test results.

The presence of spontaneous or positional nystagmus at eye velocities above 5°/s demonstrated by an EOG-recording cannot be accepted. At revalidation / renewal, the appearance of

spontaneous or positional nystagmus should entail a thorough vestibular examination including an audiologic evaluation. Following episodes of signs or symptoms of vestibular disease, the pilot should be allowed to recover until pathological nystagmus and all symptoms have disappeared.

[For initial applicants], no abnormal caloric or rotational responses can be accepted. At later issues, the diagnostic evaluations must be completed and the reactions adjusted to the diagnosis.

6 THE NOSE AND SINUSES

6.1 General

The nose is the most important part of the air-conditioning system of the upper airways. Passing through the nose, the inspired air is heated and saturated with water vapour and cleaned from larger particles by the mucosa; when expired, the air returns some of the heat and humidity to the mucosa.

The in-door climate of an airliner is characterised by a very dry air. This is a challenge to the entire airway mucosa. If the air passage of the nose is obstructed, mouth-respiration will result in dryness of the mucosa of the throat making it sensitive to irritants and infections.

The paranasal sinuses are open cavities, which may behave as semi-closed cavities (as the middle ear) if their ostia are narrowed by a swelling of their mucosa. If the free exchange of air between sinuses and the nose through the ostia and canals is impeded, a **sinus barotrauma** will develop due to the same mechanisms as in the middle ear. From a clinical point of view, the maxillary sinuses are the most frequent location of sinus disease. This often causes mistakes as pain caused by maxillary sinus disorders is frequently referred to the frontal region. The same is valid for any sinus barotrauma.

A mucosa exposed to non-physiological challenges, [altered by allergic reactions] or infections will swell. A swelling of the nasal mucosa is regularly associated with a swelling of naso-pharyngeal mucosa and a reduction of blocked-and-locked threshold of the tubal ostia resulting in **tubal dysfunction**. Obstruction of the nasal passage or sinus cavities results in an abnormal nasal voice twang, *rhinolalia clausa* making the voice weak, difficult to modulate and less intelligible.

6.2 Standard requirements for nasal and sinus function

According to the requirements, nasal obstruction and sinus dysfunction are not [acceptable]. Septal deviation caused by either a nasal fracture or of congenital origin is the most common cause of a chronic nasal obstruction. In the case of a septal deviation, both nasal cavities should be capable of serving the air passage more or less equally.

Most people suffer from a **common cold** now and then. Many pilots are frequently exposed to fast and dramatic climatic variations. No clear limits of an acceptable common cold frequency can be assessed and a pilot's tendency to frequent common colds must be seen from a tubal or sinus function point of view. The same counts for **allergic nasal disease** and **nasal polypi**. If the nasal allergy is caused by a hypersensitivity to grass pollen, the examiner's attention should be sharpened because, during the season, airfields are very productive of grass pollen.

It should be required that a pilot not suffers from recurrent barotrauma of his sinuses or middle ears due to a nasal dysfunction. A sinus barotrauma is very painful and might considerably distract the pilots attention from his duties during the critical phase of aircraft descent, approach and landing.

6.3 Methods of examination

The nasal air passage is checked by listening to the sound produced by the air passage through each nostril separately. This is done by blocking the contra-lateral nostril with the pulp of the examiner's thumb during both in- and exhalation. The expiratory function can be examined further by making the examinee exhale on a mirror or metal surface held just below his nose and observing the symmetry of the dew spots.

When in doubt or if any suspicion of sinus disorders, an X-ray [or ultrasound] examination of the nose and sinuses should be performed.

At the specialist examination, an anterior and posterior rhinoscopy should be performed.

If a nasal allergy is suspected of interfering with normal flight duties, the applicant should be referred to a specialist for a thorough allergologic evaluation.

6.4 Guidance regarding [aeromedical assessment]

If an applicant at the first issue of a licence presents a total or subtotal obstruction of a nasal cavity or a history of recurrent barotrauma due to a nasal disease, he should not be accepted. Applicants needing chronic medication because of a nasal allergy or any other nasal disease should not be accepted either. Periodic systemic corticoid medication or antihistamine medication is unacceptable because of the side-effects.

7 ORAL CAVITY AND UPPER RESPIRATORY TRACT

7.1 General

A normal function of the oral cavity and upper respiratory tract is essential for respiration and speech and voice function. In aviation medicine, most problems in this region are attributed to disturbances in the speech and voice function which is an essential part of the ATC-communication. An applicant who constantly or temporarily is unable to communicate verbally in a comprehensible way or who suffers from a voice disorder making his voice less intelligible should not be accepted.

Stuttering is an inadequate co-ordination between the phonation, articulation and respiration. Usually, stuttering deteriorates with fatigue, anxiety or aggression. The examiner must be aware of any stuttering at the first licence application. If it results in an interruption of the normal rhythm of speech of such frequency and abnormality as to attract attention, interfere with communication or cause distress to the applicant or his audience, the applicant should not be accepted. When in doubt, the case can be conferred with a flight instructor listening to a tape-recording of the applicant's speech.

Phonastenia is a weakness of the voice which may develop both based on a laryngeal disorder and on a psychologic background. It may develop into *aphonia* making the pilot unable to communicate. This is inconsistent with pilot duties.

Laryngeal disorders should be evaluated and diagnosed by an accredited specialist. Approval should be based on a certainty that the disorder will not interfere with the ATC-communication.

7.2 Methods of examination

At all physical examinations, the examiner should listen carefully to the applicant's voice in order to detect any possible sign of malfunction of the speech or the voice. At the specialist examination, a mirror- or fibre-laryngoscopy must be performed in order to reveal signs of laryngeal disorders with possible effect on verbal communication.

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CHAPTER 15 - AVIATION PSYCHOLOGY

1 INTRODUCTION

The performance of aviators requires certain cognitive, psychomotor and interpersonal capabilities in order to perform operational tasks in a reliable way especially during high workload and stress. These capabilities may decrease to such a critical level that safe flight operation is no longer [possible]. However, a reduction in pilot capability is never easily detected or demonstrated. The majority of accidents in aviation is caused by human error not by physical incapacitation or technical failures. People may become unsafe for various reasons [. Problems may be] low mental [capacity], []psychomotor [problems, inadequate decision making] or accelerated ageing, to name a few. Such personal conditions are not usually classified by psychiatric and neurological standards as disqualifying criteria. They have to be assessed by a psychological evaluation.

2 INDICATION

A psychological evaluation should be considered when the AMS receives information which evokes doubts concerning the mental fitness or [the] personality of a particular individual. Sources for this information can be accidents or incidents, problems in training or proficiency checks, delinquency or knowledge relevant to the safe exercise of the privileges of the applicable licences. [Dependent upon the individual case] the evaluation [may be separate], part of, or complementary to, a specialist psychiatric or neurological examination.

3 TESTING FACILITIES

Only psychologists acceptable to the AMS or organisations which employ psychologists acceptable to the AMS are allowed to perform the psychological evaluation [in the aeromedical context mentioned].

4 PSYCHOLOGICAL CRITERIA

The []psychological evaluation includes a collection of biographical data, the [assessment of aptitudes] as well as personality tests and a psychological interview. The following aspects will be investigated:

- a *Biography*
 - i General life history
 - ii Family
 - iii Education
 - iv Socio-economic status
 - v Training progress and occupational situation
 - vi Critical behavioural incidents
 - vii Diseases and accidents
 - viii Delinquency

- b *Operational aptitudes*
 - i [Reasoning]
 - ii Mental arithmetic
 - iii Memory function
 - iv Attention
 - v Perception
 - vi Spatial comprehension
 - vii Psychomotor function
 - viii Multiple task abilities

- c *Personality factors*
 - i [Working behaviour and performance style] []
 - ii Social [capabilities]
 - iii [Emotional stability] []

Definitions of aptitudes and personality factors as well as recommendations for the use of adequate test methods are further elaborated below.

5 OPERATIONAL APTITUDES

5.1 General considerations

The general demands on pilots (applicants for, or holders of a Class 1 medical certificate) require operational aptitudes like cognitive and psychomotor capabilities. The complexity of the tasks and the time stress inherent to flight deck operations necessitate an accurate and fast task performance. Therefore it is recommended, when feasible, to apply tests with tight time constraints.

An adequate performance in the aptitude categories listed below is regarded as essential.

5.2 [Reasoning]

a *Definition*

The ability to find rules [(Inductive Reasoning) or] to apply [logical rules] in various task situations, using verbal, mathematical and other abstract material [(Deductive reasoning). In aviation Deductive Reasoning is more important than Inductive Reasoning].

b *Description*

[Deductive] Reasoning is a cognitive process which refers to [application of] general rules or analogies [in order to find problem solutions or to make proper] judgements. [This also includes mathematical tasks].

5.3 **Mental arithmetic**

a *Definition*

The ability to mentally operate with numbers and to solve simple and more complex computational problems.

b *Description*

Mental arithmetic requires the practical and effective use of algorithms and working memory. Typical test items include mentally performing basic calculations[].

5.4 **Memory function**

a *Definition*

The ability to memorise and retrieve from memory visually and/or verbally coded information [and to process information in the working memory].

b *Description*

The use of memory refers to holding a detailed record of sensory information for a relatively brief period of time, after which forgetting will occur unless special efforts are made to retain the information, as by rehearsal, long enough to permit identification and classification of sensory information and response with corresponding behavioural actions.

Memory function testing may include visual and/or auditory tests for working memory, tolerance against interference by required responses, memory for instructions.

5.5 **Attention**

Important aspects of attention are concentration, vigilance, divided attention and selective attention. [In aviation most information is processed via the visual and the auditory system.]

a *Concentration*

i *Definition*

The ability to direct attention for a long time to a task in order to attain a stable performance.

ii *Description*

Concentration refers to a high degree of continuous and focused attention which requires a high degree of effort. Fluctuations in concentration are reflected in the selective aspects of task performance (tunnelling, distraction). Tasks of concentration may include both monotonous tasks and tasks of varying difficulty, as well as of long duration.

b *Vigilance*

i *Definition*

The ability to maintain a state of readiness [and attention] for a long time in order to detect and respond to certain specified, infrequently occurring events in a stream of [potentially distracting] events which have to be neglected.

ii *Description*

In vigilance tests the subject has to pay attention to all the events, most of which do not need a response. Good vigilance is reflected by a high probability of detecting a signal, a low errors rate and a high speed of response.

c *Divided attention*

i *Definition*

The ability to direct attention to different tasks simultaneously in an efficient and effective way.

ii *Description*

The subject has to perform several tasks at the same time by setting priority and switching attention quickly and effectively between tasks (time sharing, see also multiple task abilities).

d *Selective attention*

i *Definition*

The ability to direct attention selectively to one of several sources of information by switching the focus of attention.

ii *Description*

Tests of selective attention may include measuring the ability to discriminate among various sources of sensory information and attend to one without being distracted by irrelevant information.

5.6 **Perception**

[Perception is the interpretation of the information taken in by our senses. It is the] ability to perceive information, auditory and visual, in an effective and efficient way. Relevant aspects of perception are: perceptual speed and []closure.

a *Perceptual speed*

i *Definition*

The ability to perceive information quickly and accurately, simple as well as complex material.

ii *Description*

Perceptual speed can be assessed by e.g. tachistoscopic instrument reading tests.

b *[Flexibility and speed of] closure*

i *Definition*

[The ability to recognise incomplete forms, i.e. that incomplete objects or patterns are perceived as complete ones or a whole (the literature uses the German term '*Gestalt*' or] to form '*Gestalts*' from []incomplete [or masked] material[].

ii *Description*

Tests presenting incomplete figures or tests where "hidden" figures are to be detected are appropriate.

5.7 **Spatial comprehension**

Two aspects of spatial comprehension should be assessed which can be designated by the classical psychological terms '*Visualisation*' and '*Spatial Orientation*'.

a *Visualisation*

i *Definition*

The ability to construct an appropriate mental image of two or three-dimensional spatial patterns and to manipulate or to transform these images into other visual arrangements.

ii *Description*

One indicator of good visualisation is the capability of rotating mental images, e.g. the capability of identifying given spatial patterns, even if these patterns are presented at various orientations in the picture plane.

[b *Spatial Orientation*

i *Definition*

Spatial Orientation is the ability to perceive correctly the spatial relations between objects or parts of a spatial pattern in a two- or three-dimensional space and to maintain orientation even if these objects or patterns are seen from different perspectives.

ii *Description*

Spatial Orientation is closely related to visualization. However, whereas visualization is characterized by the capability of transforming mental images, Spatial Orientation involves the perception and mental representation of spatial relations between fixed (immovable) objects or parts of abstract patterns with the observer himself as a reference frame. Typical tests of Spatial Orientation involve the differentiation between left, right, above, and below dependent on the position of the subject.]

5.8 **Psychomotor function**

Two aspects of psychomotor function [, as defined below,] should be assessed, namely, psychomotor co-ordination and [] reaction time.

a *Psychomotor co-ordination*

i *Definition*

Psychomotor co-ordination can be defined as the capability to co-ordinate the [movements] of arms, hands and feet in response to visual [or auditory] stimuli.

ii *Description*

Usually tests of psychomotor co-ordination involve some kind of display-control tasks, where the subject has to control a dynamic system by means of appropriate (joystick) and/or pedal inputs.

b **[Reaction] time**

i *Definition*

[Reaction] time can be defined as the interval between the onset of a stimulus [] and the subjects correct response.

ii *Description*

[Simple] reaction time [is the ability to give a fast response to one signal. More important in aviation is the choice reaction time. Choice] reaction time is measured in tasks, where the presented stimulus is randomly chosen from a set of different stimuli each of which is associated with a certain response. In order to vary the degree of

cognitive control associated with response choice, the assessment of choice reaction time should include a comparison of those for (spatial) compatible and incompatible stimulus-response mappings. Stimulus response compatibility in this sense is given when the spatial arrangement of stimuli is required (e.g. light on the left requires response with the left hand). Furthermore the possibility of speed-accuracy trade-offs should be taken into account by a recording of error rates.

5.9 Multiple task abilities

a *Definition*

Multiple task abilities (time sharing abilities) can be defined as abilities which are needed in situations where at least two independent tasks have to be performed simultaneously.

b *Description*

Multiple task abilities include:

- i effective timing of responses,
- ii rapid [inter-task] switching,
- iii parallel information processing,
- iv adequate allocation of processing resources according to task priorities.

Usually a high level of multiple task abilities is reflected in relatively low performance decrements (compared with single task performance) in the tasks to be performed simultaneously, and relatively small performance trade-offs between these tasks under multiple task conditions. In order to assess multiple task abilities, multiple tasks should be used which consist of at least dual tasks that are similar with respect to their demands on response related resources (e.g. psychomotor tasks which are similar in their demands on response-related resources, or memory demanding tasks, which are similar in their demands on perceptive-cognitive resources).

6 PERSONALITY FACTORS

6.1 General considerations

[Personality factors which are important in aviation can be divided into three categories. These categories include personality factors which are related to working behaviour and performance, to social capabilities and to the emotional stability of a person. Facets of all three aspects are a necessary completion of the operational aptitudes as listed above. These personality factors are not only important in the psychological evaluation of pilot applicants, but have a direct impact on behaviour of licence holders in daily flight environments. Personality factors related to work orientation and performance are important for aspects like flight preparation, situational awareness, decision making, risk taking behaviour, physical fitness and other aspects in aviation. Factors of social capabilities have to be considered particularly in respect to leadership behaviour, crew co-ordination and crew resource management. Emotional instability can directly affect performance as well as social behaviour and is the cause for many performance or health problems in a flying career.

A world wide accepted model of personality structure is the OCEAN – model, also known as the Big-Five -Model. Five personality factors (Openness, Conscientiousness, Extraversion, Agreeableness, Neuroticism) have to be found as very stable personality traits mostly independent from cultural differences.] The concept behind this trait-oriented assessment is that relatively stable dispositions are influencing behaviour under various conditions in a typical way. Although there is no doubt that such dispositions do exist, there is even no doubt that actual behaviour is not only a function of these traits but also a complex dynamic process where the traits interact with a manifold of other aspects, e.g. actual individual needs or situational demands.

The trait structure itself can also be the reason for specific dependencies. Certain combinations of trait intensities can interact in the way of typical syndromes. Therefore, in applying the personality traits as evaluation criteria it has to be carefully considered that such complex psychological processes exist and might display critical information in addition to pure trait assessment. Often such information is revealed by behavioural observation and psychological interview which should follow psychometric testing.

[Three categories of personality factors are important for aviation (working behaviour and performance style; social capabilities; emotional stability). They are described with their facets in the following.]

6.2 **[Working behaviour and performance style]**

a *Definition*

The disposition to develop, direct, regulate and maintain energy in order to reach an objective (despite obstacles or difficulties) while keeping up a positive attitude towards work, tasks and, in general, towards occupational demands.

b *Description*

[The main personality factors related to this category are “Conscientiousness” and partly “Openness” with their different aspects. Important indicators are need of achievement, rigidity, readiness to acquire new knowledge and skills, acceptance of responsibility, vitality, mobility and decision making.]

i **Need of achievement**

a *Definition*

The aspiration to succeed in competition with some standards of excellence.

b *Description*

Achievement oriented individuals prefer challenging situations with moderate risks, like to get performance feedback, like to perform well and better (mastery) and attribute successful performance to internal factors like personal effort and/or abilities.

ii **[Rigidity]**

The tendency how structured and systematic people are as well as how flexible they are in new situations.

iii **Readiness to acquire new knowledge and skills**

Readiness and open-mindedness to acquire new knowledge and skills which are necessary for the successful conduct of new tasks and responsibilities.

iv **Acceptance of responsibility**

The readiness to accept formal roles, tasks and duties and to behave accordingly.

vi **Vitality**

The positive attitude towards physical activities like sports, hiking, mountaineering.

vi **Mobility**

The readiness to be open for new activities, to move, to travel, to take risks.

vii **Decision making**

a *Definition*

Decision making is the capability to choose actions properly in complex situations where several alternatives are possible. The capability is very important in aviation and is influenced by situational or personal factors like situational awareness, mental fitness, workload or different personality factors.]

b *Description*

Decision making is concerned with problem solving behaviour which only partially is based on knowledge and skills. Three different categories of decisions performed by humans can be distinguished.

i Choice of alternatives,

ii Decisions under uncertainty,

iii Decisions after diagnosing available information (e.g. from displays or from crew members).

The efficiency of decision making varies as a function of many different factors including appropriateness of the mental representation of the problem structure, adequate problem solving heuristics, correct estimation of probabilities of events, workload and practice. Personality factors such as flexibility, creativity and dominance are also important.

6.3 **Social [capabilities]**

a *Definition*

The capability to develop, maintain and enjoy contacts and relations with other persons.

b *Description*

In interpersonal and group activities social capability is manifested by team orientation, verbal and non-verbal expressivity, sensitivity and tolerance with respect to individual needs and cultural differences. Team orientation includes effective management of human resources, situational/group oriented leadership style, acceptance of group objectives, tasks and roles and striving towards consensus.

The main personality factors related to this category are "Extraversion" and different facets of "Agreeableness" like dominance, empathy and aggressiveness.

i **[Extraversion]**

The need for affiliation and change paired with the disposition to communicate one's ideas, opinions and feelings in a manner that conforms to social forms.

Extreme [extraverts] possess a high requirement for the company with other people and social life. They quickly make and adapt to new friends which they keep in a loose fashion. They are extremely talkative, temperamental, quick-witted and skilled in social situations.

Extreme introverts do not mind being alone. They prefer small groups and have few but very close friends. They are taciturn, serious, reserved and inhibited in social situations.

ii **[Dominance]**

Dominance refers to the need for appreciation and leadership.

High dominant people have an extreme need for appreciation and have a tendency to take on responsibility and leadership in any case paired with the disposition to impose their own goals, ideas and wishes on others.

Low dominant people have the tendency to submit themselves under the goals and leadership of others. Usually they stay passive and avoid taking on responsibility in social situations.

iii Empathy

The ability to understand and feel with the experiences and emotions of other persons.

iv [Aggressiveness]

[Aggressiveness] is characterised by a lack of self-control regarding hostile reactions which manifests itself in spontaneous as well as reactive aggressivity.

Reactive aggressivity refers to a disposition to defend oneself against unfairness and attacks.

6.4 [Emotional stability]

a *Definition*

Emotional stability (or inversely "Neuroticism" as a main factor in personality) refers to the tendency to react in an appropriate and emotional controlled way to situations which seem to be difficult or threatening.

b *Description*

People who score high on "Neuroticism" (or low on Emotional Stability) may experience primarily one specific negative feeling such as anxiety, anger, or depression or several of these emotions at the same time. They are emotionally reactive and respond emotionally to events that would not affect most people, and their reactions tend to be more intense than normal. They interpret ordinary situations often as threatening or frustrating and hopeless. Their problems in emotional regulation can make them unable to make decisions or to cope effectively with stress. They tend to avoid demanding situations. Beside the main personality factor "Neuroticism", aspects of stress management and, for professional pilots, the readiness to bear privations or deprivations are important.

i Neuroticism

A tendency to easily experience unpleasant emotions such as anger, anxiety, depression, or vulnerability.

ii Stress management

Stress coping is the capability to cope with external and/or internal stressors in order to maintain control and reach the objective. Contributing factors are emotional stability, readiness to bear privations, flexibility and stress management abilities.

Stress management is the capability to actively develop and implement cognitive and behavioural strategies in order to master stressful situations. It includes identification and evaluation of stresses and an active approach towards altering the sources of stress.

iii Readiness to bear privations

The disposition to accept, tolerate and adjust oneself to physical discomforts and/or psychological hardships like lack of privacy, sleep deprivation and separation from family.]

7 METHODOLOGICAL RECOMMENDATIONS

Because of the diversity of psychological methods (e.g. tests, questionnaires, observer ratings, interview data, biographical data) available for the assessment of the different criteria mentioned on the criteria list above, no tests, questionnaires or other methods have been recommended for the assessment of these criteria. However, general guidelines are described below for guidance and finding adequate assessment methods.

7.1 Tests and questionnaires

Whenever possible, standardised psychological tests and questionnaires which fulfil at least the following general requirements should be used for criteria assessment.

a *Reliability*

The stability (test-retest-reliability) or at least the internal consistency of tests/questionnaires has been proved (whenever possible with regard to an application in personnel selection).

b *Construct validity*

The extent to which a test-questionnaire measures the construct (aptitude, personality trait) it is intended to measure has been proved (whenever possible with regard to an application in personnel selection).

The test or questionnaire should clearly differentiate between the applications (ideally normal distribution of test scores) even in a highly pre-selected group like, e.g. holders of a pilot licence.

c *Norms*

In order to evaluate the test / questionnaire results of individual subjects, standard norms have to be available for the test / questionnaire. These norms should be derived from the distribution of test results in samples which are more similar in important characteristics (e.g. age, education, level etc.) to the group of applicants under discussion. For reasons of standardisation it is recommended to use STANINE scores as norms for all tests or questionnaire.

7.2 Rating scales and classification systems

In case that observer ratings are used for criteria assessment, it should be ensured that the observers are very well trained and that the inter-rater-reliability is high, i.e. that different observers agree about their evaluation of a certain behaviour shown by an applicant. As a rule, a high inter-rater-reliability can be achieved by using clearly defined rating scales and/or classification systems.

7.3 Sources of information

The whole test system used for the criteria assessment should be characterised by redundancy with regard to the sources of information used to assess the aptitudes/personality traits mentioned in the criteria list [(see 4 (b) and (c))]. Whenever possible each of these aptitudes/personality traits should be assessed/tested on the basis of at least two independent sources of information (tests, questionnaires, observer ratings, interview-data, biographical data). This kind of cross [evaluation] is recommended in order to improve the overall reliability of the whole test system.

7.4 Decision rules

The decision about the classification of an applicant or holder of a Class 1 or Class 2 medical certificate should be based on the following general rules. However, in the case of clear deficiencies in operational aptitudes of already experienced pilots, it has to be considered whether or not [personal] characteristics can compensate for the resulting risks.

a *Operational aptitudes*

In order to be assessed as non-critical an examinee should not have a clear deficiency in any operational aptitude as compared with the norm group (see paragraph 7.1.c, above).

b *Personality factors*

An examinee must be evaluated (by a psychologist) as non-critical with regard to the main personality factors:

- motivation and work orientation
- social capabilities
- stress coping

This usually implies that the examinee is not assessed as an extreme case with regard to the normal range of variation in the contributing factors.

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CHAPTER 16 - DERMATOLOGY

1 INTRODUCTION

[A] number of dermatological [disorders] are disqualifying initially from an Aviation Medicine point of view.

Most of the [disorders] are treatable to a level where [a]Class 1 and 2 [fit assessment] is possible. [However, there] are a few specific lesions which are disqualifying.

Some skin [disorders] are a manifestation of a more serious medical disorder which must be identified and treated before 2 [a fit assessment] can be considered.

There are some acute dermatological [disorders] that are caused by infection. This can be bacterial, viral or mycotic. Some acute [diseases] can be caused by allergy, parasites or insect bites. When some acute problems occur, a pilot has to be assessed as temporarily unfit and treated. Where possible, a cause must be found to prevent a recurrence. Some severe allergic responses can be fatal should they recur. Insect stings or bites are perhaps the most common cause in this category.

Some dermatological disorders can be disfiguring, which, whilst not in itself causing a safety problem, may present in such a way as to upset others on the flight deck, and amongst the cabin crew. These cases require handling with common sense and tact, if they are to be dealt with sympathetically and fairly.

The advent of higher speed air travel and the ease with which deck crew reach and stay in [hot] climates, has resulted in a greater increase in skin lesions caused by UV light in fair skinned people. These lesions need careful identification so as not to miss a malignant melanoma or a squamous cell carcinoma. Both of these lesions have the ability to metastasise, a melanoma more so than a squamous cell carcinoma. Diagnosis can only be made by biopsy.

[A disorder occurring] quite commonly is a 'basal cell epithelioma', sometimes called a 'basal cell carcinoma' or rodent ulcer. It is a low grade skin tumour which confines itself to the skin and does not metastasise. Those authorities, who rigidly apply their regulations in order to maintain standards, often put the 'Basal Cell Epithelioma' into the Malignant Tumour Section, which can be disqualifying. [However,] such a condition is not disqualifying as it causes no risk and cannot compromise flight safety. This particular skin lesion serves as a good example to remember when considering all of the disorders discussed in [this chapter].

The AMEs/AMCs/AMSs must use a great deal of common sense and logic at all times, but especially in this section, where a small skin lesion can cause a great deal of trouble, such as a malignant melanoma, whereas a large plaque of Psoriasis whilst being disfiguring is not a compromise to flight safety.

2 ECZEMA, EXOGENOUS, ATOPIC, VARICOSE, SEBORRHOEIC, NUMMULAR AND [POMPHOLYX]

2.1 Definition

The terms 'eczema' and 'dermatitis' tend to be used synonymously, eczema being commoner in Europe and Asia and dermatitis in the United States. Eczema is derived from the Greek word ekzein meaning to boil over or break out, and in this chapter [the term 'eczema'] will be [preferred].

Eczema denotes a special sequence of inflammatory changes in the skin, which - though similar - can vary from patient to patient. Likewise the clinical features can vary depending on the severity and/or chronicity of the disease and site involved. The principal signs are redness, swelling, blisters (large or small), scaling which may be loose and thin, or thick (hyperkeratosis), exudation of serum, which may be severe leading to weeping, or moderate and mix with the scales of the skin to form crusts. Fissures or splits may occur particularly on the palms or soles. Thickening of the skin referred to as lichenification is particularly likely to occur due to continued scratching in atopic eczema. Changes in pigmentation may occur, and this may be seen as hyper- or hypopigmentation. This physical sign is most apparent in coloured people and is sometimes the most obvious sign of the eczema. Purpura or bleeding into the skin is not common but may occur after continual scratching, particularly on the legs.

The appearance of any particular case of eczema may include one or two, or several of the above features, and thus one case of eczema may vary from another. In addition, the eczema in an individual patient may vary from one site of the body to another.

It should be emphasised that eczematous changes in the skin are completely reversible, and it is often helpful for the physician to be able to stress this point, when the pilot consults him. In aircrew it is always advisable to assess []the pilot [as temporarily unfit] until the acute phase is over.

2.2 Classification

The classification of eczema is difficult and not very satisfactory. This is because in the past some of the terms given to eczema have been based on the appearances of the eruption, while others have been based on so-called aetiological factors, or specific sites of eruption. Thus, there has been considerable overlap in the terminology, one type of eczema having three or four names, depending upon which criteria the name was given.

At the present time the eczemas are divided into two main groups. First, that in which the eczema is due to specific external factors, the eczema sometimes being termed exogenous. The subdivision is particularly important because if the exogenous factors are identified and avoided, this in itself may result in a cure.

[The second group is referred to as endogenous eczema:]

a *Atopic eczema*

This is the commonest type of eczema seen in childhood, and is often associated with a family history of asthma and hay-fever.

b *Seborrhoeic eczema*

This derives its name from the fact that the sites involved are those with the greatest sebum production per area of skin surface, e.g. scalp, face, back and chest.

c *Nummular or discoid eczema*

Derives its name from the clinical appearances, i.e. it occurs as small circumscribed areas of eczema.

d *Varicose or hypostatic eczema*

This is the eczema on the lower leg associated with impaired venous drainage of the limb.

e *Pompholyx eczema of the hands and feet*

This tends to be symmetrical occurring on the palms and soles, sides of the digits and their dorsal surface over the distal two phalanges. This is quite common in aircrew and is often associated with changes in temperature and humidity.

Any type of eczema (endogenous or exogenous) may lead to spread of the eruption with more general involvement of the skin, which - if it becomes complete - is referred to as erythroderma or exfoliative dermatitis.

3 EXOGENOUS ECZEMA

[Unfortunately, the lesions of exogenous eczema are identical to those of endogenous eczema. However, the distribution of the eczema, the occupation of the patient, and direct questioning concerning self-medication with topical preparations and cosmetics etc. may well give a clue to exogenous factors. In some instances such as nickel eczema, or clothing eczema, the distribution and localisation of the eczema suggests the diagnosis.

Exogenous eczema is usually subdivided into:

- a true allergic or contact eczema, in which the patient has an allergy to a certain substance; and
- b irritant eczema in which a substance damages the skin directly.

Until we understand more about endogenous eczema the classification will have to remain arbitrary, based on clinical criteria, and the classification below has been found to be the most useful.]

3.1 General considerations

Eczemas in this group are due to the skin coming into contact with chemicals, natural or synthetic. There are certain clues which may be present and should be looked for in establishing a diagnosis of exogenous eczema. In the early stages a sharp delineation between the affected skin and the normal skin may be apparent. Some sites are more commonly affected than others and there are three factors which determine these sites of exogenous or contact eczema. First, certain parts of the body are more likely to be in contact with chemicals e.g. hands, face, neck, and genitalia (by transference of the chemicals from the hands). Secondly, the thickness of the skin – if the hands are exposed to the chemicals, the eruption is more likely to appear first on the back of the hands than on the palms, because the skin is thinner on the back and the chemicals more easily absorbed. Thirdly, the absorption of chemicals into the skin is enhanced by moisture and thus parts of the body, which secrete large amounts of sweat, or where the evaporation of sweat is impaired by opposing skin surface and lack of air (e.g. groins, axillae and flexures of the limbs), are more likely to be affected. This point is well illustrated by contact eczema due to stockings in which the eruption first appears on the feet and popliteal fossae due to greater absorption of the allergen into the skin at these sites. This condition may arise at any time in Aircrew, and may require a temporarily unfit assessment during the acute phase or until the cause is found.

a *Spread*

The eruption in contact eczema ranges from a faint erythema to an acute blistering. It should always be borne in mind, that eczema may subsequently appear at other sites of the body, which have not been directly in contact with the chemical. This spread of the eczema may be due to 'autosensitisation' from the primary eczematous skin or due to absorption of the exogenous chemicals, which affect the skin at distant sites. Although this secondary spread of eczema may occur to any part of the skin, it has a tendency to spread to certain sites with some allergens. For example, eczema due to nickel sensitivity frequently spreads to the skin around the eyes and the ante-cubital fossae. This may be the presenting pattern to the

physician. At present, the factors, which cause eczema to spread to secondary sites, are not fully understood, but some eczemas spread after a matter of days and others only after months or even years, with continuing eczema at the primary site.

b *Cause*

The cause of contact eczema may be primary irritant (non-allergic) or an allergenic (sensitising) agent.

3.2 **Primary irritant eczema**

Substances which cause this type of eczema may be divided into two classes.

a *Strong*

These are usually caustic substances that air crew may come into contact with at work, such as strong acids or alkalis, or chemical solvents. These are likely to produce eczema after only one or two exposures, usually as a result of inadequate protective precautions at work or, if the exposure occurred at home, of ignorance of the possible hazard. The commonest sites are the hands or face. It is not practicable to give a comprehensive list of these strong caustic substances but the patient's occupation or hobbies will usually offer confirmatory evidence if the diagnosis is suspected.

b *Weak*

There are substances not caustic or directly damaging to the skin, but which - after prolonged or repeated exposures - will induce eczema. In this category [we find the more common skin disorders, with continuous] exposure to detergents, hands in water too frequently with inadequate drying and cold windy conditions. Various solvents, degreasers and abrasives encountered in the patient's occupation can also cause this type of eczema. Other factors, such as humidity, trauma, dryness of the skin, sweating and secondary infection may all play a part in this type of eczema.

Once again the [most common] site is in the hands. In the mild form the skin is dry and scaling with slight erythema, but in the more severe and chronic forms there is thickening of the skin (hyperkeratosis) and splits or fissures. The back and palms of the hands tend to be equally affected.

3.3 **Allergic contact eczema**

There are numerous chemical substances with which we come into contact in our everyday life that are capable of sensitising the skin [and causing] eczema[]. Why some patients develop an allergy to chemicals and others do not is [still] unknown. The number of known skin allergens is now so numerous that []only []the commoner substances likely to cause contact eczema [will be mentioned]. Such allergy can be tested for by patch testing. Hence small samples of suspected items and of common []allergens in pure form are applied under standardised conditions onto the patients back. The carefully marked areas are then read [after] 2 and 4 days. Interpretation of such results is not always straight forward and patch testing is best performed in a specialised [] unit. 'User' testing can however be helpful – e.g. suspected cream can be rubbed into the same area on the forearm daily – a positive reaction sometimes taking several days to be obvious.

a *Rubber and elasticised garments*

Rubber gloves and suspenders frequently cause eczema but any article of clothing with rubber or elastic can have a similar effect.

b *Metals*

Nickel is the commonest metal to cause [sensitisation], and is most frequently found in suspenders, jewellery clips and bra(ssiere) clips.

c *Dyes*

Dyes in clothing and shoes can all cause contact eczema. Hair dyes are also a common cause of trouble.

d *Cosmetics*

There are various organic chemicals and preservatives in cosmetics which can sensitise patients. Substances in face creams, moisturisers, lipstick, eyeshadow, and nail varnish can all cause contact eczema.

e *Leather*

Chemicals in the leather or used in the tanning process can sensitise patients, and this may present as eczema due to a hatband, shoes or watch strap.

f *Therapeutic Preparations*

i Topical Local Anaesthetics

Local anaesthetics are [frequently] found in creams and ointments prescribed by doctors for irritating conditions particularly pruritus ani and haemorrhoids. It should be remembered that these substances are potent sensitisers and if eczematous changes occur contact eczema to these substances should be excluded by stopping their use and/or by patch tests.

ii Topical Antihistamines

Although these substances are widely prescribed and [available over the counter], there are many dermatologists who consider that there are no indications for their use. Antihistamines applied topically have a high incidence of sensitisation[. Acute] eczema after their use or exacerbation of an existing skin condition suggests sensitivity.

iii Topical Antibiotics and Antiseptics

Neomycin and soframycin are probably the [most common] topical antibiotics to cause sensitisation. If either of these is used combined with a topical steroid the diagnosis of a contact eczema may still be difficult as the steroid suppresses the response to sensitisation. If eczema is proving particularly chronic or shows exacerbation after the use of these substances, patch tests to the antibiotics should be carried out. Acriflavin, still a commonly used antiseptic, often causes contact eczema.

iv Patients may become sensitive to ear drops and eye drops which are particularly common offenders. The diagnosis is suggested by exacerbation or persistence of an eczematous condition or by appearance of eczema in addition to the condition which is being treated with the drops. Lanolin sometimes used in medical ointments and in a number of cosmetics can also give rise to sensitivities in some patients.

Preservatives are now necessary additives to ensure the sterility of creams and can cause sensitisation. e.g. parabens and benzalconium.

3.4 **Treatment and management of contact eczema**

The most important point in the management of contact eczema is to prevent further exposure of the skin to the substance which is responsible for the reaction. If this is done, no further treatment may be required. If further exposure is not prevented then there is no treatment which will keep the patient clear of eczema.

[It should be emphasised that the changes occurring in the skin in eczema are completely reversible, and it is often helpful for the physician to be able to stress this point when the pilot consults him. In aircrew it is always advisable to assess []the pilot [as temporarily unfit] until the acute phase is over.]

a *Topical therapy*

Only bland and non-sensitising substances should be used. Topical antihistamines and local anaesthetics should be avoided. [More] severe cases should be referred [to a specialist].

b *Systemic therapy*

i *Corticosteroids*

These are required, and justifiable, only in a small number of patients with contact eczema in whom the eruption is very extensive and acute.

ii *Antibiotics*

Not infrequently acute eczema becomes secondarily infected. If so a broad spectrum antibiotic should be given by mouth.

iii *Antihistamines and sedatives*

An acute eczema is very irritating and causes a great deal of discomfort. Oral antihistamines taken daily are helpful because of their anti-pruritic and hypnotic action. Care must be taken when these preparations are prescribed as the sedentary effects may take some time to wear off.

[]

4 ENDOGENOUS ECZEMA

4.1 Atopic eczema

a *Symptoms*

Although usually seen in children it can occur in adults and involve any part of the skin. This type of eczema is associated with a personal or family history [of] asthma or hay fever. The name implies an allergic eczema. The exact cause is unknown but is becoming more common.

It usually presents in childhood but 5% of cases may persist into adult life. A smaller percentage will develop asthma or hay fever in early adult life.

The condition has been largely screened out of the military pilot population, but cases can and do occur in the growing younger civil pilot population.

b *Treatment*

Topical steroids are only 'suppressive' not curative. Topical or systematic antibiotics may be needed to cure secondary infection. Antihistamines may be required in the acute irritating phases. It may be best to assess []the pilot or crew member [as temporarily unfit] until the acute phase is over. Hay fever or asthma, if it develops, usually responds to modern inhalers of local steroid bronchodilators and only rarely is depot steroid injection necessary.

4.2 Varicose eczema and ulceration

a *Symptoms*

This [disorder] is seen in older aircrew and is due to venous stasis. Varicose veins may be present, but there are other causes of venous incompetence, such as [post thrombotic syndrome]. A previous thrombophlebitis may predispose to this type of eczema. The [most common] site is the medial side of the lower leg above the malleolus. It usually begins with a red itchy scaly patch. In severe cases it may [ulcerate] and become infected.

b *Treatment*

It can be a serious problem in long haul aircrew. Changes in pressure and temperature do not help healing. A temporarily unfit assessment may be necessary with some investigation into the cause with doppler flow studies possibly leading to surgery as the only way to stabilise and cure the condition. Early varicose veins should be treated in all aircrew to prevent such eczema or ulceration developing. Many aircrew play down the importance of varicose veins and varicose eczema. The AME should always check [for the disorder] and see if there has been any change in any early varicose vein development.

4.3 Seborrhoeic eczema

a *Symptoms*

[This eczema] is confined to areas of maximal grease secretion – the scalp, eyebrows, moustache, naso-labial folds and ears. [Less frequently] the great flexures and central chest and back can become involved. Secondary infection is quite common. Most authorities now believe that Pityrosporum yeasts are the most significant trigger for the eczema. These yeasts feed on skin lipids and their numbers increase with humidity, after antibiotics and with lowered immunity. Predisposed individuals develop eczema in response to a high [amount of yeasts].

[]The term ‘seborrhoea’ can be misleading as it is not always present. Whilst the exact cause is unknown it can be precipitated by overwork, lack of sleep and fatigue.[]

It can be present as a diffuse scaly condition of the scalp or around the ears, hence the disagreeable appearance. It can also cause severe intertrigo of the axilla or groin areas with resulting pain, irritation and discomfort.

[The problem in professional aircrew is that it can disturb other crew and passengers.]

b *Treatment*

Topical steroids with anti fungal medication can be used with great success for intertrigo. The scalp eczema may resolve with the better ‘dandruff’ shampoos, zinc pyrethione, sulphur and imidazole containing shampoos curtail the yeast population.

[If the disorder] develops it should be treated as soon as possible. A temporarily unfit assessment may be necessary until the condition becomes socially acceptable in appearance.

The Intertrigo form tends to be seen in overweight aircrew, so weight control is important to prevent opposing skin surfaces from [rubbing on each other]. Proper laundry helps to reduce clothing abrading already affected areas. Handwashed underclothes in the Hotel sinks is a well known cause for the Intertrigo form of eczema.

4.4 Nummular eczema

a *Symptoms*

This form of endogenous eczema occurs in young and middle aged adults, particularly in those with dry skins. It can last for several months on the exterior surfaces of the limbs, occasionally all over the trunk but eventually tends to clear.

It can occur very quickly and the skin can [ulcerate].

b *Treatment*

This will require a temporarily unfit assessment until the [disorder] stabilises and dries. Steroid topical creams should be used. Return to flying status depends on the general skin condition and the routes flown. The skin condition will improve without extremes of temperature and humidity.

4.5 Pompholyx eczema

a *Symptoms*

This [disorder] is for some reason becoming more common. It is characterised by the skin bubbling either on the hands or feet. It can be aggravated by extensive sweating. It tends to occur in 'attacks' which run a self limiting course of two and four weeks. It can become chronic if not treated properly. Severe cases in aircrew can be very uncomfortable especially if affecting the hands, with extreme tenderness and skin cracking.

b *Treatment*

A temporarily unfit assessment in severe cases may be necessary with topical steroid and antifungal treatment. Antihistamines may be necessary if there is irritation. The usual precautions are necessary when taking antihistamines.

5 PSORIASIS

5.1 Symptoms

This is a common skin disorder which affects approximately 2% of all races at some stage in their life.

It is frequently seen in aircrew, and can run a life long benign chronic course. Chloroquine and its derivatives can some times precipitate or aggravate Psoriasis. [Aircrews requiring anti- malarials,] should always be asked about skin [disorders].

The [most common] age of onset is between fifteen and thirty years. Care must be taken in the selection of aircrew who may present with some form of the disorder at pre-employment or first [] medical examination.

What can be a minor condition can develop into a severe discoid type[. Whilst] it may not cause any physical limitation in younger aircrew, it could present a social problem from scaling, in appearance, or itching and scratching and so on.

Its distribution and presentation are well known. [[On] the knees, elbows and sacral region, this may be acceptable, but it can appear on the scalp or the hands. It may then be unacceptable until treated. The nails when affected may also not be acceptable for others to look at.

5.2 Treatment

It is not an easy condition to treat. Friction and scratching can worsen the condition. 'PUVA' cabinets have resulted in almost complete remission in some crew members. There are other drugs available which should only be given under the guidance of a Dermatologist.

Whilst a temporarily unfit assessment may be necessary in severe cases, very few people, [] have permanently lost their licence as a result of having psoriasis.

5.3 Psoriatic arthritis

Five [%] of psoriatics will go on to develop some form of arthritis. This is not a rheumatoid type. It is often referred to as sero-negative arthritis. The finger, knee and ankle joints are commonly affected.

[The diagnosis has to be made on clinical features and exclusion of other causes of arthropathy such as gout and systemic lupus erythematosus. There is often a family history of psoriasis.]

Treatment is non-specific in using NSAID's. A diet high in oily fish can give modest benefit. [Physiotherapy would also be needed to restore normal function.]

There are a few cases on record when the arthritis was bad enough to [prevent] flying. [It must also be stated that rarely 'Psoriatic Arthropathy' can occur without the skin lesions of Psoriasis.] In those cases treatment has to [produce] normal hand or leg function [before a fit assessment can be considered].

[]

6 PITYRIASIS ROSEA and LICHEN PLANUS

6.1 Pityriasis rosea

This annoying skin [disorder] of younger adults has a differential diagnosis which includes secondary syphilis, some forms of eczema, psoriasis and tinea corporis.

The herald patch always starts the condition but never on the face, always on the trunk. On direct questioning the pilot may admit a mild sore throat, malaise and feeling unwell. Within a few weeks other lesions begin to appear on the trunk, and can cover the trunk completely.

Apart from the appearance the condition is frequently symptomless. There may be some irritation. It runs a self limiting course and usually clears within six months.

No treatment has been shown to be of value, though itching may respond to sun exposure.

It is never severe enough to warrant a temporarily unfit assessment although in the severe phase the appearance of the [disorder] may be unacceptable for a few weeks.

6.2 Lichen Planus

This [disorder] is another of the papulosquamous eruptions of unknown aetiology. Whilst not as common as psoriasis, it does account for one [%] of all new cases seen in skin clinics. It affects young and middle aged adults of both sexes.

It appears as flat topped bluish shiny papules. It can appear on the arms or legs, therefore making it unacceptable on the grounds of appearance.

[i *Treatment*]

If left untreated it usually lasts for several months and then tends to disappear.

Topical corticosteroids are helpful in alleviating the irritation.

It can occur in the mucous membranes, the buccal mucosa being the [most common] site. This can cause diagnostic problems as it can occur around the vulva and vaginal mucosa.

The vast majority of these lesions will undergo spontaneous resolution.

7 FUNGAL INFECTIONS

7.1 Symptoms

[Disorders of the skin, hair and nails caused by fungus have become more prevalent in the last twenty years.] These are very common in aircrew, more so in long range crews visiting exotic places on a regular basis. []

[The common fungal infections include a number of similar organisms which target specific areas. Specimens of scrapings of skin toe nail clippings or plucked hairs should be sent to a good laboratory for culture in order to identify the fungus causing the disorder. and to verify the diagnosis.

Ringworm is a non medical term for fungus infections and the name is derived from a small inflammatory lesion which spreads out to form a ring-like skin pattern. The disorders that the fungus causes are referred to as 'Tineas', and can affect the feet (Tinea Pedis), the groin (Tinea Cruris), the body (Tinea Corporis), or the scalp (Tinea Capitis).

Tinea Pedis (Athletes foot) can -if severe -, cause pain and discomfort on walking and be a reason for a temporarily unfit assessment whilst treatment is initiated to cover the acute phase.]

Tinea Capitis affects the hair and the skin of the scalp. It can be unsightly and a reason [for a temporary unfit assessment and treatment] in the acute phase.

There are many types of fungal infection, most of which respond to the new oral antifungals. Many however will respond to topical preparations containing econazole/miconazole etc. Some preparations have hydrocortisone added to resolve the itching and inflammation caused by the infection.

Whilst such infections rarely require a temporarily unfit assessment for medical reasons, some can present as being socially unacceptable. If oral antifungals are used, care must be taken in aircrew with regards to side effects which can include headache, drowsiness and GI upsets. Photosensitivity has also been recorded. Terbinafine seems to cause far fewer side effects, but occasional patients experience nausea or urticaria. []

7.2 Treatment

[[This is best started with antifungal/hydrocortisone mixtures in creams and ointments. There are shampoo mixtures for Tinea Capitis.

Oral anti fungals may be needed if topical applications fail, or the condition is serious enough to warrant oral use initially.

7.3 **Tinea versicolor**

[Tinea versicolor (Pityriasis versicolor) is a fungal condition caused by *Malassezia furfur*.

It appears as [brownish] coloured patches on the upper trunk, the neck and the upper arms, which may coalesce to form confluent areas.

In sunlight the affected areas do not pigment [and appear as white spots (Pityriasis versicolor alba)]. It can be unsightly and therefore be a cause for a temporarily unfit assessment.

8 **CANDIDIASIS**

8.1 **Symptoms**

Candida albicans is a yeast. It most commonly affects the skin and mucous membranes, and rarely it can also cause systemic disease, such as gastroenteritis, endocarditis, septicaemia and meningitis.

Candidiasis is most frequently found in moist areas of skin. When it appears as intertrigo it often presents [with] erythematous macerated skin in the axilla, between the fingers, in the vulva spreading on to the buttocks and down the thighs. *Candida vulvitis* is a common presenting symptom of Diabetes Mellitus. [Candida infection of the oesophagus may be a symptom of a HIV infection.]

Ideally the diagnosis should be established by microscopy and culture.

8.2 **Treatment**

Oral treatment is now possible with single dose prescriptions. Topical remedies are effective and can be combined with a corticosteroid such as Hydrocortisone when pruritis is severe.

In its most acute cases the crew member should be assessed as temporarily unfit until the [disorder] is under control and without discomfort.

8.3 **Oral Mucocutaneous Candidiasis**

a *Symptoms*

Candida of the mouth is often referred to as 'Thrush'. It is more common with the advent of HIV infection. The appearance of creamy white patches on the mucous membranes of the mouth should alert the AME to a diagnosis of candida, but also be aware of any other underlying [cause].

b *Treatment*

A temporarily unfit assessment is necessary until the [disorder] improves with oral or topical anti fungals. Failure to improve requires further investigation.

8.4 **Candida Vulvo Vaginitis**

This type of problem is not uncommon in female aircrew and cabin crew. It can cause great pain and discomfort. The aircraft environment is not [favourable] for treatment, so the person must be assessed as temporarily unfit until the condition begins to improve and is comfortable. Remember [that this disorder] can be the presenting feature in Diabetes Mellitus.

9 VIRAL INFECTIONS

9.1 *General considerations*

The [most common] skin virus presents as warts. The virus affects the epidermal cell causing cellular proliferation and excess keratin.

Warts are, despite popular opinion, contagious. Warts occur almost anywhere, but commonly on fingers, feet, and ano and genital areas, and rarely on the face.

Warts can be unsightly on the hands and painful on the feet. Treatment is difficult and can cause considerable morbidity, fortunately natural resolution always occurs eventually.

Peri-anal and genital warts can be a cause of not only discomfort, but [even] embarrassment. The most effective method of treatment is to paint lesions with a 25 percent solution of podophyllin in spirit or tinct benz co.

9.2 **Herpes Simplex**

a *Symptoms*

This [disorder] has increased in its numbers over the last twenty years. It is characterised by a small group of blisters. The [most common] site is the lips (herpes labialis). It is usually preceded by a tingling or burning sensation and can be precipitated by an illness with a high fever (herpes febrilis) or []exposure to the sun or wind.

It can be unsightly on the face. It can cause pain and discomfort. Genital Herpes Simplex can be very uncomfortable and incompatible with the work environment in the acute stages.

b *Treatment*

Acyclovir has proved to be very useful if started at the initial outbreak.

In severe cases referral to a Dermatologist is necessary. The crew member must be assessed as temporarily unfit during this treatment phase as the condition is contagious.

If the condition does not improve in 5 to 10 days, deficiencies in the immune system should be considered.

9.3 **Herpes Zoster (Shingles)**

Skin lesions due to the herpes zoster virus tend to occur in the area supplied by one particular sensory root ganglion.

It commonly affects the thoracic nerves. If the ophthalmic division of the fifth cranial nerve is involved conjunctivitis and keratitis may occur in addition to the skin lesions. This is a condition requiring the crew member to be assessed as temporarily unfit immediately and treatment started as soon as possible. Referral to an Ophthalmologist may be required to monitor the effects on the eye.

In the otic form [(Zoster oticus),] in which the geniculate ganglion is involved, there may be an accompanying Bell's Palsy with lesions in the external ear and tongue.

Obviously the crew member must be assessed as temporarily unfit until the Bells Palsy has improved and any other complications have resolved.

Herpes Zoster accompanied by generalised chicken pox must be investigated as it can be the presenting feature in Hodgkins Disease, or Leukaemia, or deficiencies in the immune system. In such cases referral to the AMS [is] necessary [and] the crew member [should] be assessed as temporarily unfit for some time.

Herpes Zoster has one post skin eruption complication that can cause problems for aircrew. This is post herpetic neuralgia. The older the patient, the worse []the pain [can be]. Strong analgesics [or] even opiates may be necessary. If this is the case, then the crew member will have to be assessed as temporarily unfit until the pain has gone, which may be some weeks.

10 BACTERIAL INFECTIONS

10.1 General considerations

The [most common] bacterial skin infection is Impetigo, usually caused by staphylococcus aureus in colder climates, and B haemolytic streptococcus in tropical countries. Whilst it is predominantly a disease of children, it is quite common in the flying population. [The] latter infection can give rise to renal and cardiac complications.

It is therefore important to ground [], investigate and treat [these cases] as soon as possible. It is a highly contagious condition, which responds to topical and systemic antibiotics.

10.2 Beard Folliculitis (Sycosis Barbae)

Bacterial infection can cause folliculitis in the beard area. It is more common in Africans than Caucasians due to the shorter curling hairs growing back into the skin.

It can be very unsightly and aircrew so affected may need to be assessed as temporarily unfit whilst being treated.

10.3 Syphilis

a *Symptoms*

This disease is still very present in the world and is not uncommon amongst aircrew. It is covered elsewhere in the guidance material [(Chapter 8 Sexually transmitted diseases and other infections)] and in JAR-FCL Part 3 Appendix 7.

The only point to be made here, is that the AME must always ask about skin lesions. The AME must be aware of any reports of painless ulcers, a generalised psoriatic like rash, or [areas with] discrete papules, like viral warts. These are skin manifestations of primary and secondary syphilis. Tertiary Syphilis can be present as reddish brown lesions appearing in groups called Gummae, which are a mass of syphilitis granulation tissue, or as chronic interstitial glossitis.

b *Treatment*

Penicillin is still the drug of choice. It is the best, however, that this disease is treated and followed up in a Specialist genito-urinary Clinic.

11 [ERUPTIONS CAUSED BY MEDICATION (DRUG ERUPTIONS)]

Almost any drug/medication can produce a skin eruption. This may mimic most skin conditions or produce bizarre patterns of reaction [on] the skin. Any member of aircrew or cabin crew presenting with any skin condition no matter how obvious, must []be asked about having taken any medication, in the immediate past or at present.

Laxatives, tonics, pain killers, anti malarials [or any over-the-counter as well as any prescription medication] all count as drugs/medication[].

Some [] medication may have been taken for some length of time before a reaction occurs.

Despite a wide variation in pattern, below are some guidelines to suggest [, if] a drug/medication may be the cause [of a skin eruption].

- a It is frequently widespread and symmetrical.
- b It commonly appears as an inflammatory response with widespread itching.
- c It is often of sudden onset.
- d It can be associated with a constitutional upset, such as malaise or fever. Other organs may be affected.

Some drugs can cause specific patterns of skin reaction, as follows:

a *Urticaria and angioneurotic oedema*

Can be caused by penicillins and the salicylates. Other drugs causing urticaria include thiouracil, isoniazid, various vaccines, serums, and quinine.

b *Exanthem or morbilliform eruption*

This is a widespread macular erythematous eruption. It can be caused by Ampicillin, NSAIDs, gold, para-amino salicylic acid (PAS) phenothiazines and barbiturates.

c *Erythema multiforme*

This well recognised annular erythematous and vesicular [skin disorder] occurs predominantly on the exterior surfaces of the hands, forearms and feet. It is commonly caused by sulphonamides, tetracyclines and NSAIDs.

d *Photosensitivity*

This is important with aircrew visiting sunny climates. The acute erythematous eruption on exposed areas can in some cases cause blistering. It is caused commonly by phenothiazines, particularly chlorpromazine. Tetracycline is another cause as can be sulphonamides, quinidine and thiazide diuretics.

e *Blistering eruptions*

Large blisters can occur with sulphonamides, but they have been described after penicillin, NSAIDs and barbiturates [, too].

f *Purpura*

This is commonly seen on the legs. It can be caused by NSAIDs, quinidine and chloramphenicol.

g *Erythema nodosum*

These painful reddish indurated plaques usually seen on the front of the legs can be caused by sulphonamides.

h *Lichen planus-like eruptions*

These can be caused by [Beta- blockers], anti-diabetic agents and gold.

i *Acne*

Systemic corticosteroid therapy can cause acne. It can also be induced by iodides, phenytoin, steroids and in some cases the oral contraceptives.

j *Lupus erythematosus*

This syndrome can be induced by procaine amide and hydralazine.

k *Pigmentation*

Oral contraceptives can cause facial pigmentation mainly distributed on the cheeks and forehead. (Melasma)

l *Pruritus ani and vulvae*

These are a common complication of broad spectrum antibiotics and due to candidal overgrowth.

The diagnosis of these skin reactions is often difficult. Once a [] medication has been suspected of causing a skin reaction, it should be avoided, if possible. It may be necessary to assess [] the crew member [as temporarily unfit] in the acute phase and treat with systemic antihistamines. In several cases systemic steroids may be necessary. A temporarily unfit assessment may be mandatory in cases as severe as this, with reference to the AMS if the AME has any doubts about how long the condition will last or take to treat.

12 PEMPHIGUS (BULLOUS DISORDERS)

12.1 Symptoms

This is a Bullous disorder in which the predominant sign is blistering of the skin and mucous membranes. It is not common [and] can occur in early to middle age. It can be a serious condition, if left untreated. A temporarily unfit assessment is mandatory.

12.2 Treatment

This is always with high doses of systemic steroids. It is best handled by a Dermatologist under hospital/clinic conditions as the doses of steroid required are high.

There are other Bullous disorders which are fairly rare. All cases should be referred to a Dermatologist for full investigation. All aircrew should be assessed as temporarily unfit until a diagnosis is established. Referral to the AMS should be considered in all cases.

13 MALIGNANT CONDITIONS OF THE SKIN

13.1 General considerations

[Malignant] lesions can present aircrew [, AMEs, AMCs] and the AMS with a number of problems.

[Until] now, there were no separate rules and regulations to cover this group of [disorders]. It is hoped that by listing the various conditions, the management of these cases will be made easier. In all cases where any doubt exists, the diagnosis [has to] be confirmed by biopsy.

13.2 Basal Cell Epithelioma

a *Symptoms*

This [disorder] is sometimes referred to as a Rodent Ulcer. It is the [most common] 'malignant' tumour of the skin. It is more common in those aircrew who are exposed to high UV light conditions. The lesion is more frequent in fair skinned people. It is rarely seen in young people, occurring more in the middle aged group. If left untreated the lesion can erode deeper tissues causing serious ulceration problems later on in life.

It usually occurs on the face, the commonest site being below the eyes or on the sides of the nose. It has a pearly appearance, breaking down centrally to form bleeding crusts. Anyone presenting with a skin lesion about which any doubt exists should have it biopsied.

b *Treatment*

If the diagnosis of Basal Cell Epithelioma is made by biopsy then treatment should be started immediately.

Surgery is the treatment of choice offering a 95% cure rate. Other forms of treatment are not recommended in aircrew. Regular follow up should be maintained. There are no reasons for a temporarily unfit assessment [for] aircrew with this condition.

13.3 Squamous Cell Epithelioma

a *Symptoms*

This group of lesions is also considered to be part due to over exposure to UV light.

The [most common] site is the face, but this lesion can also affect the mucous membranes particularly the lips or tongue. Other sites are the backs of hands and ears.

It often begins as a small nodule with overlaying thick scale which becomes oval with a flat top. It can be unsightly which may be the first time an opinion is requested.

b *Prognosis*

This diagnosis should be established by biopsy and then the lesion treated by surgery.

There [would be] no reasons for assessing []aircrew with this condition [as temporarily unfit], [provided] the biopsy shows complete excision. If excision is not complete, further surgery is required. [However, all cases of squamous cell epithelioma in pilots require an unfit assessment. The AMS may consider a fit assessment, depending on size and depth of the lesion, provided the lesion is totally excised and there is an adequate follow-up]

13.4 Malignant Melanoma

a *General*

This can be a very serious condition. It requires the AME to be alert for any lesion he may see or [being] reported to him at routine examination, that may have suddenly appeared, any lesion that has changed in any way, become irritable, may bleed when touched, have an irregular shape or have a surrounding pigmented halo. The lesion may not always be pigmented. It can occur anywhere on the body surface but the legs have a relatively higher incidence in women and the trunk in men. Malignant melanoma usually, but not always, arise in pre-existing 'moles' [or naevi].

b *Prognosis*

Early 'thin' lesions are cured by surgery, but a percentage of patients with older 'thicker' lesions may develop distant spread (Metastases) (see [Chapter 17] Oncology).

c *Treatment*

This is surgical, usually by wide excision and graft if necessary. A temporarily unfit assessment is mandatory at this stage. Providing the biopsy shows a wide clear excision there [would] usually [be] no need to assess [the aircrew [as temporarily unfit] for more than it takes the excision or graft wound to heal. [However, all cases of malignant melanoma in pilots require an unfit assessment. The AMS may consider a fit assessment, depending on size and depth of the lesion, provided the lesion is totally excised and there is an adequate follow-up]. If secondary [lesions] occur, then a temporarily unfit assessment is mandatory. The treatment will vary if secondary [lesions] occur according to each particular case. The AMS must be notified [in all these cases and may consider a fit assessment depending on the individual case].

14 ACNE

14.1 Acne

Acne is now used synonymously with and has virtually replaced the term Acne vulgaris. It is essentially a disorder of adolescence but can persist into adulthood. It can present as a difficult social problem in young applicant aircrew.

Fortunately the new drug Roaccutane, derived from Vitamin A, has enabled dermatologists to cure even the most severe cases of cystic acne, and provided they are adequately treated such individuals need no longer be discouraged from flying.

14.2 Rosacea

This is a skin disorder of young and middle aged adults. It only affects the face and in some cases the eyes, in the form of Rosacea Keratitis, where there is pain and photophobia. There may be blepharitis, conjunctivitis, iritis and even episcleritis. It can become chronic. The [disorder] nearly always responds to Tetracycline taken for at least six weeks. Cases of this sort should be referred to the AMS for assessment.

15 LUPUS ERYTHEMATOSUS, SCLERODERMA AND DERMATOMYOSITIS

These three [disorders] are known as collagen diseases. Whilst they all have specific cutaneous appearances, there may also be systemic involvement.

a *Discoid Lupus Erythematosus*

Although confined to the skin, [it] can become a chronic problem, which may not require a temporarily unfit assessment, but should be managed through the AMS. It can be adversely affected by sunlight which may prevent someone continuing with a flying career.

Systemic LE presents with skin lesions in about half of those affected.

Such cases require a great deal of care and management. All cases should be assessed as temporarily unfit and referred to the AMS.

[A fit assessment] for Class 1 or 2 may be considered [, if] a period of remission has allowed the treatment to be stopped.

b *Scleroderma*

This can affect the kidneys, gastro intestinal tract and lungs. All cases should be assessed as temporarily unfit and referred to the AMS.

c *Dermatomyositis*

This is a disorder involving skin and skeletal muscle. In adults it is associated with internal malignancy in 50% of cases. All cases should be assessed as temporarily unfit and referred to the AMS. The prognosis is variable and [a fit assessment] may be considered where appropriate.

16 URTICARIA

This is an acute dermatological response [to various, sometimes unknown causes]. It is also called 'hives' or 'nettle rash'. It can be very severe and can be caused by drugs, foods, heat, cold, trauma, sunlight, plants etc. However, in many patients no cause is found. In general it runs a self-limiting course.

It can be a medical emergency if the tongue, pharynx or larynx are involved as the person may [be asphyxiated].

Any crew member suffering from this condition must seek urgent medical advice and receive immediate treatment. They may have to be assessed as temporarily unfit until the severe episode has passed and the effect of any antihistamine treatment wears off [(at least for the period of three half life periods of such a medication)]. A careful history must be taken to exclude a possible precipitating factor such as a particular drug which should be avoided in the future.]

There are several other forms of this type of erythema, one is Erythema Multiforme. This can present as mild or in a very severe form; Stevens-Johnson syndrome being one of the most important and severe.

A temporarily unfit assessment and hospitalisation may be necessary. The AMS must be informed. [A fit assessment] may only be considered after the [situation] has settled down.[]

17 CUTANEOUS PRESENTATIONS OF SYSTEMIC DISORDERS

These [disorders] will be discussed in detail elsewhere in this manual under the various subject headings. They are mentioned here, as some can present with skin lesions and should not be forgotten. These [disorders] can be serious.

a *Diabetes Mellitus*

An annular plaque lesion can frequently be seen on the front of the legs in developing Diabetes Mellitus. The lesion can ulcerate and be persistent. Full investigation is required.

b *Lipid Metabolism*

Deposits of lipids can result in the formation of xanthelasmata around the eyelids, or xanthomata on the elbows, knees or tendons.

Whilst the skin lesions are not serious, they may point to underlying problems. Full investigation is required.

c *Gout*

This painful condition of joints may present with skin tophi on the ears, hands and occasionally on the exterior surface of the joints. Further investigation is required.

d *Erythema Nodosum*

This is a distinct clinical entity. The lesions occur characteristically on the [anterior] surface of the legs below the knees. The lesions can be very painful and red. Immediate further investigation is required with a temporarily unfit assessment until the acute phase is over. [A fit assessment] may be considered [after the disorder] has settled down, if a cause can be identified.

e *Sarcoidosis*

This [disorder] can be diagnosed in a number of ways. In the skin characteristic fleshy smooth papules, nodules or plaques may appear. All cases should be referred to the AMS for consideration of [fit assessment].

f *Purpura*

This is a skin lesion resulting from a disorder of the blood or blood vessels.

Any case of purpura must be assessed as temporarily unfit and fully investigated. All cases should be referred to the AMS [for consideration of fit] assessment.

18 PARASITIC INFESTATION AND INSECT BITES

There are a number of [] skin [disorders] caused by parasites or insect bites which may be unsociable in aircrew and when seen or known about by others.

Personal hygiene must be emphasised

18.1 Scabies

This is a fairly common disorder [under poor socioeconomic conditions and it is] totally curable. It is caused by [a] mite (*Sarcoptes scabiei*) which can be passed from person to person [, if there is a close and intensive body-to-body contact . In] a close environment, such as crew bunks[, or by bed sheets or clothes the mites are transmitted only in case of very high density of mites].

The presenting symptom is nearly always irritation, with tiny tracks on finger webs, wrists, elbows, groins etc. [The disorder can] present with a generalised erythematous rash, or as discrete excoriated papules.

The most satisfactory way to confirm the diagnosis is to scrape a lesion and examine for a mite under a low power microscope.

Treatment is standard world-wide. [Insecticides like] Gamma Benzene Hexachloride, or pyrethrum should be applied to all the skin from the neck to the soles of the feet. [In most cases a single treatment is sufficient, it has to be repeated - only if necessary because of severity or recurrence - after a period of 8 to 10 days. Irritation may continue for a week or two.] It is important that

all contact persons - even those without symptoms - have to be treated as well;

the fingernails should be treated twice in a period of 8 to 10 days (mites can be transmitted by scratching to other areas of the skin);

bedsheets, towels, underwear etc. should be washed (> 60 ° C) other items should be ventilated for 7 days outside;

carpets, cushions, furniture etc. should be meticulously vacuum-cleaned and treated with insecticides.

Any member of aircrew should be assessed as temporarily unfit and treated.

18.2 Lice

There are three forms of this infection, head body [(also referred to as clothes lice)] and pubic lice. It is a socially unacceptable infection especially in aircrew. [The infection] can cause intense embarrassing irritation. [Lice are transmitted by close contact and] can be passed from [person to person in those] living or working in close proximity to each other. The diagnosis can be made by visual sighting of the lice [themselves or - in case of head lice their nits (encapsulation of the eggs attached to hair, size about 0,8 mm)].

Modern treatment can eradicate the condition within 24 hours. [Allethrin (Hexachlorcyclohexan), Malathion or Pyrethroids have to be applied for 30 minutes, the treatment has to be repeated after 8 - 10 days. It is important that

all contact persons - even those without symptoms - have to be informed and examined;

bedsheets, towels, underwear etc. should be washed (> 60 ° C) other items should be ventilated for 7 days outside;

carpets, cushions, furniture etc. should be meticulously vacuum-cleaned

Any member of aircrew should be assessed as temporarily unfit and treated.]

18.3 Insect bites

These can cause severe reactions in some people necessitating urgent medical treatment. Some bites can become quickly infected. Medical advice should always be sought preferably from someone with aviation medicine knowledge who understands the route structures and where in the world the aircrew may have been bitten. This can be important in the treatment of more severe cases, and where the reaction from the bite has taken some hours to appear.

19 PHOTO SENSITIVITY, UV EXPOSITION AND SUNBURN

This term is used to describe an abnormal response to UV irradiation. Photosensitivity can occur as a result of some drugs taken orally and in the condition called Porphyria. All cases of photosensitivity need investigation with possible referral to the AMS. If the cause is not found then certain restrictions may need to be imposed. Full recertification may not be possible.

The [most common disorder] seen in aircrew, which can give rise for concern, is sunburn. This can cause great pain and discomfort. []The desire to get a 'tan' can overcome knowledge [of the adverse effects of sun exposure and] that []exposure must be graduated [to prevent sunburn. The UV-exposure increases with decreasing geographical latitude and therefore increasing vicinity to the equator. It may further be enhanced by reflection (sea or snow).] Going to sleep in shadow can lead to a leg or an arm becoming exposed as the sun moves round. Painful sunburn can interfere with the safe operation of an aircraft [and furthermore result in a temporarily compromised immune system (e.g. resulting in Herpes labialis or upper respiratory infections)]. It must be prevented. Sunscreen preparations are available to reduce the likelihood of burning. Sunburn can prevent necessary useful sleep which itself can cause fatigue in aircrew. Over exposure over a long period of time can initiate wrinkling and atrophy of the skin, plus a number of associated disorders. Exposure to UV light can initiate [skin malignancies (see above). Several studies have shown that these malignancies are more common in aircrew. Therefore, regular indoctrination is necessary of all crew members to avoid UV-exposure and sunburn. Care and education are necessary for all aircrew.

20 TROPICAL DISEASES

There are really only three tropical diseases which need to be mentioned in this chapter, which are noted for the skin presentations. They are discussed fully in the chapter on Tropical Disease.

a Yaws

This is a tropical disorder caused by a spirochaete, not unlike syphilis. It has, like syphilis, three stages which can cause crusted lesions developing from a single spot. It can ulcerate in a later stage. Treatment by Penicillin is simple.

b *Cutaneous Leishmaniasis*

The problem with this tropical [disorder] is that it can take weeks or even months to develop. The aircrew affected may not recall where the [disorder] may have started. Bites [of sandflies (phlebotomes)] usually on the face or limbs, lead to long lasting nodules, which grow and ulcerate. It is also known as the 'Oriental Sore'. After a few months if secondary infection does not occur the sore may heal spontaneously leaving a depressed scar. It can recur. Diagnosis is best made by biopsy.

c *Leprosy*

This [disorder is] caused by []Mycobacterium [leprae] can be missed, because few European doctors think of the possibility. The disease can infiltrate the skin causing unsightly plaques and skin thickening. There are five or six different types of leprosy. Hypopigmentation of the skin can be a presenting sign.

Diagnosis is made by biopsy. Fortunately modern treatment can cure [this disorder] completely.

21 DISORDERS OF THE HAIR

Anyone [suffering] from acute hair loss should seek medical advice, as it can be manifestation of a more systemic problem. This is to be distinguished from []hair loss [due to normal ageing] (common baldness).

Excessive hair growth in women can be very occasionally the presenting symptom of an androgen producing tumour or some other endocrine disorder. Such cases need to be assessed as temporarily unfit and fully investigated.

22 DISORDERS OF PIGMENTATION

a *Vitiligo*

[Vitiligo is the most common] disorder of pigmentation. [It presents with] symmetrical patches of complete depigmentation e.g. eyelids, backs of hands, genitalia, knees etc. Whilst this [disorder] may be socially and cosmetically distressing, it rarely has any systemic cause.

b *Hyperpigmentation*

This tends to occur commonly after an inflammatory condition of the skin. It can however be found in more serious conditions such as Addisons Disease, Renal failure and a number of other serious conditions.

All cases should be assessed as temporarily unfit and fully investigated. The case should be referred to the AMS if there is any problem with the diagnosis or management. [A fit assessment may be considered, if] the [disorder] is fully [diagnosed] and under control.

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CHAPTER 17 - ONCOLOGY

1 INTRODUCTION

[1.1 Overview]

Every pilot who has been treated for malignant disease will need an individual assessment before returning to flying. Recovery from surgery or radiotherapy should be assessed. Current curative or adjuvant chemotherapy is incompatible with certification, and recovery from the effects of these drugs will demand a period of a temporarily unfit assessment after the treatment has finished. If the pilot has recovered from the primary treatment, and, as far as is possible with available techniques, there is no sign of residual tumour, then the level of certification will depend on the likelihood of recurrent disease. This chapter of the guidance material will explore [] assessing the risk to flight safety from air crew who have received treatment for malignant disease [].

[1.2 Disqualifying conditions]

[In addition to ensuring that treatment has been effective, pre-requisites for certification after treatment for malignant disease include satisfactory haematological parameters and no on-going side effects from therapy.

A history of malignant disease involving the central nervous system is disqualifying for certification.]

2 PRIMARY TREATMENT FOR MALIGNANT DISEASE

2.1 Surgery

Surgery is the commonest primary treatment for malignant disease, and is [] frequently the only treatment. A return to flying, from the purely surgical aspect, depends on the extent of the operation, and this can be conveniently broken down into minor, intermediate and major surgery. Examples of minimum times assessed as temporarily unfit for various types of surgery [] are shown in [Table 1].

Operation	Example	Minimum time assessed as temporarily unfit
Minor	Excision of mole Lymph node biopsy	1 week
Intermediate	Orchidectomy for testicular tumour	4 weeks
Major	Hemicolectomy for carcinoma of colon	12 weeks

Table 1: Minimum periods of temporary unfitness before returning to flying after surgery.

It is stressed that these are minimum times, and any more extensive procedures, or any complications with, for example, wound healing will extend these times.

The [Aeromedical Section (AMS)] may consider earlier recertification if recovery is complete, the applicant is asymptomatic and there is a minimal risk of further complication.

2.2 Radiotherapy

[Pilots should be assessed as temporarily unfit during any course of radiotherapy.] Radiotherapy treatment for malignant disease is usually given as an intensive course. The aim of this may be curative, for example to an isolated group of lymph nodes which have proved by biopsy to contain lymphoma; or as adjuvant treatment, for example to the abdominal nodes following orchidectomy for a seminoma of the testis, on the assumption that they may contain metastatic tumour. Since most courses are intensive, there is little time to fly even if the pilot wished to, but many patients undergoing radiotherapy suffer non-specific systemic effects (tiredness, malaise and nausea) which make it inadvisable for any pilot to fly whilst receiving this treatment. Apart from physical symptoms there are often psychological effects and worries associated with radiotherapy, which, in common with chemotherapy, may also affect flying ability.

2.3 Chemotherapy

Pilots should be assessed as temporarily unfit during any treatment with chemotherapy. All these drugs are toxic to normal cells, and in particular to rapidly dividing cells in the bone marrow. During chemotherapy the patient is routinely tested for normal blood levels such as haemoglobin, and this should serve as a reminder both to the pilot and his AME that there are potential risks if he enters a hypoxic environment. A temporarily unfit assessment applies to curative chemotherapy, for example in the treatment of disseminated lymphoma, and also to adjuvant chemotherapy, for example in drugs given to prevent the possible recurrence of colorectal cancer following surgical excision. The latter treatment may extend over a prolonged period of time, and there may well be a conflict between the 'medical' advice to have the adjuvant treatment and the pilot's desire to regain a medical certificate to fly. The only exception to a temporarily unfit assessment during adjuvant treatment for malignancy is endocrine therapy. Certain adjuvant hormone and anti-hormone treatment following (for example) breast [or] prostate cancer treatment may be acceptable if there are no side effects.

[2.4 Stem cell transplantation]

It is possible to return to flying after stem cell transplantation providing there is sustained remission.

3 CERTIFICATION AFTER PRIMARY TREATMENT []

3.1 Defining acceptable risk

In this discussion the assumption is made that the primary treatment (be it surgery, radiotherapy, chemotherapy or a combination) has removed all signs of tumour X measured clinically or by investigation. The risk to flight safety is now the possibility that local or metastatic recurrence will cause sudden or subtle incapacitation whilst the pilot is flying[].

The concept of 'acceptable risk' has been discussed elsewhere, and much work in aviation cardiology has defined a the current risk of incapacitation of up to 1% per year to be acceptable for two crew professional and unrestricted private flying. This can also be applied to certification after treatment for malignant disease. One difference between cardiology and oncology is that with the former, once the risk has been defined and certification achieved, the pathological condition is not likely to go away. After treatment of malignancy however, the prognosis [usually] improves with recurrence free time away from the original episode. Thus to consider the full range of certification possibilities, from no certificate to unrestricted Class 1, and including Class 2 certification for private flying, acceptable incapacitation risk levels have to be defined.

In this discussion the following annual incapacitation risks will be used to define the appropriate certification. It should be noted that the exact levels for restricted Class 2 certification (private flying with a safety pilot) have never been defined. [For single crew professional flying a figure of 0.1% has been empirically quoted and is a reasonable basis given that it is an order of magnitude less than the maximal acceptable multicrew figure and is the approximate cardiovascular risk of

men in their 40s (Table 2).] For the purposes of these calculations a [5%] annual incapacitation risk has been taken as the upper limit [for restricted private flying].

Risk per year of incapacitation	Acceptable level of certification	Licence
Less than 0.1%	Any	Any
Between 0.1% and 1%	Class 1 restricted ('OML') Class 2 unrestricted	2 crew professional Solo private
Greater than 1%	No Class 1 Possible Class 2 restricted ('OSL')	No professional Private with 'Safety Pilot'

Table 2: Certification possibilities according to acceptable risks of incapacitation

Thus if an incapacitation rate per year can be derived for tumour X at any particular time away from its original treatment, then an acceptable level of certification for that pilot, at that time, can be calculated from the table above.

Following 'successful' primary treatment, the risk that tumour X will cause a subtle or sudden incapacitation depends on two factors. The first is the actual risk of recurrence, which will depend on the pathological stage of the tumour or its TNM classification (Tumour Node Metastasis). The second is the site of that recurrence, and this will depend on the primary tumour type. These two factors will now be discussed individually, again in relation to a hypothetical tumour X.

3.2 Defining the risk of recurrence

The annual recurrence rate of tumour X can be calculated from survival curves. Ideally these should be 'recurrence free' survival curves, but those are often not available, and thus simple survival data will need to be used. However, unless it is possible to cure many patients once their tumour has recurred (not a common situation) then the two curves will be very similar in shape. [Figure 1] shows a hypothetical five year survival curve for tumour X, and is used to show the usual representation of this type of data. It includes percentage figures along the curve showing the recurrence rates for each of the five years following treatment.

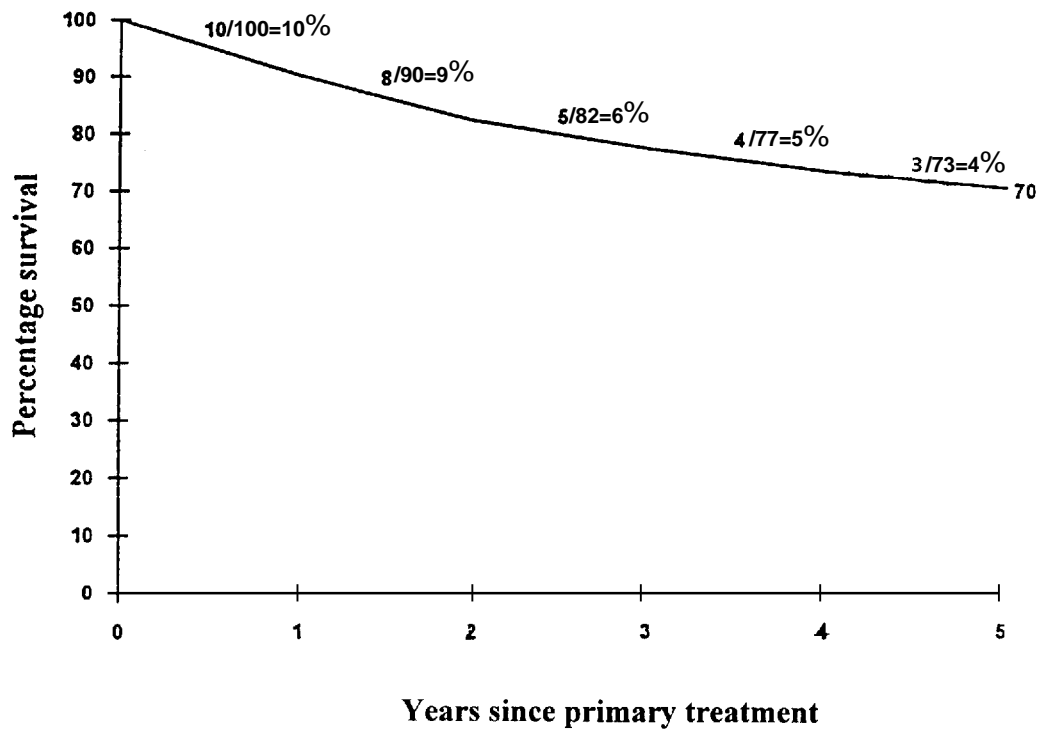


Figure 1: Overall five year survival after primary treatment for tumour X.

The graph represents the recurrence rates for all cases of tumour X. [These] data however, include a large spectrum of recurrence rates from very low (early stage disease) to very high (late stage disease). [To illustrate the effect of different stages on prognosis it is assumed that tumour] X lesions can be divided into three types, or stages, based on the pathological examination of the resected specimen.[]

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Studies have shown that the prognosis following surgical treatment for tumour X is related positively with the stage of the tumour at operation. Thus the previous overall five year survival curve of tumour X can be broken down into three separate curves relating to the three separate stages as shown in [Figure 2]. As would be expected, the more advanced stage tumours (stage 2 and 3) have a worse prognosis than early lesions.

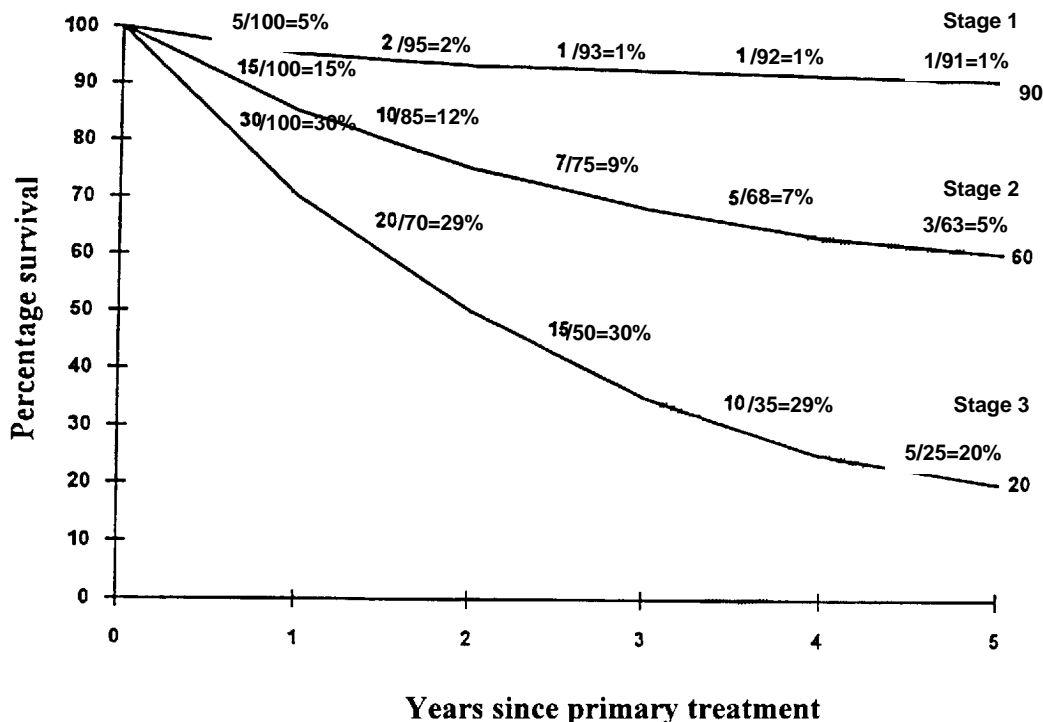


Figure 2: Five year survival for Tumour X divided into pathological stages

From the data in [Figure 2] it is possible to derive a yearly percentage risk of recurrence for any stage of tumour X. For instance, the risk of a recurrence between 2 and 3 years after surgery for a stage 2 tumour is [9 %].

3.3 Defining the site of recurrence

Each tumour has its own particular sites of recurrence, and these have been recorded in pathology textbooks since [they] were first written. Although metastases can occur in any part of the body, the majority are found in the organs listed in [Table 3].

[]

Site	Incidence
Local and lymph nodes	60%
Liver	20%
Lung	5%
Bone	5%
Bone marrow	0%
Brain	10%

Table [3]: Incidence of metastasis by site

[The percentage incidence figures in Table 3 are examples for the theoretical tumour X.] Ideally [these] data should relate to the incidence of a ‘first recurrence’ at these sites. This, however, is often difficult to find in the literature. Figures for the incidence of metastases in various organs at post-mortem is more easily obtained, and in some tumours an extrapolation from this data may be necessary to obtain a ‘first recurrence’ incidence.

3.4 Defining the risk of a particular metastasis causing incapacitation

A first recurrence in a regional lymph node carries a very small risk of incapacitation. A brain metastasis however, as the first indication of recurrent disease, [is assumed to] carry a 100% potential for sudden incapacitation in the form of a fit or seizure [or other neurological event such as paresis, sensory loss or headache]. Metastatic disease in bone marrow can cause anaemia and bleeding disorders. Rarely metastases may erode major vessels with catastrophic consequences (lung and liver). The risk of subtle incapacitation is harder to quantify, but it must be assumed that any recurrence of any tumour will degrade the operational abilities of air crew [] to some extent.

Thus a table of ‘incapacitation weighting’ can be constructed to give [an estimate] of the potential for sudden and subtle incapacitation by a recurrence at each metastatic site. This is shown in [] [Table 4].

Site	Incapacitation ‘weighting’	[]
Local and lymph nodes	5%	
Liver	5%	
Lung	5%	
Bone	5%	
Bone marrow	20%	
Brain	100%	

Table 4: Incapacitation weighting

3.5 Defining the total risk of incapacitation

Three parameters are now known about tumour X, and these can be used to [estimate] a ‘total’ risk of incapacitation. They are:

- The recurrence rate per year for any stage of tumour X (as a percentage).
- The frequency of metastatic disease in a particular organ (as a [percentage]).
- The risk that a metastasis in a particular organ will cause incapacitation (as a [percentage]).

A formula can now be derived to calculate the total risk of a particular metastasis causing incapacitation [in any year after completion of primary treatment]. The example below is for brain metastases.

Tumour X recurrence rate (%)	X	Incidence of brain metastases (%)	X	Risk of a brain metastasis causing incapacitation (%)	=	Incapacitation risk for brain metastases in tumour X (%)
------------------------------------	---	--	---	--	---	--

Using the figures that we have obtained, numbers can be put to this formula. The tumour recurrence rates per year are from **Figure 2**.

Year 1 / Stage 1 : 5% X 10[] % X 100[] % = 0.5% risk of incapacitation

Year 1 / Stage 2 : 15% X 10[] % X 100[] % = 1.5% risk of incapacitation

Year 1 / Stage 3 : 30% X 10[] % X 100[] % = 3.0% risk of incapacitation

In the first year, therefore, the risk of incapacitation due to brain metastases ranges from 0.5% to 3.0%. This would allow a range of certification as shown in [Table 5].

YEAR 1 – BRAIN METASTASES			
Stage	Incapacitation risk	Professional certification	Private certification
1	0.5%	‘As or with copilot’	Unrestricted
2	1.5%	None	‘Safety pilot’
3	3.0%	None	‘Safety pilot’

Table 5: Range of certification possible in first year after completion of treatment

By year 5 the prognosis has improved and so have the incapacitation risks. Again the tumour recurrence rates are taken from **Figure 2**.

Year 5 / Stage 1 : 1 % X 10[] % X 100[] % = 0.1% risk of incapacitation

Year 5 / Stage 2 : [5] % X 10[] % X 100[] % = [5] % risk of incapacitation

Year 5 / Stage 3 : [20] % X 10[] % X 100[] % = [2] % risk of incapacitation

In the fifth year the risk of incapacitation has now fallen to between 0.1 and [2] %. The range of certification has also improved, as shown in [Table 6]:

YEAR 5 – BRAIN METASTASES			
Stage	Incapacitation risk	Professional certification	Private certification
1	0.1%	Unrestricted	Unrestricted
2	0.5%	‘As or with co-pilot’	Unrestricted
3	2%	None	“Safety Pilot”

Table 6: Range of certification possible in fifth year after completion of treatment

Obviously other types of recurrence are possible (and indeed more likely) than brain metastases, but because of the ‘incapacitation weighting’ given to each anatomical recurrence, brain lesions contribute most to the total risk of incapacitation. [The combined risks of several sites of recurrence may need to be taken into account].

3.6 Presenting the total risk of incapacitation

[A table can be used to show the type of certification possible depending on time since completion of primary treatment and stage (Table 7):

Stage	Year since completion of primary treatment				
	1	2	3	4	5
1	0.5% (5%x10%x100%)	0.2% (2%x10%x100%)	0.1% (1%x10%x100%)	0.1% (1%x10%x100%)	0.1% (1%x10%x100%)
2	15%x10%x100% =1.5%	12%x10%x100% =1.2%	9%x10%x100% =0.9%	7%x10% x 100% =0.7%	5%x10%x100% =0.5%

Table 7: Certification possibilities according to stage and time since completion of treatment

This can be displayed graphically as in Figure 3:

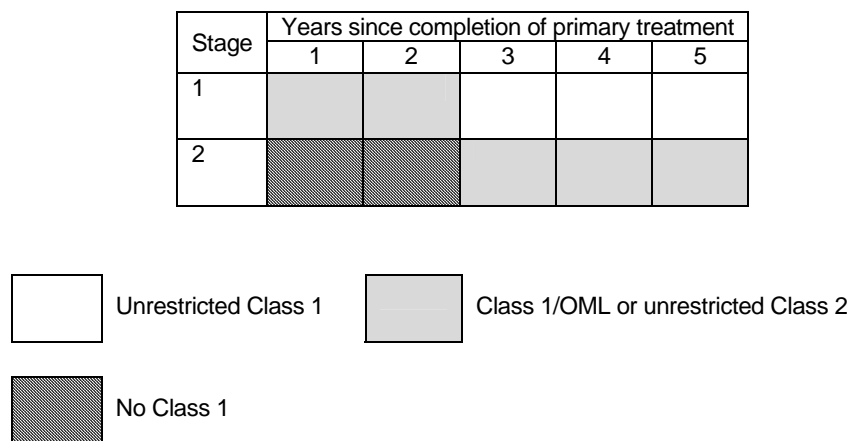


Figure 3: Bar chart representation of certification possibilities according to stage and time since completion of treatment]

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3.7 Using certification assessment [charts]

[It must be emphasised that charts are only for guidance and that aircrew with tumours that have a number of additional good prognostic factors may be returned to flying earlier than the ‘average’ example demonstrated by the chart. Conversely if adverse prognostic factors are present there may be a further delay before recertification.

The charts are based on published survival statistics following treatment for a particular type of tumour and may need revision if new therapy is introduced or the results of new studies become available. States can develop their own charts as guidance for the more common tumours based on the local prognostic factors and treatments used. Studies used to calculate the certification assessment figures may use overall, event-free or disease-free survival, and may include subjects unrepresentative of a pilot population (in terms of age, sex, country of residence, lifestyle and other variables) and may include cases where curative treatment has not been attempted. Individual case assessment therefore remains paramount.

These charts are useful for tumours that have a prognosis that improves with time. Some malignancies have a long median survival time of 10 years or more but the rate of progression remains relatively constant with time. It may be possible to maintain certification in this situation provided the licence holder remains asymptomatic, is not on active treatment and is reviewed regularly.]

3.8 Tumour Markers

[The relapse or active progression of certain tumours may be effectively followed by measuring tumour markers. The most common example in pilots and controllers is adenocarcinoma of the prostate where levels of Prostate Specific Antigen (PSA) can be tracked over a period of time.

Analysis of the tumour marker is very useful in determining the risk of relapse for an individual and it is inappropriate to use a certification assessment chart where this alternative type of targeted risk assessment is possible.]

[]

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CHAPTER 18 – TROPICAL MEDICINE AND TRAVEL MEDICINE

MEDICAL ADVICE FOR AMES, CONCERNING FLIGHT OPERATIONS IN TROPICAL AREAS

1 Introduction

1.1 Definition of the tropics

The Sun, spherical shape and rotation of the earth result in characteristic meteorological phenomena. Because the transmission of solar energy to the earth depends on geographical latitude (the higher the latitude the lower the transmission), air circulation systems build up. At the equator, air is lifted up, resulting in areas of low pressure. The humidity precipitates as heavy rain. With higher latitudes less energy reaches the ground, the dry air sinks down, and areas of high pressure are formed.

The areas of low pressure around the equator (between 23,5 ° North and 23,5 ° South) are described as the tropics, the areas of high pressure to the North and South as, Subtropics. With high solar radiation (as in summer) the continents are warmer than that of the oceans, areas of low pressure and sea wind are typical, the latter transporting humid maritime air resulting in monsoon rains. The tropical and subtropical climates result from these conditions. Where there is high temperature and high humidity, high precipitation results, giving rise to rain forests in the tropics. Very low precipitation with a dry and desert climate is typical for the subtropics. To the North and South more temperate climates result.

1.2 Medical stress factors in the tropics

Not only geographic location and climate relate to possible health effects in areas outside the temperate zones. Therefore, the standard of development and life standard have to be considered as well. Regarding these facts medical advice given here is not restricted to the tropics proper but to Subtropics as well. On the other hand, some tropical countries have health systems similar to industrial countries and pose much less risk.

Medical stress factors in the tropics can be caused by the climate, factors related to travel (jet lag, means of transport etc.), and insects (because of the warm climate). These insects can act as vectors of diseases. Other factors can be the low standard of hygiene, infectious diseases, socio-economic problems and psychosocial stress.

The **climate** – a humid and hot tropical, more than a dry and hot subtropical climate – can be a significant stress factor. Sufficient fluid intake, protection against solar radiation, suitable clothing etc. should be recommended.

Because of economic constraints **the standards of hygiene** are mostly lower than in temperate climates. The means for treatment of drinking water and sewage are very often not adequate.

High humidity and warm to hot temperatures are favourable conditions for a large variety of **insects**. These can act as vectors of several diseases.

The unfavourable conditions caused by the environment, can result in a host of **infectious diseases** typical for, or very common in the tropics. The worldwide mortality from tropical diseases is estimated as 22 million people.

The risk of acquiring infectious disease is more likely whilst travelling abroad, but it depends on the kind of travel and activities undertaken. This also applies to the kind of disease acquired. Of the various health problems that may occur in some tropical zones, 15 to 25 % of these disorders may be caused by tropical diseases or certain other types of infectious diseases more common in the tropics than in temperate zones. The most frequent infection acquired is traveller's diarrhoea. Next come infections of respiratory tract, malaria, and Hepatitis A. Giving advice to flight crews about malaria, Hepatitis A and B, yellow fever and travellers diarrhoea, is most important.

There are a lot of **psychosocial stress** factors that can affect people who are travelling abroad. One is staying away from home for long time (e.g. flight crews stationed abroad). Other types of stress may result even from being away only for a short time.

There may be intercultural conflicts, unfamiliar working situations, living in strange surroundings, being in the company of strangers from an unfamiliar cultural heritage (socio-cultural factors), foreign languages, a bad infrastructure plus the problems that can occur in every-day-life. These may result in anxiety and phobic disorders. Cumulative stress may result in burnout, alcohol abuse etc. Alcohol consumption is easier abroad because the normal social control is absent. Where a longer stay abroad is intended, addiction disorders, alcohol abuse, psychiatric disorders etc. should be excluded.

Psychiatric disorders have to be considered in any counselling. Up to 25 % of the population, could possibly experience, at least one relevant psychiatric disturbance in a lifetime. Being confronted with a host of stress factors, may lead to such an event being more likely to happen. Anxiety and psychotic disorders may often appear together. "Abroad" neurosis and psychosis can manifest itself as well. When a depressive disorder or psychosis is diagnosed, the side effects of Mefloquin medication (malaria chemoprophylaxis and/or treatment) have to be excluded. In divers, a similar disorder may be caused by decompression sickness. Anoxia can also cause similar symptoms. Exogenous psychosis has to be taken into account. Alcohol abuse can also be a clinical sign of an underlying anxiety disorder.

2 Medical Travel Advice

Medical Travel Advice for Flight Crews

- Information about the relevant risks in the proposed area to be visited

- Information about,
 - General precautions
 - Hints for behaviour abroad
 - Malaria prophylaxis

- Information about vaccination

- Information about personal protection

- Information about medication for self therapy

Those who are physically and mentally fit, acclimatise more easily for service in tropical climates. The traveller should abstain from visiting the tropics, if they have any existing disease, which the tropical climate may exacerbate.

The medical travel advice has to minimize the risks of staying in the tropics by informing the traveller of the problems and possible precautions. If possible, 4 to 6 weeks should be allowed to start any prophylaxis. This will allow a build up of sufficient immunization status. **Flight crew should be informed about the risks in tropical areas and have the appropriate vaccinations before starting any flight duties in these areas.**

The medical travel advice should be individual and not schematic. It is primarily intended for flight crew and is directed to cockpit and cabin crew. It has to differentiate depending on the kind of duties and activities undertaken such as, staying in the tropics for short layovers, or for a long-time stationing, staying in crew hotels or compounds, undertaking adventure trips of short or long duration etc. Furthermore, individual factors such as intelligence, readiness for risks, general views (e.g. aversion against remedies), experience, individual disposition (age, diseases etc.) have to be taken into account. The doctor giving the advice has to find out about the persons planned activities such as cross country walking, climbing, diving, actual health state, possible allergies possible immune defects, vaccination state, previous malaria chemoprophylaxis including tolerance, possible or even planned pregnancy etc. Epidemiological data, the time of travel (rainy or dry season), the climate at the destination, have also to be considered. The possibility of a lower standard of medical care being available at the tropical destination should also be taken into account.

Risks and prophylaxis must be objectively presented, with matter-of-fact information about the possible dangers, so that the traveller can decide. Exaggeration should be avoided. The "need to know", has to be differentiated from the "nice to know". Written information can complete, but not replace the spoken information.

Medical travel advice depends on

- Destination
- Time of travel
 - Duration of travel
 - Character of stay (short layover/long stay), short or long adventurous trips, or only staying in crew hotel, close contact with local population)
 - Climate
 - Epidemiological data

Individual Factors in medical travel advice

- Personality, general view, intelligence, readiness for risks
- Experience
- Particular activities planned
- Age, physical and mental condition, individual disposition (previous or actual diseases, allergies, medication)
- Vaccination state
- Tolerance of previous malaria chemo-prophylaxis
- Actual or even planned pregnancy

3 Medical Travel Prophylaxis

Medical Travel Precautions:

- | | | |
|-----------|--------------------------------|--|
| 1. | Exposure prophylaxis | <ul style="list-style-type: none"> - General recommendations - Protection against sun and climate - Food and beverage hygiene - Protection against insects |
| 2. | Vaccination Prophylaxis | <ul style="list-style-type: none"> - Active (and passive) vaccinations |
| 3. | Medical prophylaxis | <ul style="list-style-type: none"> - Malaria chemo-prophylaxis - Prophylaxis against [travellers'] diarrhoea (only exceptionally!) |

3.1 Exposure prophylaxis – general recommendations

Exposure Prophylaxis is avoiding those factors, which may cause or [deteriorate] health problems. It is the basis of all the precautions and prophylactic means against any disease, which can exist in the tropics and subtropics.

In the context of exposure prophylaxis, swimming and wading in tropical ponds, lakes or rivers should be discouraged (there is a danger of infection with schistosomiasis) as well as walking barefooted on beaches etc. (infection with ankylostoma). Wearing adequate footwear on the ordinary beach, or in the calm waters of exotic beaches, can protect against such infections such as ankylostoma, and the stings of maritime fauna (sea-urchin, stingray, corals). The inexperienced traveller may fear snake-bites. These and bites of scorpions are extremely rare, under normal travel arrangements.

Respiratory Tract Infections are often underestimated. Nevertheless, they remain the second-most common health disorder contracted abroad after travel diarrhoea. The reasons can include the change of climate, moving between hot and humid conditions outside, to the cool air in rooms with air-conditioning, cool draughts in cars and public transport, as well as temporary immune suppression due to sunburn. Dust and dirt from city streets are also main contributory factors. Exposure prophylaxis can be very important, if this type of problem is to be avoided.

Intensive **solar radiation** in low latitudes and altitude, reflection from water and snow surfaces, can result in significant UV exposure to the skin and eyes (More care is required in the southern hemisphere, where there is greater UV exposure due to the ozone gap). Acute dangers are photo-dermatitis, which causes

sunburn, and can lead to meningeal irritation. In extreme cases, cerebral oedema may occur, in combination with excessive heat emission. Sunstroke can occur, with keratitis, conjunctivitis, snow blindness in mountain areas, and temporary immune suppression. The chronic consequences can result in skin tumours, accelerated aging of skin (due to destruction of elastic fibres), chronic photo-dermatitis and cataract. Adequate sun protection must be afforded, especially during the strongest exposure around noon time, by using the appropriate clothing, by wearing sensible headgear and by using sun cream with a high sun protection factor (at least factor 20) and minimizing the time of exposure. The so-called sun blockers should be water resistant and contain a high percentage of micro-pigments). The use of sunglasses is important.

There are many **skin disorders** that can occur abroad due to the climate. Increased sweating may result in Pityriasis versicolor, intertriginous excema and mycosis (fungal infections) of the skin. Therefore, cotton underwear and clothing, frequent cold showers and possible local therapy with anti-mycotics should be recommended. Superficial skin injuries, insect stings and bites can lead to super infection and inflammation etc. Ulcers can occur due to bad hygienic conditions, or contact with sea- water. Local therapy with anti-mycotics, antibiotics etc. may be helpful.

Some travellers suffer from constipation at the beginning of their stay abroad. This is mainly due to the fluid intake being too little or changing the nutrition. Stool consistency decreases with continued residence. The use of laxatives is not usually necessary („Travelling can expand the mind and loosen the bowel.“)

Furthermore, an appropriate **medical kit** should be recommended. The contents depend on the duration, the destination and the kind of travel, as well as on the traveller's individual situation.

After a certain time, or after termination of a longer stay abroad, or on clinical indication, a routine medical examination should be carried out. This should include an examination for intestinal parasites

The **teeth** should be checked and made good, especially before longer stays abroad. On one hand dental care is not guaranteed everywhere, on the other hand, tooth pain may greatly reduce the well being of a person. Inflammation or infection of a tooth may result in barodontitis. This condition can be very painful and can occur when the pressure of the cabin changes. **Inflammation or infection of the teeth makes aircrew unfit for flying duties.**

General recommendations when staying in the tropics

- Protection against solar radiation (sun blocker, sun protection factor at least 12), sunglasses, headgear/hats
- Fair coloured, light, loose fitting clothing out of natural fibres
- Appropriate fluid intake (at least 2 to 3 litres daily,) a good guide may be the colour of urine. The colour should be a pale yellow and not dark yellow.
- Air conditioning (bedrooms should be cooled down before entering, switch off A/C at night)
- No skin penetrating procedures (piercing, tattoo, chiropody)
- No swimming in freshwater (lakes, ponds, rivers) and sea- water, near settlements and sewage dumps
- No barefoot walking at beaches
- No touching of animals
- The advice of local people should be taken.
- Do not believe advisers who trivialize the potential dangers
- Care must be taken to avoid violent crime (no open valuables or money, "low profile" clothing, no jewellery or very expensive watches should be displayed
- Make enquiries from local people about safety issues. Do not go out alone. Avoid provocative behaviour, only small amounts of money should be carried.
- Do not play the "hero", have a small bill at hand for possible assailants, better losing some money than your life
- Take care with food, beverage and general hygiene
- Ensure local protection against insects

- Always take care. Never relax!

3.2 Special considerations for Flights on short notice

Flights on short notice, can pose special problems. Frequently, the time until departure is too short for the appropriate preparation, because flight and destination may have been planned at the last-minute. Often, travel advice is totally ignored. Furthermore, the time for immunizations is often too short. Therefore, all prophylactic means may become disregarded.

This possible outcome has to be prevented. For flights on short notice a thorough briefing has to be carried out. General preventative means, food, beverage and personal hygiene as well as malaria precautions can be followed even on these kinds of flights. Boosters of most vaccinations and appropriate immunization may be possible as well.

Where there is a possibility that flight crews may have many of such types of flight, they should be briefed and immunized before they should be engaged in flights to tropical areas. Maintaining vaccination status and carrying sufficient Chemo-prophylaxis for malaria can be delegated to crew members themselves.

4 Vaccinations

4.1 General Considerations

Vaccination is the most efficient means of prophylaxis for a number of infectious diseases. Vaccination is generally effective and well tolerated. Therefore it is one of the most efficient medical measures to hand. The individual is protected and the public are protected, because the vaccinated person cannot transmit the respective disease any more.

Flight crews are unfit for flight duties for at least 24 hours after a vaccination.

4.1.1 Information and Documentation

Vaccination requires personal informed consent. The person to be vaccinated has to be fully informed about the vaccination in sufficient time prior to a planned vaccination. The information should include a description of the disease to be prevented, and its treatment (What kind of vaccine is it? What if any, are the benefits, both individually and collective. What are the contraindications, possible side effects and what could be the complications. What is the duration of immune protection being given by the vaccination? What boosters will be required? What is the recommended behaviour after the vaccination?). All the information given should be documented and show that written consent has been given.

After any vaccination, the date, type, manufacturers-number, stamp and signature of the vaccinating physician has to be written down on the appropriate document (The international vaccination certificate of the WHO is one recommendation.). Any missing documentation of any former vaccination, prior to a booster vaccination, should not delay or even exclude a planned vaccination. A probable booster vaccination over and above the basic scheme does not normally have any side effects.

4.1.2 Side effects and complications

Slight erythema, swelling and pain are not uncommon at the site of the inoculation. There may be a slightly elevated body temperature in the first three days after vaccination. This is common and of no consequence. An antipyretic can be prescribed, where this might be anticipated.

Allergic reactions and anaphylactic shock are only rare complications. Nevertheless, these reactions should be anticipated. Emergency equipment and emergency drugs (injections such as Adrenaline injections of 1 -1000, Glucocorticoids, H1 and H2 blocking agents, Aminophylline, as well as Beta-agonist aerosols) should be on hand to manage anaphylactic reactions. Those who have been vaccinated should stay under medical supervision for 30 minutes after vaccination.

4.1.3 Scheduling vaccinations

The immune protection afforded by vaccinations, should be completed prior to flights into tropical areas. The onset of the effect of the respective vaccination has to be taken into account. The briefing and vaccinating physician, has to check whether a basic immunization or a booster immunization is required. For a **basic primary immunisation schedule**, a certain number of inoculations have to be performed, over a certain period of time. **Booster immunisations** have to be performed at certain intervals after a basic programme, to prolong the immunization protection. Should the interval between the inoculations of the primary schedule, or the maximal interval between basic and booster immunization be exceeded, a new basic schedule should **not** be started all over again, the required booster can be given without any profound side effects. There are no maximal intervals between vaccinations either. Every inoculation counts. Every tropical medicine briefing, should be used to check the immunization status for Tetanus, Diphtheria and Poliomyelitis, etc. With children, the immunization status for measles, rubella, mumps etc should also be checked.

Scheduling inoculations, of a primary immunization programme, the minimum interval, until onset of effectiveness of the respective vaccination, has to be taken into account. The immunization schedule should be completed in good time, prior to the flight to tropical area. A sufficient **protection** builds up about 10 – 14 days after last booster inoculation, or the last inoculation of a basic schedule. The vaccination programme has to be scheduled respectively. A certain minimum time for a programme, prior to the flight, has to be taken into account. This should not be misinterpreted. No vaccination should left out or missed. If there is any doubt, it is better to travel having been given a vaccination, which is not yet fully efficient, rather than not having been vaccinated at all.

Minimum interval between vaccination and departure into tropical areas for important vaccinations (modified from Hartmann P (2000): Fast prophylaxis for last-minute travelers. Which measures are still possible 1 week before traveling? MMW Fortschr Med 142 (20): 28 - 30)

Kind of vaccination	Time interval prior to departure*
Tetanus, Diphtheria	Possible until departure
Polio	Possible until departure
Hepatitis A	Possible until departure
Hepatitis B	3 – 4 weeks
Typhoid	1 – 2 weeks
Yellow Fever	10 days

* Flight operations should not be carried out for 24 hours after vaccination

If different vaccinations have to be given at the same time, live vaccines can interfere with one another. Therefore live vaccines should be given either on the same day or with a minimum interval of four weeks. The vaccinations for Yellow Fever, Measles, Mumps, Rubella, Oral Poliomyelitis Vaccine and the BCG, are in this group. The oral live vaccine for Typhoid does not require any minimum interval. Live vaccine status, can however be jeopardized by immuno- globulins. Therefore live vaccines should not be given before 90 days after the inoculation of immune globulins. Vice versa after live vaccines, a certain minimum interval must be allowed before an inoculation of immuno- globulins; i.e. 7-10 days after vaccination against Yellow Fever, and 14 days after vaccination against Measles, Mumps and Rubella. With inactivated vaccines no intervals are necessary when given with other vaccines either live or inactivated. Several vaccines can be given at the same time, even at the same site (e.g. right deltoid muscle).

If surgical operations are necessary after vaccinations, they should not be performed in the first three days after inactivated vaccines have been given, and not in the first 14 days after live vaccines have been given, such as Yellow Fever, Measles, Mumps, Rubella, Oral Poliomyelitis Vaccine, Oral Typhoid Vaccine and BCG. Urgent operations can be done right away.

For Booster immunizations the effective period of the respective vaccination has to be taken into account.

The effectiveness and the effective period of vaccinations (modified from Steffen, R., von Sonnenburg, F. in W. Lang, T. Löscher, Tropenmedizin in Klinik und Praxis, 3rd Ed, Stuttgart, Germany, Thieme, 2000). This schedule is up to date as of Jun 2004, it should be checked periodically to see if there have been any changes.

Vaccination	Application	Effectiveness (%)	Effective from	Effective period
Cholera parenteral	i.d., s.c., i.m.	< 50	d 6 (first immunization), d 1 (booster *)	Officially 6 m Effective 3 – 6 m
Cholera oral (WC-BS)	p.o.	60 - 86	d 6 (first vaccination), d 1 (booster *)	Officially 6 m Effective 3 – 6 m
Cholera oral (CVD-103 HgR)	p.o.	13 - 100	d 6 (first immunization), d 1 (booster *)	Officially 6 m Effective 3 – 6 m
Diphtheria	i.m.	~ 80	4 w	5 (-10) yrs
ESME (Tick borne Encephalitis)	i.m.	99		> 3 yrs
Hepatitis A	i.m.	> 99	d 14 (evtl. d 0)	10 (- 30) yrs
Hepatitis B	i.m.	~ 90	d 30 – d 60	Responder lifelong
Influenza	i.m.	70 - 90		> 1 yr
Japanese Encephalitis	s.c.	> 90		> 4 yrs
Meningococcal Meningitis	s.c.	70 -90	d 7	1 – 3 yrs
MMR (Measles, Mumps, Rubella)	i.m.	90 - 95		lifelong
Plague	i.m.	?	A couple of d	6 m
Poliomyelitis (IPV)	i.m.	> 99	4 – 6 w	10 yrs
Poliomyelitis (OPV)	p.o.	> 99	4 w	Life-long
Tetanus	i.m.	> 99	4 w	10 yrs
Rabies	i.m. (s.c.)	> 99	~ 7 d	2 – 3 yrs
Tuberculosis (BCG)	i.c.	0 -80	Not sure	10 yrs
Typhoid F. Ty 21 a	p.o.	~ 70	d 14	1 – 3 yrs
Typhoid F. Vi	i.m.	~70	d 14	2 – 3 yrs
Yellow Fever	s.c.	> 99	d 10 (first immunization) d 1 (booster *)	Officially 10 yrs Effective lifelong ?

* If vaccinated within effective period of former immunization

4.1.4 Combination vaccines

In order to promote the compliance of vaccinations, a couple of combination vaccines have been developed in the past years. Different studies have shown that the immuno-genicity of the individual components are not reduced by such a combination, but actually enhanced. The combination vaccines for Hepatitis A and B (Twinrix®) and for Tetanus, Diphtheria and Poliomyelitis (Revaxis®) are of special interest for frequent travellers.

4.1.5 Contraindications

General Contraindications of Vaccinations (modified from Zieger BW (1998): Reisemedizinische Impfberatung. Flug-u. Reisemed 5, 1: 10 - 11)

- **Acute febrile diseases (A Common cold or a sub-febrile temperatures below 38,5 °C are not a contraindication!). A time interval of up to 2 weeks after recovery should be allowed. A post exposure vaccination against Rabies should be given right away.**
- **During incubation of infectious diseases**
- **During period of convalescence**
- **Purulent infections of skin and the mucosa**
- **Severe acute allergic conditions**
- **Allergies against the components of a particular vaccine**
- **Acute diseases of CNS**
- **Epilepsy (except for febrile convulsions and seizures some years ago)**
- **Pregnancy if applicable, especially with live vaccines**
- **Live vaccines where there is immunodeficiency or immune suppression (e.g. due to steroids, Immuno-suppressive agents, chemotherapy, radio-therapy) etc. ***
- **I.m. injection during oral anticoagulation therapy**

* Under certain circumstances it may be possible where there is a real indication. The serologic control of a successful vaccination is recommended

4.1 6 Site of vaccination

The vaccination should always be given at the site recommended by the producer, mainly either deltoid muscle. As immunogenicity studies usually rely on a particular vaccination site, the results can only be accounted for, if the standardised site is used. More than one vaccines can be given at the same site.

4.2 Vaccinations in Travel Medicine

When briefing flight crews and other people who travel, a distinction has to be made between mandatory vaccinations, generally recommended vaccinations and specific travel vaccinations.

Mandatory vaccinations according to the WHO, used to be the vaccinations against Smallpox, Cholera and Yellow Fever. Smallpox was eradicated in the 70's of the last century. The injection type of vaccination against Cholera showed no sufficient effect, and was omitted from the list of mandatory vaccinations. Nevertheless one should be aware, that the vaccination against Cholera might be demanded by certain border controls. This is against the general practice and scientific findings. It is often done in order to extract money dishonestly, by exaggerating the risk.

The vaccination against Yellow Fever is now the only mandatory vaccination, when travelling to certain countries. Some countries (16 countries in tropical Africa and French Guyana) demand the vaccination for every person entering that particular country. Other countries require YF, only for those who have visited an endemic area within the last 6 days. The vaccination against meningo-coccal meningitis is mandatory for pilgrims who are travelling to Mecca. For flight crews taking pilgrims to Saudi Arabia, this vaccination is also mandatory.

The **generally recommended vaccinations** against Tetanus, Diphtheria and Poliomyelitis are also recommended as a matter of principle. The immunization status should be checked and a booster given if necessary. The combination vaccines are generally recommended. If a tetanus immunization is necessary because of an injury, a combination vaccine with diphtheria vaccine, or diphtheria and poliomyelitis vaccine, should be used.

The indication for **specific travel vaccinations** depends on the areas to be visited, the time (rainy or dry season etc.), the duration and the style of travel (staying in the hotel or travelling around during the layover). These vaccinations should ensure an optimal protection for the flight crew or the traveller. For

members of flight crew, immunization for Hepatitis A and Yellow Fever are recommended in general, others depend on each and every situation.

Specific Travel Vaccinations

1. Hepatitis A
2. Hepatitis B
3. Typhoid Fever
4. Meningo-coccal meningitis
5. Rabies
6. Japanese Encephalitis
7. Cholera
8. ESME (Tick Borne Encephalitis)

4.2.1 Tetanus

Spores of *Clostridium tetani* can be found world wide, especially on or within the soil. The soil in the tropics in particular, contains high concentrations of these spores. The infection can occur after almost any injury. There is a higher risk of this type of infection in tropical areas. Under such anaerobic conditions (as in necrosis, deep wounds, with foreign bodies or infected wounds) the spores transform into vegetative stages, multiply and produce the neurotoxins, tetanospasmin and tetanolysin. Only tetanospasmin has clinical effects. The neurotoxin is transported within the neurons, in a retrograde way into the CNS, where it blocks the inhibitor neurotransmitters at the pre-synaptic neurons. The classic syndrome then develops, with muscle spasm, risus sardonius, trismus and opisthotonus.

As a prophylactic it is sensible for this vaccination to be given. In the case of an injury, careful wound toilet should be undertaken, as well as checking the vaccination state, and where applicable a booster should be given.

The basic immunization schedule consists of three inoculations with tetanus toxoid (Tetanol®) (0 – 4 to 8 weeks – 6 to 12 months). Boosters are necessary every ten years. As mentioned before, there are no intervals too long between inoculations, every inoculation counts. Therefore, an incomplete or complete basic immunization does not have to be started again from the beginning, if the intervals mentioned above are exceeded. **The vaccination is generally recommended, especially for flight crew. Before entering tropic zones at least two inoculations should have been given.** If applicable the occasion should also be used to immunize against diphtheria, or even diphtheria and poliomyelitis simultaneously, with the respective combination vaccines.

Should, in case of an injury, an incomplete immunization status be detected, a basic immunization schedule should be completed or should be started. Under certain conditions an **additional passive immunization** with tetanus antitoxin (tetanus immuno-globulin) has to be applied (see table).

Tetanus Vaccination in Case of Injury (after STIKO-Recommendations, Epidemiology Bulletin 28/01)

Number of previous inoculations	Clean, minor wounds		All other types of wounds ¹	
	Td or DT ²	TIG ³	Td or DT ²	TIG ³
Unknown	Yes	No	Yes	Yes
0 - 1	Yes	No	Yes	Yes
2	Yes	No	Yes	No ⁴
3 or more	No ⁵	No	No ⁶	No

- 1 Deep and / or dirty (with dust, soil, saliva, stool contaminated) wounds, injuries with damaged/open tissue and reduced oxygen supply or foreign bodies (i.e. contused, ruptured, bite, stabbing or shooting injury)
- Severe burns or coagulation
 - Tissue necrosis
 - Septic necrosis

- 2 Children under 6 years DT, older persons Td (i.e. Tetanus-Diphtheria) Vaccine with reduced amount of diphtheria toxoid in comparison with DT
- 3 TIG = Tetanus Immuno-globulin, in general 250 IE are given, the dose can be elevated to 500 IE; TIG is used with Td/DT-if necessary simultaneously.
- 4 Yes, if injury happened longer than 24 h ago.
- 5 Yes, if more than 10 years since last inoculation have passed.
- 6 Yes, if more than 5 years since last inoculation have passed.

4.2.2 Diphtheria

Diphtheria occurs as a result of an infection by an organism, which is called *Corynebacterium diphtheriae*. In temperate zones it affects mainly the respiratory system, and is transmitted by droplet infection all the year round, with a higher number of infectious cases during the cold season (be careful of asymptomatic carriers!). A highly effective exotoxin is the pathological agent. After initial general symptoms the main infection starts with the development of pseudo-membranes involving the pharynx, the nose, the larynx and trachea and bronchi. Eventually the highly potent toxin may cause complications such as myocarditis and polyneuritis, which may be lethal. (In tropical areas, wound diphtheria is common, but does not have such an insidious course.)

Because the therapy has to be started urgently, the diagnosis has to be established by the clinical appearance (pseudo-membranes and Caesar's neck, due to enlarged cervical lymph nodes). The definitive diagnosis follows by a bacteriological demonstration of *C. diphtheriae*.

The basic immunization consists of three inoculations with diphtheria toxin, which is inactivated by formol. These should be given at (0 – 4 to 8 weeks – 6 to 12 months). The vaccine for adults contains only 5 (at least 2) IE diphtheria toxoid (in contrast to the children's vaccine which has the greater amount). This should be used after age 6 or 7. Boosters are necessary every ten years. As mentioned before, there are no intervals too long between inoculations, every inoculation counts. An incomplete or a complete basic immunization schedule does not have to be started again from the beginning, if the intervals mentioned above are exceeded. **The vaccination is generally recommended, especially for flight crew. Before entering tropical zones at least two inoculations should have been given.** If applicable the occasion should be used to immunize against tetanus, or even tetanus and poliomyelitis simultaneously with the respective combination vaccines. Even after having had the diphtheria infection, there is no protection against another infection without proper immunization.

Adverse side effects of the vaccination can be local reactions at the site of inoculation, febrile general reactions, rarely thrombocytopenia or neurological complications, such as neuritis. **Contraindications**, apart from the general contraindications against vaccinations, can be haematological and neurological side effects after a former inoculation.

4.2.3 Poliomyelitis

Poliomyelitis is caused by three strains of poliomyelitis virus. It is normally transmitted by, the faecal-oral route. A transmission by droplet infection is also possible. There is a risk of infection from poor levels of hygiene, large crowds of people etc. The clinical course can vary from an abortive infection to a pre-paralytic, or to a paralytic poliomyelitis. The latter shows a case fatality rate of 5 – 10 %.

Vaccination against Poliomyelitis

Indication	All persons with missing or incomplete basic immunization In some countries: after age of 18 years a booster is only necessary when exposure is possible. No more boosters need be given as a routine
Vaccine	Inactivated vaccine IPV Live vaccine OPV
Vaccination Scheme	Depends on which producer: - 2 x 1 ml with interval of 8 w better 6 m i.m. (IPV-Virelon®) 3 x 0,5 ml (0 - 4 to 8 w - 12 m) i.m. (IPV-Mérieux®) - 3 x 0,5 ml (0 – 4 to 8 w – 6 m) (OPV) (care must be taken with the interval of OPV with other live vaccines)
Effective Period	IPV: 10 yrs (?), after that booster OPV: 10 yrs (lifelong), after that booster
N.B.	IPV: no intervals with other vaccinations required In certain countries OPV is not used any more because of the risk of VAPP (only for containing epidemics) Immunizations begun with OPV can be completed with IPV

Vaccination [was] usually carried out using an oral poliomyelitis vaccine (OPV, Sabin) or an inactivated poliomyelitis vaccine (IPV, Salk). In industrial countries only IPV is in use, OPV is not available any more there. Both vaccines contain all three strains of virus. There is an epidemiological situation in some European countries, with a very low risk of infection on the one hand, and the certain risk of vaccine associated paralytic poliomyelitis (VAPP) and of contact poliomyelitis (risk < 1: 4 million, < 1: 15 million respectively) on the other. In these countries OPV has been omitted in favour of IPV from the vaccination schedule (e.g. Germany). These countries recommend a vaccination for poliomyelitis for patients above 18 years of age, with a former basic immunization, only for travels into endemic areas. In the past years several clusters of VAPP occurred in countries still using OPV due to remutation of the vaccine virus to a pathogenic strain. A certain risk for those not immunised may arise from such remutations as well. The vaccination is generally recommended for all flight crew therefore. Immunizations that have been started with OPV can be completed with IPV.

4.2.4 Yellow Fever

Yellow Fever is endemic in the tropical rain forest zones of South America and Africa and is caused by a Flavivirus. Endemic and infectious zones can be readily distinguished. In **endemic zones** the virus circulates within a so-called sylvatic cycle between monkeys as reservoir and mosquitoes as vectors (Haemagogus and Sabethes mosquitos in South America, Aedes in Africa). In **infectious zones** (found within endemic zones) transmission to man occurs due to an urban cycle with anthropophilic Aedes mosquitoes as vectors. Epidemics can be caused in the same way.

Yellow Fever is a viral haemorrhagic fever. The severity of the disease varies from a virtually unnoticeable or mild course (especially found in endemic zones) to severe and even lethal, classic or haemorrhagic yellow fever. In the latter cases the general condition rapidly deteriorates, with failure of the liver and the kidneys. There is generalized haemorrhagic diathesis with haematemesis, melaena, metorrhagia,

haemorrhages in the skin and mucosa. Involvement of heart and CNS are common. 7 to 10 days after onset of symptoms the patients may die. The mortality of yellow fever in general is 10 to 20 %, and up to 50 % with classical yellow fever.

Vaccination against YF is recommended when visiting endemic zones. It is mandatory when entering certain countries of the endemic zones and, after having visited endemic zones within the last 6 days, when entering certain other countries of the endemic zones and outside. The vaccination may also be necessary when travelling within countries of the endemic zones, e.g. Brazil and Ecuador. **Flight Crews should be vaccinated even if they only fly over endemic areas, because an immunisation might be required after a diversion to an airport, which is in the endemic zone. Therefore all flight crew operating in Africa or South America should be vaccinated against Yellow Fever.**

The vaccine consists of a highly effective, attenuated live vaccine. The substantial residual virulence of the vaccine should be taken into account when vaccinating patients who are immuno-suppressed (HIV positive patients can be immunized with a CD4-count > 400 / μ l.). The vaccine virus is bred on eggs or chicken fibro-blasts, therefore chicken protein allergy might be a contraindication or at least relative contraindication. On the day of vaccination, and for the three successive days after the vaccination, those who have had a vaccination, should not do anything requiring muscular exertion or exposure (e.g. sport, sauna or being out in the strong sun and receiving UV exposure). **Side effects** can be slight, local reactions at the site of inoculation (up to 10 % of those vaccinated). After, 4 – 6 days there may be more general reactions, such as an elevated body temperature and malaise (about 10 % of those vaccinated). The malaise, headache and muscle pain usually lasts for about 24 hours (2 – 5 % of those vaccinated). **Contraindications** are acute febrile diseases within the last two weeks, immuno suppression and immune defects (see above), corticoid medication, allergy against chicken protein and age < 6m.

Only Authorized Vaccination Centres may give the Yellow Fever vaccine. These Centres only, certify the vaccination on the official vaccination certificate. The stamp is valid from ten days until 10 years after inoculation. In case of contraindications, an exemption certificate has to be given (The text should state that "No vaccination was possible on medical grounds"). One should be aware that the health authorities of certain countries might not acknowledge the exemption certificate.

Yellow Fever Vaccination

Indication	Travel into infection zones According to health regulations of certain countries for every visitor or after visits of endemic zones within the last 6 days
Vaccine	Live Vaccine of attenuated virus of 17 D - strain
Vaccination Scheme	1 x 0,5 ml sub.cut or im.
Effectiveness	Reliable, probably lifelong
Validity	As mandatory vaccination: from d₁₀ until 10yrs after vaccination
N.B.	Vaccination only by authorized vaccination centres Intervals to be observed with other live vaccines Care must be taken with the chicken protein allergy and HIV infection!

4.2.5 Hepatitis A

Hepatitis A is an acute viral infection affecting the liver. The infection is predominantly self-limiting. In children the clinical course is mostly unnoticed. Even though the case fatality rate is overall only about 0,2%, it increases by age (> 40 a: 2 %, > 50 a: 2,7. Moreover, recovery may take a couple of months, because of a protracted course or a delayed recovery.

Hepatitis A is acquired by fecal-oral transmission (especially in children by smear infection) by contaminated food and beverages. Raw seafood and oysters are a predominant source of infection. For exposure prophylaxis, good hygiene is effective because of the high resistance of Hepatitis A-virus against the environmental influence. In spite of this, vaccination is very effective because of the low hygiene standards and high rate of infectivity in the tropics.

A very effective, and inactivated type of vaccine, has existed since 1992. The effective period is 10 years. The new vaccine only needs two inoculations with an interval of six months in between. Even after the first inoculation an immune protection of six months to one year, can result. At the latest, two weeks before departure to tropical areas, the first inoculation should be given. Nevertheless, a later inoculation should not be omitted, because the immune protection will have built up a couple of days after arrival. Because of the high infection rate in children, even in first world areas in former days, a lot of the older aircrew might have had hepatitis A as a child even without knowing about it. Therefore, the titre of Anti-HAV of patients born before 1950-1960, with otherwise unexplained jaundice, or after a longer stay in third world areas, should be checked prior to the vaccination. Only patients with no titre (the threshold of immune protection being around, 20 IU/l) need a vaccination. Nevertheless, a vaccination of patients with titre of Anti-HAV is not harmful.

Hepatitis A Vaccination

Indication:	Wide indication, travels overseas and to the Mediterranean and Eastern Europe encountering low hygienic standards Patients born before 1950-1960 depending on titre of Anti-HAV
Vaccine:	Inactivated vaccine (formalin activated virus) (HAVRIX®, VAQTA®, Epaxal®, HAVpur®)
Vaccination Scheme:	0 - 6 (to 12) months, i.m. Immune protection starts after 2 – 4 w for 6 to 12 m
Booster:	After 10yrs
N.B.:	Testing of titre of Anti-HAV in patients born before 1950-1960

4.2.6 Hepatitis B

Hepatitis B is transmitted parenterally (blood, blood products and body fluids like sperm, vaginal fluid). 10 % of infected persons develop chronic hepatitis with complications such as cirrhosis of liver or hepatocellular carcinoma. Whilst staying in the tropics, sources of Hep B infection are, unprotected sexual contacts, close contact to local population, acupuncture, piercing, tattooing, dental treatment, and contact with blood, in or after traffic accidents. The % risk depends on the length of stay.

Beside exposure prophylaxis, an effective recombinant vaccine exists. Flight crews need this vaccination only under particular circumstances. Indications are long or frequent stays, as well as close contact to local population in areas which are highly endemic, adventure trips, sport with high risk of injuries, possible sexual contacts, possible medical or dental treatment, tattoos or piercing. Only in high- risk groups does a titre control need to be done, about 6 weeks after completing the vaccination. The patients should be advised that even after a successful vaccination, unnecessary exposure could still result in infection with Hepatitis C or HIV. Prior to departure two inoculations should have been completed.

In Non-Responders (4 – 8 w after the last of 3 inoculations titre < 10 IU/l) another inoculation should be given. An inoculation with a double or fourfold dose (e.g. vaccine for patients under dialysis), or in combination with influenza vaccination can be administered, probably sub-cutaneously, to enhance the effect. If the titre of Anti HBs has risen once above 100 IU/l the immune protection will last for 10 years.

Hepatitis B Vaccination

Indication:	long time stay, close contact to local population, adventure tours, bad hygiene
Vaccine:	Recombined vaccine (Engerix B®, Gen H-B-Vax®)
Vaccination Scheme:	0 - 4 w - 6 (to 12) months, i.m. Rapid scheme d₀ - d₇ - d₂₁ - 12 m i.m.
Booster:	Depending on titre of Anti HBs < 100 IE/ml → another inoculation > 100 IE/ml → booster after 10 years

4.2.7 Combination vaccine Hepatitis A and B

A combination vaccine of Hepatitis A and B (Twinrix®) exists, reducing the number of inoculations for those who need both vaccinations (0 - 4 w - 6 (to 12) m). The effective period is identical with the single vaccinations. As with the single vaccination against Hepatitis B at least two inoculations should have been completed prior to departure. A rapid scheme (d₀, d₇, d₂₁, 12 m) is possible. An immunization begun with mono vaccines can be completed with the combination vaccine.

4.2.8 Typhoid Fever

Typhoid fever (enteric fever) occurs worldwide. It is rare in industrial countries (0,24 - 3,7 cases/100.000),. It is more widespread in the third world (up to 540/100.000 with a mortality world-wide of 66.000/a). The areas of high risk are Latin America, Africa except Tunisia, and the Indian subcontinent. Most of the cases diagnosed in temperate areas have been infected whilst travelling. The risk of infection whilst staying in endemic areas varies between 2 – 12: 100.000, depending on the style of travelling. The case fatality rate is below 1 %. A well-known victim was aviation pioneer Wilbur Wright.

Typhoid Fever is a highly febrile infection caused by certain kinds of Salmonella, due to the contamination of food and beverages, by faeces. Life-threatening complications are intestinal haemorrhage and intestinal perforation. Paratyphus runs a similar slightly milder course.

Beside exposure prophylaxis, a vaccination is indicated in areas of high risk for low budget travellers, where there may be lower hygienic standards and the traveller may come into close contact with the local population. This does not apply for flight crew. However, flight missions visiting epidemic areas may warrant immunization. Two kinds of vaccines exist. A live vaccine consists of an apathogenic defect mutant of Salmonella typhi (Typhoral L®). The inactivated vaccine is administered parenterally i.m., as a single inoculation. Antibodies can be found up to three years after vaccination.

Vaccination against typhoid fever

Indication:	Travelling under simple conditions, with close contact with local population, Where there are lower standards of hygiene, stays > 4 w, epidemics or catastrophes
Vaccines:	- Oral live vaccine (Typhoral L®, Vivotif®) - Injectable inactivated vaccine Typherix®, TyphimVi®)
Vaccination Scheme:	- Live vaccine: d₁, d₃, d₅ 1 capsule - Inactivated vaccine: a single inoculation i.m. or s.c. into deltoid muscle
N.B.:	During vaccination with the oral live vaccine there should be no chemo-prophylaxis against Malaria or the administration of antibiotics

4.2.9 Meningococcal Meningitis

Meningococci exist worldwide, permanent epidemic areas, reach from Brazil in the west to the sub-Saharan Sahel Zone in Africa, to the Arabian Peninsula and to the Indian subcontinent. The African Meningitis belt is located in the Sahel Zone and south of it. Particularly during the dry periods (December to June) epidemics occur in intervals over several years, e.g. pilgrims to Mecca. The infection is spread by large groups of people, such as Mecca pilgrims and high density of housing, such as in shantytowns, slum or mass tented areas.

The causative agents are gram-negative diplococci, *Neisseria meningitidis*. Eight serogroups A, B, C, X, Y, Z, W 135 und W 29 exist. Within the Meningitis belt infections with serotype A can be found, whereas in middle Europe, Australia and North America, infections with serotypes B and C occur. Meningococci are transmitted face to face by droplet infection. The reservoir is the nasopharyngeal area of healthy carriers. During an epidemic, up to 10 % of the population are carriers that can infect mainly susceptible non-immune children. The clinical course varies between an asymptomatic infection of the nasopharyngeal tract, (this is the most frequent type) to an acute meningococcaemia with light fever and petechiae. This may develop in 10% of those with the asymptomatic infection. The more serious infection has a case fatality rate of about 10 %, especially in children and juveniles and leaves long time residuals in up to 20 %. **If close contact with infected persons has occurred over a period of several hours (> 8 h) such as within an aeroplane, a prophylactic dose of Rifampicin is recommended.**

The polysaccharide vaccine protects against sero-groups A and C or additionally sero-groups W 135 und Y. The immunization is effective 10 to 14 days after the last inoculation and lasts at least for three years. Those vaccinated should be older than two years.

Population in these areas. It is mandatory for pilgrims to Mecca (Art. 84, International Health Regulations). Serotype W 135 is responsible for the most infection in this group. Therefore, the vaccine protecting against this serotype is recommended and is mandatory from 2002 onwards. **For flight crews transporting pilgrims to Saudi Arabia on pilgrim flights the vaccination might be mandatory, whether entering the country or not.**

Vaccination against Meningococcal Meningitis

Indication	Long-time stay in risk areas. Travel into rural areas under basic conditions and with close contact with the local population in these high risk areas
	Mandatory for pilgrimage to Mecca or flight crew transporting pilgrims upon entry to Saudi Arabia
	Under certain circumstances probably required by certain countries upon entry from risk areas
Vaccine	Inactivated vaccine, depending on producer -Tetavalent vaccine with serotypes A, C, W 135, Y (Mencevax ACWY®)
Vaccination Scheme	1 x 0,5 ml s.c.
Effectiveness	Reliable immune protection from 1 - 2 w after vaccination lasting 3yrs
N.B.	Mandatory vaccination valid from 10 d after until 3yrs after vaccination
	No protection against serotype B (Europe, South America)

4.2.10 Rabies

Rabies occurs worldwide, especially in Latin America, Africa, and Asia. The reservoir and main source of infection are stray dogs, in America also blood sucking bats. The worldwide mortality is 35.000 to 50.000 per year, 85 % of them in Asia, particularly India. In Europe only Romania, Russia and Turkey are risk areas. After the disease has been contracted it is 100% lethal, unless the traveller has been vaccinated or can reach medical assistance where the vaccine is available.

After bites from animals suspected of having rabies there are some local things that can be done which might be lifesaving. These consist primarily of meticulous sterilisation of the wound, plus to follow, an active and probably additional passive immunization schedule.

A pre travel vaccination is necessary only for those staying for a long time, or planning adventure trips into the countryside where there is a high risk and where an effective and well-tolerated vaccination (vaccine from India has serious adverse effects!) cannot be obtained within 24 hours. This does not apply to flight crew.

At days 0, 7 and 21 (alternatively 0, 28, 56) the inoculation is administered i.m. To maintain the immunization, if the risk continues, a booster is recommended after one year and subsequently at 5 years.

4.2.11 Japanese Encephalitis

Japanese Encephalitis is the most common viral encephalitis worldwide. The frequency differs between the Eastern Asia from Siberia, Korea and Japan to South East Asia and the Indian subcontinent as well as Taiwan, Philippines, the Mariane Islands and Guam. The disease has been spreading further worldwide in more recent years.

Birds are a reservoir, with an augmenting reservoir in pigs. The infection occurs in areas with rice paddies, where the vectors breed. The vector is the Culex mosquito, which is active from dawn to dusk. The virus circulates between these vectors and the reservoirs. Humans get infected when the density of the mosquito increases. Birds may carry the infection from the rural to the urban areas. Sporadic infections can occur all through the year. During the monsoon season the mosquito population can expand a great deal, causing epidemics.

In travellers Japanese Encephalitis is very rare. Nevertheless, an infection may be lethal. Beside exposure prophylaxis, the vaccination is indicated for individual travellers, who spend more than 4 weeks during the summer monsoon (May to October) in rural areas in endemic zones or who do extensive cross-country expeditions. This does not normally apply to flight crew. Only with extensive outdoor activities in endemic areas longer than 4 weeks duration is a vaccination warranted for flight crews. The inactivated vaccine contains inactivated virus from mouse brains (producers Biken or Connard). It is not licensed in every European country, but can be obtained by international pharmacies. In case of adverse side effects the immunizing physician is liable. Those to be vaccinated should be informed about this situation.

Vaccination against Japanese Encephalitis

Indication:	Individual travels >4 w in rural areas of endemic zones
Vaccine:	Inactivated vaccine with inactivated virus from mouse brain
Vaccination Scheme:	1 ml s.c on days 0 - 7 - 28 An alternative rapid scheme at days: 0 – 7 - 14 A booster after 1 – 2 years
Effective period:	4 years
Side effects:	local at site of inoculation (rare).

4.2.12 Cholera

Cholera is neither a typical travel nor a typical tropical disease. It occurs as epidemics in third world countries because of the insufficient cleansing treatment of drinking water and sewage. Occasionally cases do occur in travellers, where there has been neglect in food and beverage hygiene. Otherwise mainly humanitarian workers are at risk during catastrophies (refugee camps etc.).

The causative agents are different serovars of *Vibrio cholerae*, which are transmitted by the faecal-oral route. The pathogenic agent is the toxin produced by *V. cholerae*. The disease is characterized by diarrhoea with vomiting and excessive loss of fluids and electrolytes. Therapy consists of fluid replacement. Antibiotics hamper the toxin formation of *V. cholerae* and may thus shorten the course of the disease.

The parenteral vaccine of inactivated *Vibrio* is given (2 x 0,2 – 2 ml s.c. with an interval of 1 – 2 w). It was once a mandatory vaccination. It does not give effective protection and is not recommended any more. Oral live vaccines or vaccines consisting of inactivated *V. cholerae*, sometimes with recombinant apathogenic parts of the toxin added, are well tolerated and effective over a period of 6 months to 2 years. Indications are for journeys under basic conditions with a high infection risk and for humanitarian workers. This does normally not apply to flight crew. The best protection against cholera is appropriate food and beverage hygiene. Because of crossreactivity of antitoxin antibodies the inactivated vaccine with β -Toxin protects against ETEC as well.

4.2.13 Tick Born Encephalitis

Tick born Encephalitis is a viral disease. The central European variant is also known as ESME and occurs in Central and Eastern Europe, from Southern Germany and Switzerland to the Urals, and to the south of Sweden and Finland. The Far East or Russian variant, also known as RSSE, occurs from the Baltic States in the west, throughout Russia to the Pacific Ocean.

The causative agent is a flavivirus, transmitted by ticks. In endemic areas the virus circulates between ticks and wild animals. Humans staying in forests areas, walking through long grass etc. can be infected due to tick bites. Infections often have a clinically unnoticeable or uncomplicated febrile course. Overall the prognosis is good, apart from the rare (5 %) who may develop the severe meningo-encephalitic type of the disease, which if not fatal, may leave long term residual neurological damage (in 30%), up to 2% may be lethal.

Vaccination against Tick Born Encephalitis

Indication:	Repeated, long-term or occupational stays in forest areas of endemic areas (Or living in rural areas of endemic zones)
Vaccine:	Inactivated vaccine with inactivated virus
Vaccination Scheme:	3 x 0,5 ml i.m. , 0 - 1 to 3 m - 9 to 12 m Booster after 3 to 5 years
	Alternative rapid scheme d₀, d₇, d₂₁ Booster after 1 year
Effectiveness:	Sero-conversion in 99 %, protection rate 60 to 70 %
N.B.:	If applicable active or passive immunization (hyper-immuno-globulin) is possible up to 96 hr after tick bite (not suitable for children)

Beside exposure prophylaxis, a vaccination is indicated for repeated, long-time and professional stays, in forest areas in endemic zones, or for those living or with extensive outdoor activities in rural areas of endemic zones. This does not apply to most flight crews. The vaccine consists of inactivated ESME virus, by cross immunity it protects against RSSE virus infections as well. The inactivated vaccine is well tolerated. Occasional side effects are only local or febrile general reactions. Special contraindications do not exist. Pre-existing diseases of CNS or immune system and severe allergies are relative contraindications. The vaccine Encepur® is licensed for persons over 12 years of age.

4.2.14 Further vaccinations

Further vaccinations to be considered are those against influenza and pneumococci. Both are recommended for those above 60 years of age and for children, adolescents and adults with increased

health risk due to immune deficiency or chronic disease. The vaccination against influenza is furthermore recommended for those with professional exposure due to common contact with customers, and in case of impending epidemics.

Vaccination against influenza

Indication:	Persons above age 60. Persons with increased risk due to immune deficiency or chronic disease. Professional exposure. Impending epidemic.
Vaccine:	Inactivated vaccine, depending on producer
Vaccination Scheme:	1 x 0,5 ml i.m
Effectiveness:	good, protection after 1 - 2 weeks, lasts for about 6 months
N.B.:	The relevant influenza virus is different every season, a new vaccination with a new type of vaccine is required each influenza season
	Vaccination before beginning of influenza season if possible (season from November - April in Northern and May - October in Southern hemisphere
	Contraindication if acute diseases, allergy against contents of vaccine or chicken protein

Vaccination against pneumococci

Indication:	Persons above age 60. Persons with increased risk due to immune deficiency or chronic disease.
Vaccine:	Inactivated vaccine, polysaccharide vaccine with 23 most common capsule types
Vaccination Scheme:	1 x 0,5 / 1 ml s.c. or i.m
Effectiveness:	satisfactory
N.B.:	Booster after 6 years if exposure continues (adults), children after 3 years
	Vaccination before beginning of influenza season if possible (season from November - April in Northern and May - October in Southern hemisphere
	Contraindication if acute diseases, pneumococcal disease within last 6 (children 3 - 5 years)
	Conjugate vaccination with better effectiveness in children is available

4.2.14 Vaccination Schemes for Flight Crews

Vaccination Schemes for Flight Crews: Recommended Vaccinations

Missions in Europe and North America	
Generally recommended vaccinations	Tetanus
	Diphtheria
	Poliomyelitis
	Hepatitis A ¹

1 if operating to Mediterranean destinations or Eastern Europe

Missions in Tropical and subtropical Zones	
Generally recommended vaccinations	Tetanus
	Diphtheria
	Poliomyelitis
	Hepatitis A
Additionally recommended vaccinations	Yellow Fever ³
Recommended under certain circumstances ²	Meningitis ⁴
	Typhoid Fever
	Hepatitis B
Malaria prophylaxis	Exposure prophylaxis
	Chemoprophylaxis ⁵
	Making sure of early diagnosis and treatment ⁶

2 Recommended if crews perform adventurous trips or live under probably lower levels of hygiene during layover, or stay longer than four weeks in a tropic area

3 Mandatory upon entry into certain countries, mandatory upon entry in to certain other countries after having visited endemic zones

4 Mandatory upon entry into Saudi Arabia, especially if transporting pilgrims, the tetravalent vaccine has to be used and is recommended otherwise, too

5 Recommended according to actual national and WHO recommendations during layover in high risk destinations in West Africa or East Africa or during longer layovers in risk areas

6 An early diagnosis and treatment of Malaria should be available at all destinations and at the home base in case of symptoms suspicious of malaria for all flight crews operating in tropical and subtropical areas

5 Malaria

Malaria is a febrile, potentially lethal infection. The causative agents are plasmodia, a kind of protozoa transmitted by the evening/night active, female Anopheles mosquito. Four kinds of plasmodia are pathogenic in humans, of which three can cause a variety of severe clinical conditions.

Plasmodia and malaria

Causative agent	Type of malaria	Incubation Period	Type of Fever	Prognosis
Pl. malariae	Malaria quartan	16 – 50 (longer possible)	Fever attacks every 3 d	No spontaneous recovery
Pl. vivax	Malaria tertian	12 - 20 d (up to 10 months. possible)	Fever attacks every 2 d	Spontaneous recovery possible
Pl. ovale	Malaria tertian	12 – 20 d (longer periods are possible)	Fever attacks every 2 d	Spontaneous recovery possible
Pl. falciparum	Falciparum Malaria	7 – 30 d (longer periods are possible)	Irregular fever attacks	Without treatment mostly lethal

Malaria occurs in the tropics and subtropics, depending on the habitats of the vector mosquito Anopheles. In Asia and South America a risk of infection exists up to an altitude of 1.800m, in Africa it can go up to 2.600m. The main risk areas (in order of decreasing risk) are West Africa, East Africa (particularly Kenya), and South Africa. Without the proper precautions, the risk is as follows (example West Africa):

2.500 Travellers (= 5 Jumbos) → 60 cases of malaria → 1 Fatality

The risk of malaria varies by the season. (There is a higher risk, during and immediately after the rainy season). In urban centres of the tropics, malaria transmission is occurring with increasing frequency. This is especially noticeable in the western African cities of Lagos, Accra, Abidjan, Dakar and Banjul. **Flight crews staying in these cities during their layovers (even short layovers) have a significant risk of being infected unless all the precautions are taken.**

Falciparum Malaria, the most dangerous form of malaria (case fatality rate 2 to 3,5 %), makes up the majority of malaria cases imported to Europe. It is mostly picked up in tropical Africa.

Even with meticulous malaria prophylaxis, it is not always 100 % safe. **In any patients with fever or other suspicious symptoms after staying in risk areas, malaria has to be suspected before anything else, and diagnostic measures must start immediately.**

In any case of fever, malaria has always to be suspected.

In any case of fever, always do a thick and thin blood film. It must be done to exclude malaria.

5.1 Malaria Prophylaxis

1. Exposure prophylaxis
2. Chemo -prophylaxis (drug prophylaxis)
3. Establish an early diagnosis and therapy.
If applicable standby therapy (probably malaria quick test)

There are three elements of malaria prevention, which are based on each other. The kind of prophylaxis (only exposure prophylaxis, or exposure prophylaxis with standby therapy, or exposure prophylaxis plus chemo-prophylaxis, probably in combination with standby therapy) depends on the destination, season, style and duration of stay, as well as individual factors such as previous diseases, probable medication and probable intolerance of anti-malarials. Furthermore, the risks of the adverse side effects of chemo-prophylaxis, have to be weighed up against how effective is the method of prophylaxis and how great is the risk of getting malaria. General recommendations for relevant malaria areas may be a great help for physicians giving advice for malaria prophylaxis.

The relevant recommendations have been worked out by several scientific organisations, adapted to the actual epidemiological situation and published. The recommendations of the WHO are published in the brochure "International Travel and Health" (WHO Library, Genf 2003 ref. <http://www.who.int/ith/english/index.htm>). A couple of national recommendations exist, too. The Swiss and German and some other National recommendations for example differentiate for countries, travel areas and seasons. Therefore, the preventative measures can be adapted to the local epidemiological situation.

5.1.1 Exposure Prophylaxis

Exposure prophylaxis of Malaria is to protect against mosquito bites. It has to be carried out throughout the active time of the vectors – from dusk throughout the night to dawn. Exposure prophylaxis can reduce the risk of malaria by 90 %.

1. **Cover as much as possible of the body surface by fair-coloured, loose-fitting cotton clothes (Long trousers, long sleeves).**
2. **Uncovered skin should be treated with insect repellents (e.g. Bayrepel, DEET. Permethrin is not favoured in some countries). These products should not be used on damaged areas of skin and children < 2 yrs**
3. **Staying inside with closed rooms during evening and night. Rooms should be mosquito-proof: use mosquito screens, air conditioning, and if applicable insecticides.**
4. **Mosquito nets are recommended (they should be big enough not to be touched while sleeping, loose ends should be fixed under mattress). If applicable mosquito nets impregnated by Permethrin**

Electric vaporizers, mosquito coils and insecticides reduce the number of mosquitoes, but can produce possible irritating and toxic substances. Insecticides containing pyrethroids are often considered inappropriate.

5.1.2 Chemo-prophylaxis

The decision for an **additional** medical prophylaxis has to take into account, the risk of infection, the efficacy e.g. the resistance situation, and the adverse side effects. This is especially so for long-term prophylaxis where the side effects have to be balanced against the possible benefit. Therefore, the decision to use chemo-prophylaxis, and to use certain anti-malarials, has to be based on a meticulous risk-benefit-calculation. Chemo-prophylaxis does not replace, but supplements, exposure prophylaxis. **However, it has to be taken into account that no prophylactic drug is 100 % effective.**

As with antibiotics, the sub-therapeutic levels of an anti-malarial as used in chemo-prophylaxis, can result in resistance. Resistance exists using Chloroquine and other antimalarials, especially with *Pl. falciparum* and *Pl. vivax*. According to the resistance situation the WHO has defined **resistance areas** (A, B, C), for which certain prophylaxis regimes are recommended. These areas are not defined according to transmission of malaria. Therefore, the malaria risk does not depend on the resistance zone.

If a mission into an endemic area has to be started so early, that a sufficient blood level of the anti-malarial chosen cannot be achieved, a rapid saturation is possible with Chloroquine or Mefloquine. **Mefloquine is not approved for pilots. However, chemo-prophylaxis with Atovaquone + Proguanil (Malarone®) or with Doxycycline has to be started only the day before entering the malaria risk area.**

a) Chloroquine (e.g. Resochin®) + Proguanil (Paludrine®)

The effectiveness of this combination of two anti-malarial medications is only about 60 % (West Africa) and should not be recommended, if a more effective, alternative drug like Atovaquone + Proguanil (Malarone®) is available. It can be used over long periods continuously (Up to 100 g of Chloroquine, corresponding to continuous intake over 5 years, is harmless. For continuous intake – which normally does not apply for flight crew – an ophthalmological control is recommended every 2 years. The combination of Chloroquine and Proguanil used to be the only anti-malarial approved for pilots before Atovaquone + Proguanil (Malarone®) was approved. Severe adverse **side effects** do not exist, for Chloroquine, short term stomach discomfort, flickering of eyesight, light dizziness, sleep disturbance occur rarely. For Proguanil reversible loss of hair, ulceration of the mouth and stomach discomfort may occur rarely. The medication should always be taken with food and with plenty of fluid. **Contraindications** for Chloroquine are psoriasis, retino-pathology, visual field defects, myasthenia gravis, glucose-6-phosphate dehydrogenase deficiency, hepatic porphyria, severe liver disorders, renal insufficiency and intolerance of 4-Aminochinolins. Contraindications for Proguanil are, severe renal insufficiency (reduction of dose necessary). A rapid saturation for chloroquine can be achieved by the intake of a weekly dose (2 Tablets) on 2 subsequent days. Subsequently, the chemo-prophylaxis has to be continued in a regular way. It has to be continued for 4 weeks after leaving the risk area.

[Chloroquine (e.g. Resochin®) + Proguanil (e.g. Paludrine®)]

Generics:	- 150 mg Chloroquine-Base resp. 100 mg Proguanil
Intake:	- 2 Tbl. Resochin / w (with body weight > 80 kg: 3 Tbl), starting 1 week before mission, continuing for 4 weeks after leaving risk area
	- 2 x 1 Tbl. Paludrine / d, starting 1 day before mission, continuing for 4 weeks after leaving risk area
N.B.:	- For better compatibility intake with lots of fluid at meal times.
	- With continuous intake > 2 a ophthalmological control every 2 years
	- In New Guinea there is resistance against Proguanil
	- Chemo-prophylaxis is possible for children and in pregnancy
	- Rapid saturation with Chloroquine using: 2 Tbl/d for 2 d

b) Mefloquine (e.g. Lariam® or Mephaquine®)

Mefloquine is not approved for pilots! If a pilot should take it by mistake, then that pilot must remain unfit for flying duties for four weeks, and then be observed to see if any neuro- psychiatric side effects have occurred. Mefloquine in special circumstances can be used for flight attendants. The discussion about mefloquine for flight crew has not yet come to any fixed conclusions. Therefore until some conclusions have been reached, there is no reason why flight attendants should have to take the risk

of using a less effective type of prevention, when this very effective anti-malarial for chemo- prophylaxis is available. Effectiveness is about 90 % in West Africa. Long-term intake is possible for up to 2 years. The **Side Effects** can include neuro- psychiatric symptoms (0,1 to 1 %)[There are some reports of a higher percentage]. Visual blurring can occur. Epileptic seizures have been reported as well as psychotic symptoms. These effects can be dose related and occur more frequently with rapid saturation, or therapeutic intake, or in women (higher blood levels). Side effects are more likely to occur after a second intake. When the chemo-prophylaxis is taken for the first time, it should be started 3 weeks before onset of any exposure, therefore, in order to change the prophylaxis regime in case of side effects. **If side effects occur, Mefloquine should never be used again.** Vice versa, if side effects are absent, Mefloquine should be tolerated well in the future, although there is no guarantee or clinical evidence to prove this. The **Contraindications** include the first trimester of pregnancy when genetic abnormalities have been recorded. Three months after taking mefloquine, effective contraception is recommended. It should not be taken during the lactation period. It should not be given to children < 5 kg of body weight and / or < 3 yrs of age. It can cause cardiac conduction disturbances. It must not be taken with quinidine, or given to people with severe liver disorders, or with neuro psychiatric disorders, and of course, it must never be given to people with epilepsy. Interference with frequently used medicines such as beta-blockers, calcium antagonists and other anti arrhythmics should be considered. Even with diarrhoea Mefloquine can be sufficiently effective. A **rapid saturation** for mefloquine can be achieved by the intake of a weekly dose (1 Tablet) on 3 subsequent days. The prophylaxis with mefloquine should be started 1 week before the onset of a mission and continued for 4 weeks after leaving the risk area.

****Mefloquine should only be considered, where the risk of infection outweighs the probability of severe side effects. Because of the risk of both short term and long-term neurological side effects, mefloquine is forbidden for use in pilots****

Mefloquine (Lariam®)

- Generic:** - 250 mg Mefloquine
Intake: - 1 Tablet. /w, starting 1 week before exposure, continuing for 4 weeks after leaving risk area
N.B.: - Intake with plenty of fluid
 - For women 3 months of effective contraception is recommended after intake
 - Rapid saturation 1 x 1 Tbl for 3 d
 - Rapid resistance to mefloquine has occurred in SE Asia. Resistant cases have now been reported in Africa.

c) Malarone® (Atovaquone + Proguanil)

According to preliminary results of scientific studies about the interference of Atovaquone / Proguanil with flight duties it seems likely, that there will not be any problems for aircrew. The combination of Atovaquone and Proguanil (Malarone®) is used by several airlines as Lufthansa and is approved for pilots by the FAA. The effectiveness is about 90 %, like that of mefloquine. It can be used for adults and for stays up to 28 days (soon to be prolonged up to 56 days and probably longer) **and for persons with body weight of more than 40 kg (These restrictions do not apply for the USA).** As with mefloquine, it is recommended for chemo-prophylaxis in areas, where there is chloroquine resistance and for treatment of uncomplicated malaria. This combination is much better tolerated than mefloquine. The combination is not associated with neuropsychiatric adverse effects, impairment of psychomotor performance, mood changes, sleepiness and fatigue, especially under hypobaric conditions. **Side effects** are minimal and do not last very long, they may include: cough, gastrointestinal disturbance (nausea, vomiting, abdominal discomfort and pain, diarrhoea) and headache. **Contraindications** are severe liver disorders and severe renal insufficiency (Creatinine-Clearance < 30 ml/min). **Due to the short time of administering (1 day before up to 7 days after staying in a malaria risk area) the combination is particularly suitable for flight crews. Acceptability of the drug by the compliance of patients proved to be very high.**

Atovaquone + Proguanil (Malarone®)

- Contents:** - Atovaquone (250 mg) + Proguanil (100 mg)
Intake: - 1 Tablet. / d, starting 1 to 2 days before mission, continuing for 7 days after leaving risk area
 - Maximum stay in risk area 28 d (Longer term intake is under consideration.)
N.B.: - effectiveness as mefloquine (90 %), tolerability better

d) Doxycycline

The antibiotic doxycycline is not officially approved for pilots yet, but it is being used in military pilots in high- risk areas, because of the lack of an effective alternative. It is not licensed for chemo-prophylaxis of malaria in some European Countries, but is used in the UK and the U.S. It is used for prophylaxis in areas with multi-resistant plasmodia (resistance against chloroquine, and proguanil, and mefloquine). This applies to the border areas between Thailand and Myanmar and Thailand and Cambodia. **For the time being Doxycycline is regarded as effective as Atovaquone + Proguanil (Malarone®) or Mefloquine (Lariam®) for chemo-prophylaxis by some Societies for Tropical and Travel Medicine in Europe. It can be used instead of them, where these are recommended.**

Side effects can include gastrointestinal disturbances (nausea, vomiting, diarrhoea), photo-dermatitis (care must be taken with solar radiation in tropical areas), very rarely it can cause increased intra-cranial pressure.

Contraindications are children < 8yrs, severe liver disorders.

Doxycycline (several brand names)

- | | |
|-----------------|--|
| Content: | - 100 mg Doxycycline |
| Intake: | - 1Tbl. / d, starting 1 - 2 days before mission, continuing for 4 weeks after leaving risk area |
| N.B.: | - Must be taken with plenty of fluid |
| | - Contraindicated in children < 8 yrs and pregnant women |
| | - Beware of photo-dermatitis (solar radiation!) |

e) Other antimalarials

Halofantrin (Halfan®), Fansidar® (Sulfadoxin + Pyrimethamin) and derivatives of Artemisin are **not** suitable for prophylaxis any more at all.

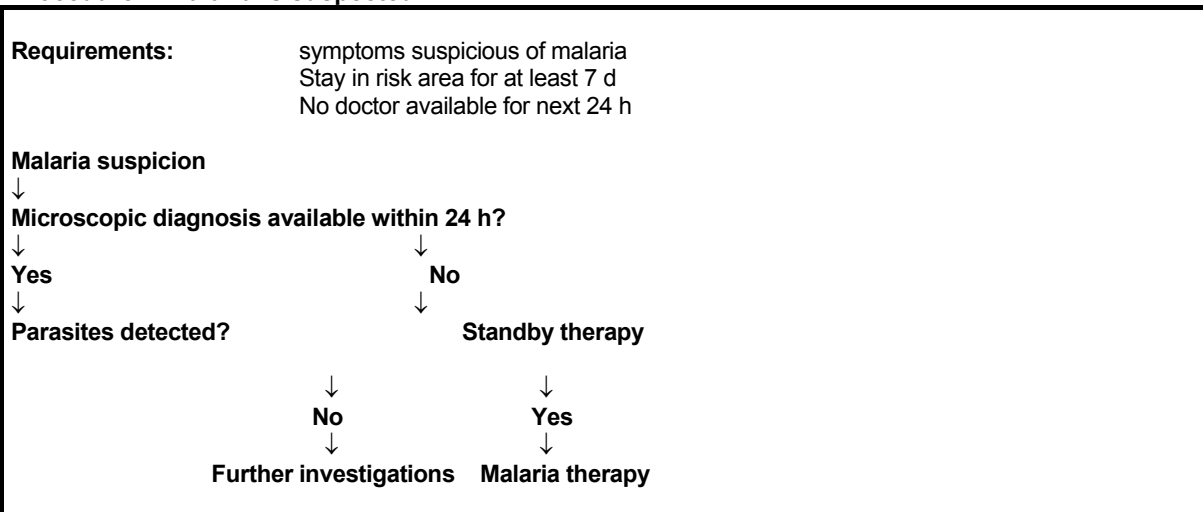
5.1.3 Standby Emergency Treatment

In Standby Emergency Treatment patients take an anti-malarial with them. This should be used if symptoms suspicious of malaria (e.g. fever > 38,5 °C, pain in the head and limbs, nausea and malaise) should occur, at least one week after having entered a risk area. Standby Emergency Treatment can be recommended in areas with low transmission risk, short stays, intolerance of anti-malarials or where side-effects of chemo-prophylaxis outweigh the malaria-risk. European recommendations, (e.g. Swiss and German Societies of Tropical Medicine, 2001) advise standby precautions. Furthermore, Standby Emergency Treatment should be recommended if chemo-prophylaxis with chloroquine / proguanil is used, particularly if a more effective prophylaxis cannot be used in pilots or where there is intolerance. It can be considered especially in case of frequent short stops in endemic areas over a prolonged period of time. However, it does not replace exposure prophylaxis, which should be carried out meticulously.

If fever or other symptoms suspicious of malaria occur and no doctor is available, the standby drug should be taken by way of self- medication. As soon as possible a physician trained in tropical medicine should be consulted. **After having taken the Standby Emergency Treatment, flight crew are not fit for flying duties for four weeks.**

Depending on the destination, different drugs have been recommended for standby prophylaxis. Halofantrin (Halfan®) and the combination of Pyrimethamin und Sulfadoxin (Fansidar®) are not now recommended by most European Societies of Tropical Medicine. This is due to a variety of serious side effects including cardiac arrhythmias.

In remote areas Standby Emergency Treatment can be appropriate, if malaria symptoms occur even though chemoprophylaxis has been taken and medical assistance is not available within the next 24 hours. The choice of drugs depends on the type of chemoprophylaxis taken before. Furthermore, a drug with no resistance in the respective area should be used. Because of lack of data no recommendation for Standby Emergency Treatment after chemoprophylaxis with Atovaquone/Proguanil can be given.

Procedure if malaria is suspected

*If applicable microscopic investigations have to be repeated every 6 h or in fever attacks

Choice of drugs for Standby Emergency Treatment according to previous chemoprophylactic regimen (International Travel and Health (2004), WHO, Geneva)

Prophylactic regimen	Standby Emergency Treatment
None	Chloroquine, for P. vivax areas only Mefloquine Quinine Artemether/Lumefantrine ^a Atovaquone/Proguanil ^a
Chloroquine alone / with Proguanil	Mefloquine Quinine
Mefloquine	Quinine ^b Quinine + Doxycycline/Tetracycline for 7 d ^b
Doxycycline	Mefloquine Quinine + Tetracycline for 7 d

^a Limited experience of drug interactions with other antimalarial drugs, therefore these drugs not recommended if taking already other antimalarial

^b Mefloquine to be resumed 7 days after last dose of Quinine

Dosages in Standby Emergency Treatment

	Mefloquin (Lariam®) (Tbl. à 250 mg)	Atovaquon/Proguanil (Malarone®) (Tbl. à 250 mg/100 mg)	Artemether/Lumefantrin (Riamet®) (Tbl. à 20 mg/120 mg)	Chloroquine (Resochin®) (Tbl. à 150 mg)
d₁	Initially 3 Tbl. After 6 – 8 h 2 Tbl. After 6 – 8 h 1 Tbl.	Initially 4 Tbl.	Initially 4 Tbl. After 8 h 4 Tbl.	Initially 4 Tbl. After 6 h 2 Tbl.
d₂	-	4 Tbl.	2 x 4 Tbl.	2 Tbl.
d₃	-	4 Tbl.	2 x 4 Tbl.	2 Tbl.
Area	All malaria areas	All malaria areas	All malaria areas	Only in areas without chloroquine resistance

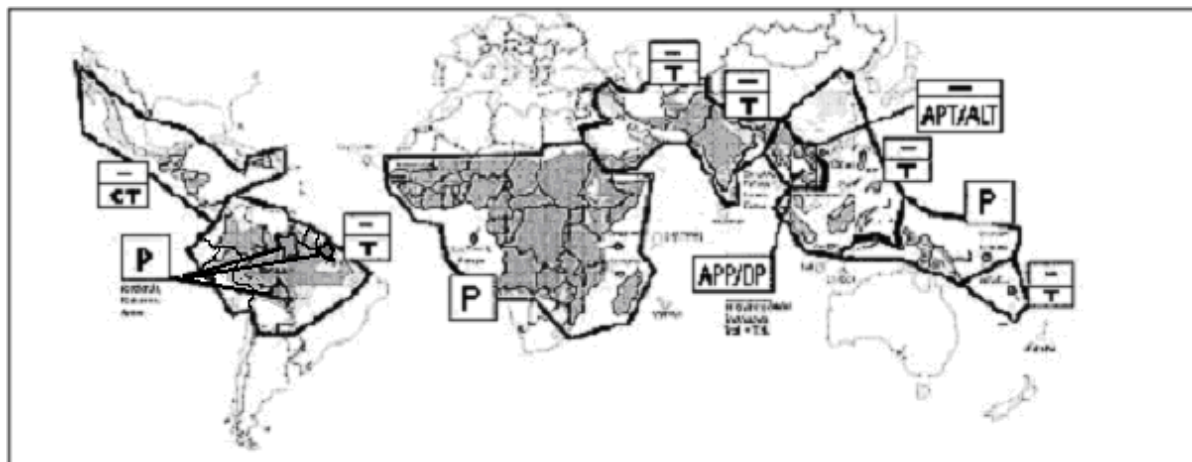
In general, travellers carrying stand-by emergency treatment should observe the following guidelines:

Guidelines for stand-by emergency treatment (International Travel and Health (2004), WHO, Geneva)




- Consult a physician immediately if fever occurs 1 week or more after entering an area with malaria risk.
- If it is impossible to consult a physician and/or establish a diagnosis within 24 hours of the onset of fever, start the stand-by emergency treatment and seek medical care as soon as possible for complete evaluation and to exclude other serious causes of fever.
- Complete the stand-by treatment course and resume antimalarial prophylaxis 1 week after the first treatment dose. Mefloquine prophylaxis, however, should be resumed 1 week after the last treatment dose of quinine.
- Vomiting of antimalarial drugs is less likely if fever is first lowered with antipyretics. A second full dose should be taken if vomiting occurs within 30 minutes of taking the medication. If vomiting occurs 30–60 minutes after a dose, an additional half-dose should be taken. Vomiting with diarrhoea may lead to treatment failure because of poor absorption.
- Do not treat suspected malaria with the same drugs used for prophylaxis, because of the increased risk of toxicity and resistance.

5.1.4 Special recommendations

An example for special recommendations are those of the Swiss/ German Societies of Tropical Medicine and various other Organisations, which differentiate their recommendations by countries, and even travelling areas within countries, seasons and duration of stay.



(after WHO International Travel and Health 2005, and SAR and DTG 2006)

	areas without risk of malaria
	areas with limited risk
	malaria risk areas

- P** Mefloquine (Lariam®), or Atovaquone / Proguanil (Malarone®), or Doxycyclin for Chemoprophylaxis
APP/DP Atovaquone / Proguanil (Malarone®), or Doxycyclin for Chemo-prophylaxis
APT/ALT no Chemo-prophylaxis but Atovaquone / Proguanil (Malarone®) or Artemether/Lumefantrin (Riamet®) for Standby-Therapy
T no Chemo-prophylaxis but Mefloquine (Lariam®) or Artemether/Lumefantrin (Riamet®) for Standby-Therapy
CT no Chemo-prophylaxis but Chloroquine (Resochin®) for Standby-Therapy

Recommendations for malaria prophylaxis (after DTG, 2003 - 2006)

Geographic Region	Prophylaxis
Tropical Africa, Eastern Indonesia, Papua-New Guinea, Salomon Islands, Amazonian-Provinces and Amapá	P
Thailand (Provinces Trat and Tak and extreme journeys to border areas with Cambodia and Myanmar)	APP / DP
Thailand (other provinces)	APT / ALT
Central America	CT
Other risk areas	T
In all malaria areas	Exposure prophylaxis

5.1.5 Frequent missions or long-term stay

Prior to long-term stays (stationing of flight crews and their families) meticulous medical advice must be given. The recommendations have to consider the individual situation. In principle, the use of chemo-prophylaxis is recommended. WHO recommends chemo-prophylaxis at least for the first 1 to 3 months of a long-term stay. Further medical advice, should be given by a local specialist. This specialist should be experienced in malaria prophylaxis of non-immune patients. Chemo-prophylaxis is particularly important where the risk is higher (e.g. rainy season, insufficient exposure prophylaxis). Even more so with tourists, a thorough risk-benefit-calculation is necessary. For long-term stays and where chloroquine is taken, the WHO recommends an ophthalmological review of the retina every six months to see if there have been any changes, beginning five years after the onset of uninterrupted prophylaxis (with intake of 100 mg/week), and after three years (with intake of 100 mg/day).

For frequent missions, which apply particularly for flight crews – The European Authorities recommend some form of chemo-prophylaxis, whereas the WHO favours a standby prophylaxis. For pilots, only chemo-prophylaxis with chloroquine / proguanil is approved.

Checklist for malaria advice (after DTG, May 2006)

1. **Information about malaria risk.**
2. **Pregnant women and children under 5 years should abstain from stays in risk areas.**
3. **Information about exposure prophylaxis (avoiding insect bites and stings).**
4. **Information that malaria may occur even with thorough prophylaxis.**
5. **Information about symptoms of malaria and necessity to consult a doctor.
Information about the potential lethal course in case of delayed diagnosis and therapy.**
6. **Consider previous diseases, intake of medicine, allergies, existing or intended pregnancy, tolerance of previous chemo-prophylaxis.**
7. **Consider intended activities during stay (diving, mountain climbing).**
8. **Information about necessity of regular intake of chemo-prophylactic drugs before, during and after staying in risk area. If applicable information about mode of intake of standby therapy.**
9. **Information about side effects of anti-malarial medication.**
10. **Written information should be given as a handout.**
11. **If medicine is purchased abroad, only those approved in Europe should be bought.**

5.2 Diagnosis and Therapy

Early diagnosis and immediate treatment of malaria is essential. The most insidious form of malaria, Falciparum Malaria, caused by *Pl. falciparum* can be lethal within a couple of days, because the complications can occur so rapidly. Often, a delay in the diagnosis and therapy by the patient and / or the doctor may result in a fatal outcome. A mistaken diagnosis for example, can include an illness like influenza, which can be fatal. Flight crews have to be informed about incubation periods, symptoms, diagnostic and therapeutic possibilities, both at the tropical destination and at home.

Every febrile disease, from 7 days after up to several months, (cases even after one year are known) **after staying in risk areas, malaria should be suspected until the opposite has been proved.** Even without a typical course of fever, malaria has to be suspected. In cases of malaria breaking through despite proper prophylaxis, the symptoms may be atypical. The course of the disease can be protracted. Malaria (especially insidious Falciparum Malaria) can be ruled out if the thick film is negative. This is furthermore confirmed by negative fluorescence-micro-haematocrit enrichment (quantitative buffy coat or QBC) absence of anaemia and haptoglobin reduction, thrombocytopenia and splenomegaly.

The diagnosis is established by thick and thin film. Whereas a positive thick or thin film proves a malaria, negative ones does not exclude a malaria. Therefore, thick and thin films have to be every 12 to 24 hours

several times in case of negative results. The thick film is a method of enrichment. If the type of plasmodia has not been determined by thick film, the thin film reveals this information. Immuno-chromatographic **quick tests** are only supplementing these tests and do not replace them as they might be false negative. They are not feasible as "Do it yourself"-tests for flight crews.

After a diagnosis of malaria has been made, therapy has to begin immediately. In case of doubt it is better to start therapy, rather than to wait for time consuming additional tests. In Europe even uncomplicated cases of malaria should be treated in hospital. **If a member of a flight crew contracts malaria he / she is unfit for flying duties until 4 weeks after successful treatment.**

6 Intestinal or food-borne infections

6.1 Travellers' diarrhoea

Travel diarrhoea is the most frequent disorder encountered in tropical and sub-tropical regions (at least 30 to 50 % of travellers). Risk and incidence increase with poor hygienic conditions. Eating with local people and food purchased from street vendors pose a special risk. Ice produced from unknown water sources is a common cause of travel diarrhoea.

The infection is acquired by fecal-oral transmission and is caused by contaminated food, beverages or smear/saliva infection. Causative agents are bacteria (e.g. enteric salmonella, pathogenic Escherichia coli, especially ETEC, Shigella, Yersinia and Campylobacter), their toxins (which can cause the food poisoning), several viruses (e.g. Rota and Norwalk virus) and protozoa. The most common are Amoeba and Giardia, and with increasing frequency Cryptosporidia. In acute diarrhoea, bacteria is the most common cause. In chronic diarrhoea, parasites are the most common cause.

Risk factors for travellers' diarrhoea

Destination Season (in subtropical destinations) Duration of stay Style of stay (Hotel during Layover < circular tour < adventure trip) Lodging, low standard of hygiene Neglect of food and beverage hygiene Reduced gastric acid (H₂-Blockers, Proton Pump Blockers, previous gastric resection) Reduced immune response Previous stay in third-world country (> 6 m before)

6.1.2 Clinical features and diagnosis

Normally travellers' diarrhoea starts on the third day of stay. **The incubation period** can be only some hours, or up to several days. Bacterial and viral infections are usually of 6 to 12 hours. A shorter incubation (frequently only 30 minutes) is normally caused by food poisoning. Typical symptoms are, more than three liquid stools. Every type of diarrhoea can cause dehydration and a reduction of the electrolytes, potassium and bicarbonate. **The mean duration** is 3 to 4 days, 10 % may take more than one week, and only 1 % may result in a chronic form of diarrhoea (duration > 3 weeks).

Uncomplicated diarrhoea is common, presenting as gastroenteritis or entero-colitis with watery diarrhoea, rarely covered by mucus, diffuse abdominal pain, vomiting and temperatures of maximum 38,5°C. Typical for dysentery (up to 10 % of travel diarrhoea) are stools mixed with blood or pus (resulting from invasion of the colonic mucosa), intestinal cramps and fever up to > 40°C.

Most patients suffer a self-limiting disorder, and often by the time a visit is made to the physician, the symptoms have subsided. Therefore, a **diagnosis is not necessary** in most cases. If further diagnostic is intended, Salmonella, Shigella, Yersinia and Campylobacter should be checked for. Negative results do not rule out an infectious cause, because travel diarrhoea is almost always of an infectious origin. Many leukocytes detected by stool examination may indicate dysentery or invasive enteritis. However, in case of a fever > 38,5 °C and / or blood or pus, further diagnostic tests are mandatory.

6.1.3 Therapy

Symptomatic treatment – mostly as self-therapy (This information has to be given to flight crew) - and is usually sufficient. Fever > 38,5 °C and / or blood or pus, makes it necessary for a consultation with a doctor and the fever will require specific therapy.

a) Symptomatic Therapy

Fluid loss resulting from diarrhoea requires urgent fluid replacement. Motility inhibitors may be used as a supplementary measure:

Rehydration

- Mild cases: fruit juice, tea with sugar, broth, juice of coconut, in children, cola and salt sticks.
- More severe cases: solution recommended by WHO (sodium chloride 3.5 g, sodium bicarbonate 2.5 g, potassium chloride 1.5 g, glucose or sugar 40.0 g, water ad 1000 ml, available also as ready mix e.g. Elotrans®, Oralpädon®, Rehydrat, Dioralyte, etc or a do it yourself solution with a 10ml spoonful of glucose or sugar, a 5ml teaspoon of salt or half salt/ half baking powder plus one litre of fluid.
- Fluid loss of > 10 % body weight: infusion therapy.

Motility Inhibitors

- Loperamid (Imodium®): initially 2 cps (4 mg), then 1 cps (2 mg) after every subsequent loose bowel movement
Max. 12 mg/24 h, not to be used for more than 48 hr, not to be used for children < 2 a or dysentery (fever or bloody diarrhoea).

b) Specific Therapy

In case of cholera or infection with Shigella, parasites, typhoid fever or para-typhus a specific treatment by specific antibiotics is required. Otherwise a calculated antibiotic treatment can be prescribed for 3 to 5 days. Antibiotics do not replace fluid replacement! **Whilst taking antibiotic therapy, flight crew are unfit for flying duties, until they are fully recovered and the antibiotic therapy has been stopped.**

Antibiotic therapy for travellers' diarrhoea

Disease	Therapeutic Options
Diarrhoea without knowledge of the causative agent (calculated antibiosis)	Ciprofloxazin 2 x 500 mg/24 h for 3 – 5 days Norfloxazin 2 x 400 mg/24 h for 3 – 5 days Ofloxazin 2 x 200 mg/24 h for 3 – 5 days
Cholera	Tetracycline 2 x 500 mg/24 h for 5 days
Shigella	Ampicillin 2 - 4 x 500 mg/24 h for 5 days Trimethoprim/Sulfamethoxazol 160 mg/800 mg 2 x 1/24 h for 5 days Ciprofloxazin 2 x 500 mg/24 h for 3 – 5 days Norfloxazin 2 x 400 mg/24 h for 3 – 5 days Ofloxazin 2 x 200 mg/24 h for 3 – 5 days
Campylobacter	Azithromycin 1 x 500 mg for 3 days Erythromycin 4 x 500 mg/24 h for 7 days
Giardia	Tinidazole/Metronidazole 2 g as a single dose

6.1.4 Prophylaxis

Food and beverage hygiene act as a exposure prophylaxis against travel diarrhoea and other intestinal infections

- ⇒ Only use fresh boiled (tea, coffee) or originally bottled and sealed beverages
- ⇒ In the field, use water filters, iodine etc. for water treatment
- ⇒ No ice into drinks, no ice cream
- ⇒ No raw milk or dairy products
- ⇒ Only well-done or well-boiled meat or fish
- ⇒ Avoid raw fish and raw seafood
- ⇒ No raw salad only fruits, that can be peeled by oneself or under ones own supervision
- ⇒ No dishes with cold dressings (e.g. ketchup), mayonnaise or products of raw eggs
- ⇒ No sandwiches with salad or mayonnaise
- ⇒ Avoid dishes that have been kept warm for long periods of time. The fresh and thorough preparation of food is essential.
- ⇒ Thorough hand and body hygiene
- ⇒ Use mineral water for brushing teeth
- ⇒ Avoid tableware and cutlery that may have cleaned in dirty water (if applicable drinking from bottle or can)

Peel it, boil it or forget it!

Medical prophylaxis is only indicated in very rare cases (e.g. high-ranking business travellers, sportsmen prior to competition, patients with chronic inflammation bowel disease or gastric resection. Ciprofloxacin-1x 250/500 mg/daily).

This is not approved for flight crews.

6.2 Amoebiasis

Amoebiasis occurs in tropical and subtropical areas. Most cases seen in temperate zones are imported. Amoebae are rarely a cause for travel diarrhoea. The causative agent in Amoebic dysentery is a pathogenic protozoa called *Entamoeba Histolytica*, which is potentially invasive. About 10 % of the world population is infested with *Entamoeba Histolytica*. Nevertheless, most of those infested with *Entamoeba* exhibit the apathogenic type called *Entamoeba dispar*, which appears and behaves like *E. histolytica*. The two can be differentiated by molecular genetic and protein chemical measurements. Both species infest the lumen of the colon, but only *E. histolytica* can invade the bowel wall. Only the pathogenic *E. histolytica* results in the formation of antibodies. Proteins, which have a particular pattern of iso-enzymes, the (so-called zymodemes), are responsible for the pathogenic effects of *E. histolytica*.

The infection is acquired by fecal-oral transmission. Cysts are ingested in contaminated water and food. The risk of infection depends on the hygienic standards of the person excreting the cysts and the potential recipient. Cysts are resistant against gastric acid and go through a development to trophozoites, so-called minuta forms in the small intestine. These multiply and colonize the upper colon. In the lower colon cysts are developed and excreted. Only in the case of accelerated intestinal passage (diarrhoea) are the minuta forms excreted. Magna forms develop from minuta forms and are characterized by phagocytized RBC, which may invade the wall of the colon. **Amoebic cysts are frequently found in flight crew.**

6.2.1 Clinical features

The **asymptomatic luminal infection** shows excretion of cysts without clinical symptoms. **Invasive amoebic disease** starts with invasion of the bowel wall. It shows different clinical features: In **amoebic dysentery** abdominal pain, tenesmus, diarrhoea with blood and mucus (raspberry jelly stool) develop within 2 to 3 weeks. The clinical course may vary between common diarrhoea with only occult blood, to more than 20 bloody bowel movements a day. Complications such as perforation, peritonitis, and toxic mega-colon may occur. An **Amoebic liver abscess** develops after the invasion of the blood vessels and is the most frequent extra-intestinal complication. Severe pain in the right upper abdomen, fever and severe malaise are typical. Complications are hepatic failure, perforation into abdominal cavity or thorax, causing diaphragmatic pain and severe shortness of breath. The most severe complication can be a brain abscess. Rigors are common and may be mistaken initially for malaria

6.2.2 Diagnosis

Luminal infection is diagnosed by laboratory's specialising in tropical diseases. This requires studying fresh stools or by using enrichment methods. Using **zymodeme** (isoenzyme analysis), *E. histolytica* and *E.*

dispar can be differentiated as well as by **Stool culture** and **PCR**. **PCR** or **Stool Antigen ELISA** can detect *E. histolytica* directly. Invasive amoebiasis, is proved by **specific antibodies** (mostly by the beginning of clinical symptoms or at least 1 week after).

Procedure if amoebic cysts have been detected

- **Asymptomatic excretion of cysts** → **serology (test for specific antibodies)**
 - **Negative serology** → **asymptomatic luminal infection, probably *E. dispar***
 - **Positive serology** → **PCR / Zymodeme to differentiate *E. dispar* / *E. histolytica***
- **Symptomatic excretion of cysts** → **serology and PCR / Zymodeme to differentiate *E. dispar* / *E. histolytica***

Amoebic liver abscess is diagnosed by ultrasound (CT or NMR), supplemented by serology.

6.2.3 Therapy

Therapy of amoebiasis (Modified after Lunzen, Tannich, Burchard, Dt. Ärzteblatt 93, 51 - 52)

Diagnosis	Drug	Dosage	Time of treatment
Luminal infection	Paromomycin	25 - 35 mg / kg / d, tid	7 days
	Diloxanidfuroat	3 x 500 mg p.o.	10 days
Amoebic dysentery	Metronidazole	3 x 10 mg/kg KG p.o. or i.v	10 days
	Tinidazole	2 g / d p.o.	5 days
Amoebic liver abscess	Metronidazole	3 x 10 mg/kg KG i.v.	10 days

In invasive amoebiasis, a luminal infection is present as well and should be treated with Paromomycin or Diloxanidfuroat (available in the U.K.) (Paromomycin is more effective than Diloxanidfuroat) after treatment with tissue amebicidal drugs like Metronidazol or Tinidazol and the amoebic colitis has been cured. Success of intestinal eradication should be checked after about 6 weeks by microscopic stool diagnosis. **During medication with either drug, members of flight crew are not fit to fly.** The **side effects** of the medication can include extra-pyramidal tremors and a severe reaction with any form of alcohol. In asymptomatic luminal infection, fitness for flying is not restricted. Flight crew are not fit for flying duties with amoebic dysentery or with liver abscess or other manifestations. 2 weeks after successful treatment (proved by ultrasound, CCT, NMR, EEG depending on clinical manifestation), flight crew may return to duty.

6.3 Giardiasis

Giardiasis (Lambliasis) occurs worldwide. In temperate areas up to 10 % of diarrhoea, and in the third world up to 20 % is caused by *Giardia*. The causative agent is the protozoa *Giardia lamblia*. Humans are a source of infection, particularly children, who can excrete very many cysts. Transmission is via the oral faecal route, or by smear infection or from contaminated food and water.

The **course of disease** varies between the asymptomatic excretion of cysts, to heavy diarrhoea and malabsorption. Early symptoms include diarrhoea, nausea, vomiting, intestinal hurry and abdominal pain. This can continue for about 1 to 2 weeks. Chronic Giardiasis may develop, even without the previous acute phase. Symptoms appear continuously or intermittently with intestinal hurry, diminished consistence of stool, sometimes diarrhoea, and a loss of weight. Severe cases show malabsorption, reduced growth rates in children, dehydration, and very rarely, a fatal outcome.

Cysts and trophozoites can be detected in fresh stool analysis by naked eye microscopic **diagnosis** or in conserved stool by enrichment methods in specialized laboratories. Antigenic stool tests are a new development. Sometimes diagnosis has to be more invasive by taking biopsy specimens from the jejunum.

Tinidazole (Simplotan®) 2 g as single dose is used for **therapy**. If necessary, this treatment can be repeated after 7 days. Alternatively, Metronidazole (Clont®, 2 g/d for 3 d or 3 x 400 mg for 5 – 7 d) can be used. During pregnancy Paromomycin should be used. During medication with either of the drugs **members of flight crew are not fit for flying duties**. Success of intestinal eradication should be checked after about 6 weeks by microscopic stool diagnosis.

6.4 Cryptosporidia

Intestinal infections by cryptosporidia are occurring with increasing frequency. Cryptosporidia are now resistant against chlorides. Therefore the usual chloride treatment of drinking water cannot now prevent this type of infection.

Transmission is via the oral-faecal route. In immuno-competent persons a self-limiting course of 1 to 4 weeks can be found with diarrhoea, fever and febrile symptoms. A specific therapy is not necessary. Severe disease occurs in immuno-deficient patients. In these cases Paromomycin (Humatin®, 4 x 500 mg/d p.o. for 14 – 28 d, then 2 x 500 mg/d p.o. as suppression therapy for long-time) is used for treatment. **Whilst taking such medication, flight crew are not fit for flying duties.** Exposure prophylaxis should ensure that all drinking water should be filtered.

7 Patients with symptoms after visits to tropical areas

A host of other tropical diseases occur outside of Europe, most are of little significance for flight crews. Nevertheless, they may be of significance in the differential diagnosis of patients who complain of symptoms such as fever, diarrhoea, exanthema, and jaundice, after visits to the tropics. In patients presenting with fever or even unspecific symptoms, malaria should be suspected after staying in endemic areas. Diarrhoea with fever and / or bloody stools, or chronic diarrhoea should be diagnosed also be diagnosed meticulously. Diagnosis should be performed in hospitals and treatment given by physicians, who specialise in tropical medicine.

Differential Diagnosis for Fever after staying in tropical areas

<ul style="list-style-type: none"> Malaria Infections of upper respiratory tract Acute Hepatitis Typhus / Para-typhus Amoebiasis, Liver abscess Acute phase of helminthic infections e.g. Katayama Fever Dengue Fever and other Arbo-virus Infections Campylobacter Enteritis Borreliosis Rickettsiosis Visceral Leishmaniasis

Differential Diagnosis of Diarrhoea

<ul style="list-style-type: none"> Amoebiasis Giardiasis Shigellosis Enteric Salmonellosis Campylobacter Enteritis

Differential Diagnosis of Exanthema and other disorders of skin

<ul style="list-style-type: none"> Pyodermia Dermatomycosis Ektoparasites Larva migrans Cutaneous leishmaniasis Filariasis Myiasis

Dengue Fever is a common diagnosis for febrile patients who have stayed in endemic zones. Where flight crews are concerned this disease represents an important differential diagnosis with malaria. Infections occur worldwide in the tropics and subtropics and have spread in the past years, especially into conurbations. The disease is caused by a flavivirus (4 Serotypes) and transmitted by Aedes mosquitoes (active day and night). After an incubation period of 2 – 7 days patients complain of a biphasic fever up to 40 °C, severe muscle and limb pain (break bone fever), headache, malaise, and generalized exanthema. After malaria has been ruled out, the diagnosis is established clinically and can be verified by an increase of antibodies. The only treatment required is symptomatic.

The administration of antipyretics and analgesics such as Paracetamol can be used. Acetylsalicylic Acid should however be avoided. The complications of **Dengue Haemorrhagic Fever** and **Dengue Shock Syndrome** are very rare in travellers. Treatment requires intensive care medicine.

Apart from Hepatitis A and B, Hepatitis C, D, E, can be encountered in tropical areas as well as in Europe. This depends on the local epidemiology. Clinical diagnosis and treatment do not differ either. Exposure prophylaxis include, avoiding contact with blood and body fluids (Hepatitis C and D) and the practice of good food hygiene (Hepatitis E) is recommended.

Bacterial diseases like Borreliosis (Relapsing Fever), Rickettsiosis (different febrile diseases presenting as atypical pneumonia or cyclic general infections are often accompanied by exanthema). Protozoal diseases like visceral leishmaniasis or trypanosomiasis, are fairly rare in travellers and in flight crews.

Haemorrhagic Fevers such as Lassa, Marburg and Ebola Fever are very rare and of little significance for flight crews. When patients suffering from these particular fevers or any other type of infectious disease have been transported by air, the flight surgeon has the responsibility to inform any member of the crew that flew that particular aircraft. The Flight Surgeon should offer the crew an examination or a transfer to a specialized institution. The Flight Surgeon is also obliged to report the matter to the health authorities according to the local health regulations.

8 Other Tropical diseases and Infections

There are some tropical diseases that are rarely encountered by flight crews. In this context it should be mentioned, that a lot of diseases occurring in tropical and subtropical areas are not typical tropical diseases. This applies to diseases that may occur even in temperate zones, but having a much higher prevalence in the tropics than in Europe where they may have been eradicated.

Helminthic diseases can be avoided by good food hygiene or by exposure prophylaxis. Rare infections and complications such as Hydatid disease caused by *Echinococcus granulosus* or Cysticercosis caused by *Taenia solium* with intracerebral symptoms renders flight crews unfit for flying duties.

The infection **Schistosomiasis** (Bilharziosis) is marked by an initial period of fever (Katayama Fever) and then an infection of wall of bladder and the colon. This causes haematuria and bloody stools. One of the complications can be portal hypertension. The infection can be avoided in tropical areas by not swimming or walking in lakes and rivers. Helminthic infections that are transmitted by insect vector's are not of any real significance for flight crews.

A further disease transmitted by ticks is Borreliosis, which is caused by different species of *Borrelia*. It appears in three stages with skin, joint, cardiac and neurological symptoms. There is no vaccination for the European form of the disease. Antibiotics are given as therapy. **Flight crew are unfit for flying duties until successful treatment has been documented.**

Sexual transmitted diseases as well as HIV infection can be avoided by sensible sexual hygiene and precautions. The flight surgeon should not hesitate to advise flight crew on this subject.

Flight crews may encounter many types of skin disease, when they are operating in tropical areas. **Larva migrans. (Creeping Eruption), is one type of this condition.** This can be diagnosed by seeing lines like threads appearing on the skin that are slightly raised above the skin level. The disease is caused by, the larva of *ankylostoma*. This is found in dogs. It is common after skin contact with sand on beaches that is contaminated by dog faeces. Walking on beaches with bare feet can also result in another disease caused by the sand flea called **Tunga Penetrans**. This can present as a severe irritation, with secondary infection and ulceration in the inter-digital, sub-ungual and genito-anal areas. Tetanus and gangrene are occasional complications. The developing larvae of the dipterous flies cause **Myiasis**, after the eggs have been deposited under the skin. This is a relatively uncommon in humans. It often occurs by accident. Sweating and poor hygienic conditions encourage fungal infections. This is encountered more readily in the tropics. Good hygiene and cotton clothes can prevent these diseases. **Ectoparasitic infections** such as scabies, lice, fleas, and bed bugs are more likely to be encountered where there are poor living conditions and where there is poor personal hygiene amongst the flight crew. **Prickly heat** is a condition of the sweat glands caused by heavy sweating, more so in tropical areas. It can be avoided by using the correct clothing and by using the appropriate body hygiene.

Other food borne diseases like **Ciguatera, tetrodotoxin, and paralytic shellfish poisoning** present with light to severe neurological symptoms, nausea, vomiting and diarrhoea, and can be prevented by not eating certain fish. When flight crews are operating in areas where these diseases occur, and they present with typical symptoms, they can be treated by symptomatic therapy. The symptoms normally subside after a couple of weeks.

Haemoglobinopathies such as sickle cell anaemia (drepanocytosis) or thalassaemia are common in people originating from tropical areas. These conditions have to be taken into account by flight surgeons examining applicants from tropical areas or of African origin. These genetic abnormalities are of significance because the homocytotic form will make someone unfit for the flying environment and for flying duties. Fitness with the heterocytotic form depends on the actual haematological variables.

The Haematocrit values should be > 32 % for flight crews on duty.

Venomous fish. There are over 100 fish species that have proved dangerous to man. Most are found in tropical areas. When handling any fish dead or alive, great care must be taken. Unnecessary contact with fish should be avoided in the vicinity of Coral reefs. This is important for scuba divers and those who snorkel.

9 Medical Fitness for Air Crews after Infectious Diseases (Guidelines for Medical Assessment)

Disease	Condition	Period of Unfitness	Notes
African Tick Typhus			See Rickettsial Diseases
African Trypanosomiasis			See Trypanosomiasis
AIDS			See HIV
American Trypanosomiasis			See Chagas Disease
Amoebiasis	Asymptomatic Luminal Infection	No restriction	
	Amoebic Dysentery	Unfit until therapy and full recovery	
	Liver Abscess	2 w after therapy and full recovery	No residual mass in ultrasound
	Other manifestation	2 w after therapy and full recovery	In case of brain abscess or meningoencephalitis if no residual mass in CCT or NMR and normal EEG
Anaemia	HK < 32 %	unfit	
Ancylostoma duodenale			See Helminthic Diseases
Angiostrongyliasis			See Helminthic Diseases
Anthrax	All forms of disease	2 w after therapy and full recovery	No spores or vegetative forms of B. anthracis in bacteriologic studies
Antibiotics		Until cessation of therapy	
Arboviral Encephalitis		4 w after therapy and full recovery	In case of normal EEG and absence of convulsive periods. In case of symptomatic epilepsy on discretion of AMS
Arbovirus Fever	Chicungunya (CHIK)	4 w after therapy and full recovery	No restriction of joint mobility
	O'Nyong Nyong (ONN)	4 w after therapy and full recovery	No restriction of joint mobility
	Oropouche Fever	2 w after therapy and full recovery	
	Ross River Fever (RR), Epidemic Polyarthritis	4 w after therapy and full recovery	No restriction of joint mobility
	Sandfly (SF) Fever, Pappataci Fever Phlebotomus Fever	2 w after therapy and full recovery	
Argentinian Hemorrhagic Fever			See Haemorrhagic Fever
Ascariasis			See Helminthic Diseases
Aspergillosis			See Fungal Pulmonary Infections
Bacillus anthracis			See Anthrax
Bacterial Meningitis			See Meningitis
Balantidium coli	Asymptomatic Infection	No restriction	
	Symptomatic infection	After therapy and full recovery	
Bartonella henselae			See Cat Scratch Disease
Bartonella bacilliformis	Oroya Fever		See Bartonellosis
	Verruga peruana		See Bartonellosis
Bartonellosis	Cat Scratch Disease	2 w after therapy and full recovery	Normal liver function tests and normal neurological examination
	Oroya Fever	2 w after therapy and full recovery	
	Verruga peruana	No restriction	
Beta Thalassaemia			See Thalassaemia
Blastocystis hominis	Asymptomatic Infection	No restriction	
	Symptomatic infection	Until therapy and full recovery	

Cont'd

Medical Fitness for Air Crews after Infectious Diseases (Guidelines for Medical Assessment) (Cont'd)

Disease	Condition	Period of Unfitness	Notes
Blastomycosis			See Fungal Pulmonary Infections
Bolivian Hemorrhagic Fever			See Hemorrhagic Fever
Borreliosis	Lyme Disease , skin, joint and peripheral enurologic manifestation	Until therapy and full recovery	Individual assessment by serodiagnostic
	Lyme Disease , cardiac manifestation	Until therapy and full recovery	Echocardiogram must demonstrate normal contraction and ejection and 24 h ECG must demonstrate absence of significant arrhythmias
	Lyme Disease , encephalitis and meningitis	Until therapy and full recovery	Neurological examination and EEG must be normal
	Relapsing Fever	4 w after therapy and full recovery	Normal ECG, 24 h ECG, Echocardiogram, liver function tests and normal neurological examination
Burkholderia			See Melioidosis
Buruli Ulcer		No restriction	Normal function of limbs, sufficient local therapy and sufficient hygienic conditions
Campylobacter			See Travel Diarrhoea
Carrion Disease	Oroya Fever		See Bartonellosis
	Verruga peruana		See Bartonellosis
Cat scratch Disease			See Bartonellosis
Chagas Disease	American Trypanosomiasis	Unfit	Unless assessed fit by AMS in absence of cardiac and gastrointestinal complications after meticulous tests (e.g. normal ECG, 24 h ECG, Echocardiogram, gastrointestinal studies)
Chicungunya (CHIK)			See Arbovirus Fever
CHIK Virus	Chicungunya (CHIK)		See Arbovirus Fever
Cholera		2 w after therapy and full recovery	
Ciguatera			See Seafood Toxins
Clonorchis sinensis			See Helminthic Diseases
Clostridium perfringens			See Travel Diarrhoea See Gas Gangrene
Clostridium tetani			See Tetanus
Coccidioides immitis			See Fungal Pulmonary Infections
Coxiella burneti			See Rickettsial Diseases
Creeping eruption		No restriction	
Crimean Congo Haemorrhagic Fever			See Haemorrhagic Fever
Cryptococcus		Unfit	Infection is sign for impaired immunity in HIV Infection
Cryptosporidium parvum	Unspecific Diarrhoea		See Travel Diarrhoea
	In HIV Patients	Unfit	Infection is sign for impaired immunity in HIV Infection
Cutaneous Leishmaniasis			In case of absence of functional sequelae (i.e. no restriction of joint movement by scar formation etc.)
Cyclosporidia			See Travel Diarrhoea
Cysticercosis			See Helminthic Diseases

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Medical Fitness for Air Crews after Infectious Diseases (Guidelines for Medical Assessment) (Cont'd)

Disease	Condition	Period of Unfitness	Notes
Cytomegalia (CMV-Infection)	Mostly asymptomatic in immuno-competent hosts	No restriction	
	In HIV Patients	Unfit	Infection is sign for impaired immunity in HIV Infection
Dengue Virus	Dengue Fever	2 w after full recovery	Rule out Malaria!
	Dengue Shock Syndrome	4 w after therapy and full recovery	
	Dengue hemorrhagic Fever	4 w after therapy and full recovery	
Dracunculus medinensis			See Helminthic Diseases
East American Equine Encephalitis (EEE)			See Arboviral Encephalitis
Ebola Virus			See Hemorrhagic Fever
Ebstein Barr Virus (EBV)			See Mononucleosis
Echinococcus			See Helminthic Diseases
EEE Virus	East American Equine Encephalitis (EEE)		See Arboviral Encephalitis
Ehrlichiosis			See Rickettsial Diseases
Encephalitis		4 w after therapy and full recovery	In case of normal EEG and absence of convulsive periods. In case of symptomatic epilepsy on discretion of AMS
Endemic Syphilis	Early Lesions	2 w after therapy and full recovery	
	Late Lesions	Unfit	Unless rendered fit by AMS
Entamoeba histolytica			See Amoebiasis
Enterobius vermicularis			See Helminthic Diseases
Epidemic Polyarthritits			See Arbovirus Fever
Epizoonosis		Unfit until infestation has been eradicated	
Escherichia coli			See Travel Diarrhoea
Falciparum Malaria			See Malaria
Fasciola			See Helminthic Diseases
Fasciolopsis buski			See Helminthic Diseases
Fièvre Boutonneuse			See Rickettsial Diseases
Filariasis			See Helminthic Diseases
Fleas			See Epizoonosis
Framboesia			See Yaws
Fungal Skin Infections		No restriction	
Fungal Pulmonary Infections, Systemic Fungal Infections	Fungal Pulmonary Infections	2 w after therapy and full recovery	Successful treatment must be demonstrated by Chest X-ray
	Other systemic manifestations	2 w after therapy and full recovery	Successful treatment must be demonstrated by ultrasound (liver), EEG (meningitis)
Gas Gangrene	Clostridial Myositis	4 w after therapy and full recovery	
Giardiasis	Asymptomatic Disease	No restriction	
	Symptomatic Disease	Until therapy and full recovery	
Glucose-6-phosphate dehydrogenase deficiency		No restriction	If oxidative stress due to antimalarials, antibiotics, analgesics, antihelminthic drugs and certain type of food (Fava Beans) are avoided. These Persons should obtain no missions to the tropics

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Medical Fitness for Air Crews after Infectious Diseases (Guidelines for Medical Assessment) (Cont'd)

Disease	Condition	Period of Unfitness	Notes
Gonorrhoea		Until therapy and full recovery	
Granuloma inguinale		Until therapy and full recovery	
Guanarito Virus	Venezuelan Haemorrhagic Fever		See Haemorrhagic Fever
Haemorrhagic Fever		4 w after therapy and full recovery	Successful recovery has to be proved by meticulous clinical and laboratory examination, 24h ECG and echocardiography
Hantavirus Haemorrhagic Fever			See Haemorrhagic Fever
Helminthic infections	Asymptomatic or unspecific Disease	No restriction	
	Anaemia	Unfit	HK < 32 %
	Portal Hypertension	Unfit	Unless rendered fit by AMS
	Cysticercosis	4 w after therapy and full recovery	No residual mass in CCT or NMR and normal EEG, normal extended ophthalmologic examination (no mass)
	Filariasis (Lymphatic)	Unfit	In case of Elephantiasis. See also Onchocerciasis
	Cystic Hydatid Disease	2 w after therapy and full recovery	Successful treatment must be demonstrated by ultrasound (liver), CT (lungs, peritoneal cavity)
	Alveolar Hydatid Disease	Unfit	Unless definite healing is demonstrated
Hemoglobin, abnormal, Hemoglobin Disorder	Homocytotic	Unfit	
	Heterocytotic	No restriction	HK < 32 %
Hepatitis	Hepatitis A	After therapy and full recovery	
	Hepatitis B acute	After therapy and full recovery	
	Hepatitis B chronic	Unfit	Unless Chronic Persisting Hepatitis, no impairment of mental abilities, in regular testing AFP normal or after successful therapy (sero conversion, normal liver function tests)
	Hepatitis C acute	After therapy and full recovery	
	Hepatitis C chronic	Unfit	Unless Chronic Persisting Hepatitis, no impairment of mental abilities, in regular testing AFP normal or after successful therapy (sero-conversion, normal liver function tests)
	Hepatitis D acute	After therapy and full recovery	
	Hepatitis D chronic	Unfit	Unless Chronic Persisting Hepatitis, no impairment of mental abilities, in regular testing AFP normal or after successful therapy (sero-conversion, normal liver function tests)
	Hepatitis E	After therapy and full recovery	
	Hepatitis F	After therapy and full recovery	No clinical significance
	Hepatitis G	After therapy and full recovery	No clinical significance

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Medical Fitness for Air Crews after Infectious Diseases (Guidelines for Medical Assessment) (Cont'd)

Disease	Condition	Period of Unfitness	Notes
Histoplasma capsulatum			See Fungal Pulmonary Infections
HIV		Unfit	Unless assessed fit by AMS
Hookworm			See Helminthic Diseases
Hydatid Disease			See Helminthic Diseases
Hymenolepis nana			See Helminthic Diseases
Immunization			See Vaccination
Influenza		Unfit until full recovery	
Intestinal Flukes			See Helminthic Diseases
Invasive Salmonellosis			See Typhoid Fever
Ippy Virus			See Haemorrhagic Fever
Isospora belli			See Travel Diarrhea
Japanese Encephalitis		4 w after therapy and full recovery	
Junin Virus	Argentine Haemorrhagic Fever		See Haemorrhagic Fever
Kala Azar	Visceral Leishmaniasis	4 w after therapy and full recovery	
Kaposi Sarcoma		No restriction	In case of absence of systemic manifestations
Katayama Fever		Unfit in acute stage	See Trypanosomiasis
Kyasanur Forest Fever			See Haemorrhagic Fever
Larva currens	Strongyloides Infection		See Helminthic Diseases
Larva migrans		No restriction	Infection by ancylostoma pathogenic for dogs
Lassa Fever			See Haemorrhagic Fever
Legionella pneumophila	Legionnaire's Disease	2 w after therapy and full recovery	
Leishmania aethiopica			
Leishmania braziliensis			
Leishmania chagasi			See Kala azar
Leishmania donovani			See Kala azar
Leishmania guyanensis			
Leishmania infantum			See Kala azar
Leprosy	Lepromatous Leprosy	4 weeks after therapy and full recovery	Normal ophthalmological findings, normal audiogram and, in case of meningitis, normal EEG and absence of convulsive periods and normal neurological evaluation
	Tuberculoid Leprosy	Unfit	Unless neurological, renal, ophthalmologic complications have been ruled out and in case of normal ophthalmological findings, normal audiogram and, in case of meningitis, normal EEG and absence of convulsive periods and normal neurological evaluation
Leptospira	Leptospirosis		See Leptospirosis
Leptospirosis	Weil's disease	2 w / 4 w after therapy and full recovery	Depending on severity of clinical course
Lice			See Epizoonosis
Loa Loa			See Helminthic Diseases
Loiasis			See Helminthic Diseases

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Medical Fitness for Air Crews after Infectious Diseases (Guidelines for Medical Assessment) (Cont'd)

Disease	Condition	Period of Unfitness	Notes
Louse Borne Relapsing Fever			See Borreliosis
Louse Borne Typhus			See Rickettsial Diseases
Lung Flukes			See Helminthic Diseases
Lymphatic Filariasis			See Helminthic Diseases
Machupo Virus	Bolivian Haemorrhagic Fever		See Haemorrhagic Fever
Malaria	Malaria suspected or proved	Unfit	
	after therapy and recovery	4 w	
	After chemoprophylaxis with Resochin/Paludrin	No restriction	
	After Chemoprophylaxis with Mefloquine or Atovaquon/Proguanil	4 w	
	After Standby Therapy with Chloroquine, Mefloquine, Atovaquon/Proguanil or Artemether/Lumefantril	4 w	
Marburg Fever			See Haemorrhagic Fever
Marburg Virus			See Haemorrhagic Fever
Measles		Until full recovery	Infectious until 2 d after onset of exanthema
Melioidosis		Until full recovery	
Meningitis		4 w after therapy and full recovery	Normal EEG and absence of convulsive periods and normal neurological evaluation. In case of symptomatic epilepsy on discretion of AMS
Meningococci			See Meningitis
Microsporidia	Unspecific Diarrhea		See Travel Diarrhoea
	In HIV Patients	Unfit	Infection is sign for impaired immunity in HIV Infection
Mites			See Epizoonosis
Mite Typhus			See Rickettsial Diseases
Monkey Pox		4 w after therapy and full recovery	Extended ophthalmological examination must be normal
Mononucleosis		2 w after therapy and full recovery	Normal size of spleen (Ultrasound)
Mopeia Virus			See Haemorrhagic Fever
Mucocutaneous Leishmaniasis		No restriction	In case of absence of functional sequelae
Mucosal Leishmaniasis			See Mucocutaneous Leishmaniasis
Murray Valley Encephalitis (MVE)			See Arboviral Encephalitis
Murine Typhus			See Rickettsial Diseases
MVE Virus	Murray Valley Encephalitis (MVE)		See Arboviral Encephalitis
Mycobacterium leprae			See Leprosy
Mycobacterium tuberculosis			See Tuberculosis
Mycobacterium bovis			See Tuberculosis
Mycobacterium ulcerans			See Buruli Ulcer
Myiasis	Facial Manifestations		Normal extended ophthalmological and ORL examination
Necator americanus			See Helminthic Diseases
Neisseria gonorrhoeae			See Gonorrhoea

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Medical Fitness for Air Crews after Infectious Diseases (Guidelines for Medical Assessment) (Cont'd)

Disease	Condition	Period of Unfitness	Notes
Neisseria meningitidis			See Meningitis
Neurosyphilis			See Syphilis
Non-Veneral Treponematosi	Endemic Syphilis		See Endemic Syphilis
	Pinta	2 w after therapy and full recovery	
	Yaws		See Yaws
Norwalk Virus			See Travel Diarrhoea
Ocular Toxocariasi		Unfit	Unless rendered fit by AMS
Old World Tick Typhus			See Rickettsial Disease
Onchocerca volvulus			See Onchocerciasis
	Cutaneous and subcutaneous manifestations	Until full recovery	
Onchocerciasis	Ocular manifestation	Unfit	Unless assessed fit by AMS
ONN Virus	O'Nyong Nyong (ONN)		See Arbovirus Fever
O'Nyong Nyong (ONN)			See Arbovirus Fever
Opisthorchiasis			See Helminthic Disease
Opisthorchis			See Helminthic Disease
Opisthorchis felineus			See Helminthic Disease
Opisthorchis guayaquilensis			See Helminthic Disease
Opisthorchis sinensis			See Helminthic Disease
Opisthorchis viverrini			See Helminthic Disease
Oropouche Fever			See Arbovirus Fever
	Oropouche Fever		See Arbovirus Fever
Oropouche (ORO) Virus			See Bartonellosis
Oroya Fever			See Arbovirus Fever
Pappataci Fever	Sandfly (SF) Fever, Phlebotomus Fever		See Arbovirus Fever
Paracoccidioides brasiliensis			See Fungal Pulmonary Infections
Paracoccidioidomycosis			See Fungal Pulmonary Infections
Paralytic Shellfish Poisoning			See Seafood Toxins
Pediculosis pubis			See Epizoonosis
Pediculosis capiti			See Epizoonosis
Phthirus pubis			See Epizoonosis
Pinta			See Non-Veneral Treponematosi
Pinworm			See Helminthic Disease
Phlebotomus Fever	Sandfly (SF) Fever, Pappataci Fever		See Arbovirus Fever
Plague	Bubonic Plague	2 w after therapy and full recovery	
	Pulmonary Plague	4 w after therapy and full recovery	
Plasmodium falciparum			See Malaria
Plasmodium malariae			See Malaria
Plasmodium ovale			See Malaria
Plasmodium vivax			See Malaria

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Medical Fitness for Air Crews after Infectious Diseases (Guidelines for Medical Assessment) (Cont'd)

Disease	Condition	Period of Unfitness	Notes
Pneumocystis carinii		Unfit	Opportunistic Infection in HIV Infection
Pneumonia		2 w after therapy and recovery	
Pneumonic Plague			See Plague
Poliomyelitis		4 w after therapy and full recovery	
Pork Tape Worm			See Helminthic Diseases
Postvaccinal Encephalitis			See Encephalitis
Pubic Lice			See Epizoonosis
Pyomyositis			See Tropical Pyomyositis
Q-Fever			See Rickettsial Diseases
Rabies		Unfit	
Relapsing Fever			See Borreliosis
Rhabdomyolysis		Unfit	Until renal function has been normalized
Rhodesian Sleeping Sickness			See Trypanosomiasis
Rickettsia			See Rickettsial Diseases
Rickettsial Diseases	Epidemic Typhus (Louse Borne Typhus)	4 w after therapy and full recovery	
	Endemic Typhus (Murine Typhus)	4 w after therapy and full recovery	
	Tick Typhus (Spotted Fever) American Tick Typhus Old World Tick Typhus Rickettsial Pox	2 w after therapy and full recovery	
	Mite Typhus (Scrub Typhus)	4 w after therapy and full recovery	
Rickettsialpox			See Rickettsial Diseases
Rift Valley Fever			See Haemorrhagic Fever
Ross River Fever (RR)	Epidemic Polyarthritis		See Arbovirus Fever
Rota Virus			See Travel Diarrhoea
RR Virus	Ross River Fever (RR), Epidemic Polyarthritis		See Arbovirus Fever
Rubella		Until full recovery	Infectious until 2 w after onset of exanthema
Salmonella			See Travel Diarrhoea
Salmonella enteritidis			See Travel Diarrhoea
Salmonella Enterocolitis			See Travel Diarrhoea
Salmonella paratyphi			See Typhoid Fever
Salmonella typhi			See Typhoid Fever
Salmonella typhimurium			See Travel Diarrhoea
Sarcoptes scabiei			See Epizoonosis
Scabies			See Epizoonosis
Schistosoma			See Schistosomiasis
Schistosoma haematobium			See Schistosomiasis
Schistosoma intercalatum			See Schistosomiasis
Schistosoma japonicum			See Schistosomiasis
Schistosoma mansoni			See Schistosomiasis
Schistosoma mekongi			See Schistosomiasis

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Medical Fitness for Air Crews after Infectious Diseases (Guidelines for Medical Assessment) (Cont'd)

Disease	Condition	Period of Unfitness	Notes
Schistosomiasis	CNS Schistosomiasis	Unfit	Unless rendered fit by AMS
	Hepatohepatic Schistosomiasis	Unfit	Unless rendered fit by AMS
	Intestinal Schistosomiasis	After therapy and full recovery	In case of absence of complications like rectal prolapsed or intussusception
	Pulmonary Schistosomiasis	Unfit	Unless rendered fit by AMS
	Urinary Schistosomiasis	After therapy and full recovery	In case of absence of urinary retention, stasis, renal failure or stone formation
Scrub Typhus			See Rickettsial Diseases
Seafood Toxins		2 w after therapy and full recovery	Absence of neurologic sequelae
Shigella			See Travel Diarrhoea
Shingles			See Varicella Zoster Virus
SLE Virus	St. Louis Encephalitis (SLE)		See Arboviral Encephalitis
Sleeping Sickness			See Trypanosomiasis
Snake Bite		Unfit	Unless any neurological, cardiac and haematological complication has been ruled out
Splenomegaly		Unfit	Unless only slightly enlarged with no danger of rupture
Spotted Fever			See Rickettsial Diseases
St. Louis Encephalitis (SLE)			See Arboviral Encephalitis
Strongyloides stercoralis			See Helminthic diseases
Syphilis		Unfit	Unless rendered fit by AMS in stage I or II
Systemic Fungal Infections			See Fungal Pulmonary Infections
Taenia saginata			See Helminthic diseases
Taenia solium			See Helminthic diseases
Tana Pox		2 w after therapy and full recovery	
Tapeworms			See Helminthic diseases
Tetrodotoxin Poisoning			See Seafood Toxins
Thalassaemia	Beta-Thalassaemia maior	Unfit	
	Beta-Thalassaemia minor	No restriction	HKT > 32 %
	Alfa-Thalassaemia maior	Unfit	
	Alfa-Thalassaemia minor	No restriction	HKT > 32 %
Threadworm			See Helminthic diseases
Tick Borne relapsing Fever			See Relapsing Fever
Tick Typhus			See Rickettsial Diseases
Toxocara cani			See Helminthic Diseases
Toxocara cati			See Helminthic Diseases
Toxocariasis			See Helminthic Diseases
Toxoplasma gondii			See Toxoplasmosis
Toxoplasmosis	Asymptomatic or only generalized Lymphadenopathia	No restriction	
	Myocarditis, Hepatitis	Until therapy and full recovery	Complications ruled out by normal ECG, 24 h ECG, Electrocardiogram and normal liver function tests
	Cerebral Toxoplasmosis	Unfit	Infection is sign for impaired immunity in HIV Infection

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Medical Fitness for Air Crews after Infectious Diseases (Guidelines for Medical Assessment) (Cont'd)

Disease	Condition	Period of Unfitness	Notes
Travel Diarrhea		Until full recovery	
Traveller's Diarrhea			See Travel Diarrhoea
Trench Fever			See Rickettsial Diseases
Treponema pallidum	Syphilis		See Syphilis
Treponema pallidum subspecies endemicum	Endemic Syphilis		See Endemic Syphilis
Treponema pallidum subspecies pertenue	Yaws		See Yaws
Treponema pallidum subspecies carateum	Pinta		See Non-Venereal Treponematoses
Trichuris trichiura			See Helminthic Diseases
Trichuris trichuria			See Helminthic Diseases
Tropical Pyomyositis		4 w after therapy and full recovery	In case of absence of functional sequelae (i.e. no restriction of joint movement by scar formation etc.)
Tropical Splenomegaly Syndrome			See Splenomegaly
Tropical Sprue		After successful therapy, substitution and full recovery	
Tropical Ulcer		No restriction	If local therapy can be performed and hygienic conditions are sufficient
Trypanosoma brucei			See Trypanosomiasis
Trypanosoma brucei gambiense			See Trypanosomiasis
Trypanosoma brucei rhodesiense			See Trypanosomiasis
Trypanosoma cruzi			See Chagas Disease
Trypanosomiasis	Sleeping Disease	Unfit	Unless rendered fit by AMS after meticulous tests (ECG, 24h ECG, Echocardiogram, EEG, neurological evaluation)
Tuberculosis		4 w after therapy and full recovery	In case of normal ophthalmological findings, normal audiogram and, in case of meningitis, normal EEG and absence of convulsive periods and normal neurological evaluation
Tunga penetrans			See tungiasis
Tungiasis		No restriction	
Typhoid Fever		4 w after therapy and full recovery	
Typhus Fevers			See Rickettsial Diseases
Upper Respiratory Tract (URT) Infections		Until full recovery	If pressure of middle ear and sinuses can be equalized and the voice is clear enough for radio communications.
Urinary Schistosomiasis			See Schistosomiasis
Vaccination		24 hours	Parenteral immunization, provided that adverse side effects (anaphylactic reaction etc.) are absent, that may impair the ability to perform the duties
Varizella			See Varizella Zoster Virus
Varizella Zoster Virus		Unfit until full recovery	If blisters have disappeared

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Medical Fitness for Air Crews after Infectious Diseases (Guidelines for Medical Assessment) (Cont'd)

Disease	Condition	Period of Unfitness	Notes
VEE Virus	Venezuelan Equine Encephalitis (VEE)		See Arboviral Encephalitis
Venezuelan Equine Encephalitis (VEE)			See Arboviral Encephalitis
Venezuelan Haemorrhagic Fever			See Haemorrhagic Fever
Verruga peruana			See Bartonellosis
Vibrio cholerae			See Cholera
Viral Haemorrhagic Fever			See Haemorrhagic Fever
Viral Hepatitis			See Hepatitis
Visceral leishmaniasis			See Kala Azar
Viral Encephalitis			See Encephalitis
Viral Meningitis			See Meningitis
Weil's disease			See Leptospirosis
WEE Virus	West American Equine Encephalitis (WEE)		See Arboviral Encephalitis
West American Equine Encephalitis (WEE)			See Arboviral Encephalitis
West Nile (WN) Fever	Fever, myalgia, exanthema	After full recovery	
	Meningitis or Meningoencephalitis	4 w after therapy and full recovery	Normal EEG and the absence of convulsive periods and normal neurological evaluation. In case of symptomatic epilepsy at the discretion of AMS
West Nile (WN)Virus			See West Nile (WN) Fever
Whipworm			See Helminthic Diseases
Wuchereria bancrofti	Lymphatic Filariasis		See Helminthic Diseases
Yaws	Early Lesions	2 w after therapy and full recovery	
	Late Lesions	Unfit	Unless rendered fit by AMS
Yellow Fever		4 w after therapy and full recovery	
Yersinia			See Travel Diarrhoea
Zoster			See Varicella Zoster Virus

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CHAPTER 19 - MEDICATION AND FLYING

Note 1. The following information and table are for guidance only and JAR FCL-3 Section 1 Requirements take precedence.

Note 2. When the AMS of a JAA member state issues its own guidance on the use of medications, such guidance takes precedence over that found in this chapter.

Note 3. Pilots taking medication either prescribed or obtained "over the counter" are unfit unless an AME / AMC / AMS has been contacted and endorsed resumption of flying duties (see JAR-FCL 3.040 (b) and 3.115).

1 INTRODUCTION

This chapter outlines the general principles for the use of medications in flying. In other sections of the Manual concerning specific systems, minor differences may be noted from these general principles. In such cases the recommendations concerning specific systems (cardiovascular, neurology, digestive, etc) take precedence. Names of medications are given as examples and are only for guidance.

Any intake of medicine or narcotic substance must be declared in the formal declaration signed by flying personnel and handed to physicians in charge of the evaluation of flying fitness at each medical examination. In principle, pilots taking medication either prescribed or obtained 'over the counter' have to be regarded as unfit unless AME / AMC / AMS have been contacted and endorsed resumption of flying duties (see JAR-FCL 3.040 (b), 3.115). Use of herbal medication and alternative treatment modalities requires particular attention to possible side effects.

The decision as to whether a pilot is fit to fly whilst taking medication has always to be taken in conjunction with knowledge of his clinical situation and the dose and form of medication.

Consumption of medicines or other substances must always be reported as it may justify temporary or permanent suspension from flying status.

The consumption of such substances may have consequences on qualification for three reasons:

- a the disease requiring treatment may be cause for disqualification;
- b flight conditions may modify the reactions of the body to a treatment (eg jet lag, dehydration, moderate hypoxia)
- c and most importantly, medication may cause adverse side effects that impair flight safety. It should be noted that the effects of medication do not necessarily immediately disappear when the treatment is stopped, and that the subject may be temporarily disqualified during the withdrawal period.

Flying personnel should nevertheless not be deprived of an efficient treatment because of their professional occupation. What is important is to find the compromise between flying fitness requirements, medical treatment and illness that is the most suitable both for the patient and flying safety.

Flying personnel must be declared fit by their AMS, AMC or AME according to the circumstances and not by their practitioner.

One of the goals of the AME must be to make flying personnel aware of the problems caused by treatment so that they refrain from taking unreported medication whose side effects may not have been assessed.

Monotherapy may in certain cases be tolerated for flying personnel but multi therapy which may increase adverse effects requires close supervision.

It is possible that new therapeutic agents will become available that offer significant treatment advantages. If such agents are considered by the LSST(M) to be appropriate for use by aircrew, with due consideration given to aeromedical and safety aspects, their use may be approved. However, as a general rule, medication shall only be endorsed by the AME, if the pilot has taken the respective medication whilst not on flying duty for an appropriate period of time (temporary disqualification) with proven efficacy and without any side effects that could interfere with flying duties.

2 DIGESTIVE PATHOLOGY

2.1 Anti-ulcer medicines (antacids)

Gastric secretion inhibitors such as H₂ antagonists (e.g. ranitidine, cimetidine) or proton pump inhibitors (e.g. omeprazole) may be acceptable after diagnosis of the pathological condition. After the initial period of treatment which may require temporary disqualification, the risk of a recurrence during the first year may justify treatment with those medicines that are compatible with flying status.

2.2 Treatment of inflammatory bowel disease

- a Topical medication, such as mesalazine, which is a well-tolerated drug, may be compatible with flying status.
- b Oral aminosalicylates such as mesalazine may be compatible with flying status.
- c Rectal corticosteroids may be acceptable.
- d Salazosulfapyridine should be avoided because of its frequent adverse effects.

2.3 Anti spasmodics

- a Antimuscarinics (eg dicyclomine, mepenzolate, pipenzolate, poldine and propatheline) are used to reduce smooth muscle spasm in non-ulcerative dyspepsia, irritable bowel syndrome and diverticular disease. They all have atropine-like side-effects of confusion, dry mouth, reduced power of accommodation, difficulty with micturition and constipation, which preclude their use.
- b Other antispasmodics – alverine, mebeverine and peppermint oil are acceptable.

2.4 Anti-diarrhoeals

Antimotility drugs such as codeine phosphate, cophenotrope, and morphine are not acceptable.

2.5 Anti haemorrhoids

Soothing preparations containing bismuth subgallate, zinc oxide and haemamelis often mixed with a small dose of corticosteroid may be acceptable in short courses for topical application.

2.6 Treatment of gallstones

Treatment for the dissolution of gallstones is not compatible with flying status as it may cause diarrhoea and cholecystitis.

2.7 Other bowel disorders

In patients suffering from gastrointestinal colic, the prescription of trimebutine, mebeverine or antacids is compatible with flying status provided that the possibility of an organic disease has been ruled out.

2.8 **Kinetosis (Motion sickness)**

Medication for motion sickness is incompatible with flying status since it may interfere with alertness.

3 **CARDIOVASCULAR SYSTEM**

3.1 **Antihypertensive drugs**

a *Beta-blockers*

These drugs may be compatible with flying status if they are prescribed for a condition having no adverse effect on flying safety.

Long-acting Beta-blockers are preferable for flying personnel (e.g. atenolol, metoprolol or bisoprolol), always trying to prescribe the smallest possible efficient dose. Treatment shall be initiated during a period of temporary disqualification. The efficacy of the treatment shall be evaluated (for example by ambulatory arterial pressure measurement during activity) as well as its tolerance by the patient. Excess bradycardia or orthostatic arterial hypotension would be grounds for a change in treatment.

b *Diuretics*

Whereas loop diuretics are not acceptable, thiazides may be acceptable. Strict laboratory and clinical monitoring is necessary due to the risks of hypokalaemia, and possible metabolic and hydration disorders. Potassium supplements may be required. A combination of thiazide diuretic and spironolactone may also be compatible with flying status.

c *Angiotensin Converting Enzyme (ACE) inhibitors*

These medications (e.g. enalapril, lisinopril) may be compatible with flying status. Treatment must be initiated outside of flying periods.

d *Angiotensin II Receptor Antagonists*

These medications (e.g. candesartan, irbesartan, losartan) may be compatible with flying status. Treatment must be initiated outside of flying periods.

e *Calcium-channel blockers*

These medications may be compatible with flying status. They may induce peripheral Oedema or headache, but they are generally well tolerated. Preference shall be given to medications with the most flexible use (e.g. diltiazem, verapamil, nifedipine). If used for angina these medications are not compatible with flying status.

f *Central antihypertensive drugs (clonidine, alphas-methyl-dopa)*

These drugs are unacceptable as they may impair alertness.

g *Vasodilating antihypertensive drugs (dihydralazin, prazosin, urapidil)*

These drugs are unacceptable because they frequently have adverse side effects such as orthostatic hypotension.

3.2 **Antiarrhythmic drugs**

Fit assessment of flying personnel with arrhythmias is only possible by AMS after review procedure. Many of these medications have proarrhythmic effects.

a)	Class I	Sodium channel blockers (e.g. flecainide)	may not be compatible
b)	Class II	Beta blockers (e.g. bisoprolol)	compatible
c)	Class III	Potassium channel blockers (e.g. Amiodarone, Sotalol)	may not be compatible
d)	Class IV	Calcium channel blockers (e.g. Verapamil)	compatible
e)	Digitalis derivatives		compatible

3.3 Anticoagulants

Anticoagulants (warfarin, heparin) are incompatible with flying status. But low dose of antiplatelet drugs (aspirin, dipyridamole) may be acceptable.

3.4 Antianginal medications

Nitrates or other antianginal substances (e.g. molsidomine) are incompatible with flying status when used for prevention or treatment of ischaemic symptoms.

4 RESPIRATORY SYSTEM

4.1 Treatment of asthma

Use of oral steroids or theophylline derivatives is incompatible with flying status. Leukotriene receptor antagonists may be acceptable.

Respiratory aerosols in low dose may be compatible with flying status :

- a) beta-2-agonists (e.g. salbutamol in moderate use);
- b) anticholinergic drugs (e.g. oxytropium bromide);
- c) corticosteroids (e.g. beclomethasone); and
- d) a regular use of a chromoglycic acid (e.g. sodium chromoglycate or nedocromil).

If the treatment fails to restore a satisfactory stable clinical condition, the applicant shall be unfit.

4.2 Antitussive drugs

Antitussive opioids are incompatible as they may induce drowsiness. They are also detected in urine tested for opioid derivatives.

4.3 Antiallergic drugs

Sedating oral antihistamines are not authorised for flying personnel and incompatible with flying status. Non-sedating oral (e.g. fexofenadine) and topical antihistamines may be acceptable.

4.4 Expectorants

Mucolytic agents (e.g. carbocysteine) are well tolerated and are compatible with flying status.

5 ENDOCRINOLOGY

5.1 Hypothyroidism

Treatment shall be initiated during a period of temporary disqualification and laboratory monitoring is required until euthyroid status has been achieved. Replacement therapy (e.g. levothyroxine) is compatible with flying status.

5.2 Hyperthyroidism

Treatment of hyperthyroidism with synthetic antithyroid drugs (e.g. carbimazole or propylthiouracil), is incompatible with flying status. After treatment, whether radioiodine, surgery or antithyroid medication, pilots may only resume flying duties once euthyroidism has been achieved.

5.3 Treatment of gynaecological diseases

Treatments of hormonal gynaecological diseases are compatible with continued flying status

- a normal or mini doses of oestrogens ;
- b progestogens, either natural progesterone, or progesterone or testosterone analogues.

6 METABOLIC DISEASES

6.1 Diabetes

Insulin dependent diabetes is a contra-indication to flying. Only diabetes not requiring insulin administration (NIDDM) and uncomplicated remains compatible with flying status. See Appendix 4 to Subparts B and C. Insulin treatment is disqualifying for all types of flying activities. Biguanides [and Glitazones (Thiazolidinediones)] under appropriate monitoring or alpha-glucosidase inhibitors, in association with diet, are acceptable. [Sulphonylurea and Glinides] medication may be acceptable in selected cases for Class 2.

6.2 Dyslipidaemia

Dyslipidaemia in flying personnel should be treated in conjunction with an appropriate diet and weight reduction if appropriate. A treatment with medication that lowers the concentration of plasma lipoproteins should be prescribed if this diet is not fully effective.

- a HMG-CoA reductase inhibitors are acceptable with preference for hydrophilic molecules such as pravastatin rather than lipophilic substances such as simvastatin which may induce sleep disorders.
- b Treatment with fibric acids (e.g. fenofibrate or gemfibrozil) should be discontinued in the case of gastrointestinal side effects or elevated transaminase concentration.
- c Cholestyramine may be acceptable after evaluation of gastrointestinal tolerance (frequent constipation).

6.3 Hyperuricemia

Acute gout is incompatible with flying status.

Hypouricaemic substances (e.g. allopurinol) may be acceptable. Flying personnel should be disqualified during the initial period of therapy.

6.4 **Obesity**

Orlistat or methylcellulose may be acceptable if dietary measures are insufficient to reduce weight.

7 NEUROLOGY

7.1 **Epilepsy**

Medication prescribed for the treatment of epilepsy is incompatible with flying status.

7.2 **Parkinson's disease**

Medication prescribed for the treatment of advanced Parkinson's disease (eg levodopa) is incompatible with flying status. Amantadine or selegeline may be acceptable for the treatment of early, minor symptoms.

7.3 **Migraine**

Beta-blockers may be acceptable for the prophylaxis of migraine.

7.4 **Smoking cessation**

Nicotine replacement therapy may be allowed. Bupropion is unacceptable.

8 PSYCHIATRY

All medication used for psychiatric treatment may affect the Central Nervous System (CNS) and alertness. Therefore they are incompatible with flying status. These medications include antidepressants, antipsychotic, antimanic, anxiolytic, barbiturate and hypnotic drugs.

The occasional use of a short-acting hypnotic (eg temezepam) may be an appropriate remedy to ensure adequate rest during a stopover. However, as medical monitoring is not always possible and sufficient time lapse between intake and subsequent flight duties cannot be guaranteed, use of hypnotics and melatonin should be discouraged by AMEs. Non-medical remedies (e.g. no caffeine, alcohol, smoking or exercise prior to bed-time, silence, darkness, fresh air, lower bedroom temperature, relaxation techniques) should be encouraged.

The use of narcotic drugs is strictly forbidden. The term 'narcotics' covers opioids (eg morphine), cocaine, cannabis, amphetamines and other CNS stimulants. Caffeine may be acceptable to enhance alertness if not taken in excessive dose.

9 ANALGESIC AND ANTI-INFLAMMATORY DRUGS

9.1 **Analgesics**

Opioid and non-opioid (eg nefopam) analgesics which act upon the central nervous system are strictly incompatible with flying status.

The most commonly taken analgesics are paracetamol, aspirin and derivatives of propionic acid. They remain compatible with flying status taking due regard of the reason for their use, if they are administered at moderate doses. These substances may come in fixed combinations with sympathomimetics and antihistamines for nasal decongestion purposes. Such combinations are disqualifying.

9.2 **Anti-inflammatories**

a *Non steroidal anti-inflammatories*

These substances, prescribed for short periods at moderate doses, may be compatible with flying status if the condition which justifies their prescription is itself compatible with flying status.

b *Corticosteroids*

Oral corticosteroids are incompatible with flying status when used for their anti-inflammatory effects in asthma or inflammatory bowel disease.

Low-dose topical steroids are acceptable.

10 **TREATMENT AND PREVENTION OF INFECTIONS**

10.1 **Antibiotics**

Antibiotics are usually not compatible with flying status due to the underlying reason for their use.

Anti-tuberculosis treatments are incompatible with flying status. Prophylactic rifampicin is acceptable.

10.2 **Antiviral treatment**

Combination antiretroviral treatment may be acceptable when used for clinically stable HIV infection. A minimum 3 month period should elapse prior to recertification with a multicrew limitation.

Interferon treatment (e.g. for chronic hepatitis) is incompatible with flying status.

10.3 **Vaccinations**

Vaccination of flying personnel against hepatitis A and B, tetanus and diphtheria is highly recommended. Vaccination against typhoid, meningitis and other infections may be recommended depending on the type of operation and routes flown. Some vaccinations (e.g. Yellow Fever) may be subject to national health regulations. Pilots should not fly for 24 hours after receiving a vaccination.

See Chapter 18 - Tropical Medicine.

10.4 **Anti-malarials**

Anti-malarial medication if used for the treatment of malaria is incompatible with flying status.

The basis of malaria prophylaxis is exposure prophylaxis, consisting of preventing mosquito bites by the use of repellents, long clothing, nets, insecticides etc.

Chemoprophylaxis will vary according to the region visited and up to date advice should be obtained prior to travelling to any area where malaria is endemic. The combination of Chloroquine and Proguanil is acceptable for use by aircrew, should be started one week prior to travel and continued until four weeks after returning from a malarial area, but is not very effective any more. Atovaquone/Proguanil (Malarone®) is the malaria prophylaxis of choice for airmen as the medication has to be started only 1 day before entering and to be continued 7 days after leaving the risk area and is very effective (90 %). The use of doxycycline may be acceptable. All ant-

malarial medication should initially be taken during a non-flying period to ensure freedom from adverse effects.

See Chapter 18 - Tropical Medicine.

11 DERMATOLOGY

11.1 Psoriasis, eczema and acne

Systemic etretinate for psoriasis may cause serious drying of the skin and mucosa and particularly of the conjunctival tissues, intensified by flying conditions. It is not recommended for aircrew.

Sedative antihistamines are disqualifying.

Systemic antibiotics are acceptable and systemic medication that acts on the immune system may be acceptable subject to close supervision. These medications should initially be taken during a non-flying period to ensure freedom from adverse effects.

Isotretinoin is not acceptable for Class 1 certification because of the risk of visual side-effects that may be irreversible.

Topical treatments for these skin conditions are compatible with flying status.

11.2 Pruritus

Systemic treatment of pruritus with oral anti-histamine medication is unacceptable.

12 EAR, NOSE and THROAT

Local ENT treatments may be compatible with flying status if the condition which requires treatment is compatible with flying status.

12.1 Decongestants

Nasal decongestants with no effect on alertness (e.g. clobutinol or oxeladine) are compatible with flying status. Their use shall be limited in time (max. 3 - 5 days) in order to avoid iatrogenic complications such as chronic inflammation of the nasal mucosa.

12.2 Mucolytic agents

Mucolytic agents (e.g. carbocysteine) are well tolerated and are compatible with flying status.

12.3 Antihistamines

Sedating oral antihistamines are not authorised for flying personnel and incompatible with flying status. Non-sedating oral (eg fexofenadine) and topical antihistamines may be acceptable.

13 OPHTHALMOLOGY

Anti-infective and anti-inflammatory eye preparations are usually not compatible with flying status due to the underlying condition. Mydriatics, miotics and cytoplegics are incompatible with flying status.

Topical treatments for glaucoma (eg beta-blockers, prostaglandin analogues) are acceptable. Systemic carbonic anhydrase inhibitors are unacceptable.

14 GENITO-URINARY

14.1 Benign prostatic hyperplasia

Selective alpha 1 blockers and 5 alpha reductase inhibitors may be compatible with flying status. Treatment should be initiated during a period of temporary disqualification of not less than 4 weeks. A multicrew limitation may be appropriate.

14.2 Urinary incontinence

Some anti-muscarinic medications (eg modified-release oxybutynin, tolterodine) may be compatible with flying after a minimum 4 week period of temporary disqualification to ensure freedom from adverse effects. A multicrew limitation may be appropriate.

14.3 Erectile dysfunction

Temporary colour vision disturbance has been reported after the use of phosphodiesterase-type-5 inhibitors (eg sildenafil). 12-24 hours should elapse after use prior to flying.

15 MALIGNANT DISEASE

15.1 Cytotoxic medication

Cytotoxic chemotherapy is disqualifying. After completion of treatment a minimum 2 month period (6 months after anthracycline treatment) should elapse prior to resuming flying duties.

15.2 Immunosuppressants

Corticosteroids and other immunomodulating medications are unacceptable when used for the treatment of malignant disease.

Interferon treatment is incompatible with flying status.

15.3 Hormones

Oestrogens, progestogens and hormone antagonists may be acceptable.

Gonadorelin analogues and anti-androgens (except cyproterone) may be compatible with flying status.

Table: MEDICATION AND FLYING

1 Introduction

The following table is intended to provide guidance. Names of medications are given as examples only. The fact that medications are listed as compatible does **not** mean that they may be used by pilots. Each case has to be considered regarding the individual patient and the respective medication with regard to intended effects and adverse effects in the flying environment. For further guidance please refer to the main text, which takes precedence in the case of any discrepancy (The respective paragraphs have the same reference number as in the table).

The table includes only the mostly used and mostly known medications whose effects and adverse effects are well-known. Therefore, the most advanced therapies might not be mentioned. With regard to the latter it has to be stated that the full spectrum of adverse effects of a new treatment is often only revealed after being some years in general use. However, with regard to aviation safety, pilots should not be a test population for new therapies. The fact that some medications might not be mentioned does not mean that they are unacceptable for pilots. In individual cases the decision pro or contra a certain medication might differ from the recommendations in this table.

	Generic International Name		Remarks	
	compatible	incompatible		
2 Digestive Pathology				
Anti-ulcer medicines	RANITIDINE			
	CIMETIDINE			
	OMEPRAZOL			
Treatment of inflammatory colitis	MESALAZINE	SALAZOSULFAPYRIDINE	Oral aminosalicylates such as Mesalazine may be acceptable. Minimal medication such as sulphasalazine or local medication like steroid or sulphasalazine enema or suppository may be acceptable	
Anti-spasmodics		DICYCLOMINE	Atropine-like side-effects preclude the use.	
		MEPENZOLATE		
		PIPENZOLATE		
		POLDINE		
		PROPATHELINE		
		ALVERINE		
		MEBEVERINE		
	PEPPERMINT OIL			
Anti-diarrhoeals	LOPERAMIDE	LOPERAMIDE	depending on individual case	
		COPHENOTROPE		
		CODEINE PHOSPHATE		
Anti-haemorrhoids			Local medication like steroid or sulphasalazine enema or suppository may be acceptable	
Treatment of Gallstone			Not compatible because of risk of cholecystitis, pancreatitis, diarrhoea	
Gastrointestinal colic	TRIMEBUTINE		May be acceptable with minor colics after organic disease is ruled out	
	MEBEVERINE			
Kinetosis, motion sickness			Interference with alertness,	

			not acceptable
3 Cardiovascular System			
3.1 Anti-hypertensive drugs			
Beta blockers	ATENOLOL		
	METOPROLOL		
	BISOPROLOL		
Diuretics	THIAZIDICS		
	SPIRONOLACTONE		
		FUROSEMIDE	
Angiotensin converting enzyme inhibitors	CAPTOPRIL		
	ENALAPRIL		
	LISINOPRIL		
Angiotensin II Receptor Antagonists	CANDESARTAN		
	EPROSARTAN		
	IRBESARTAN		
	LOSARTAN		
	TELMISARTAN		
	VALSARTAN		
Calcium channel blockers	DILTIAZEM		
	VERAPAMIL		
	NICARDIPINE		
	NITRENDIPINE		

	Generic International Name		Remarks
	<i>compatible</i>	<i>incompatible</i>	
Central anti-hypertensive drugs		CLONIDINE	
		ALPHAMETHYL-DOPA	
Vasodilating anti-hypertensive drugs		DIHYDRALAZINE	
		PRAZOZINE	
		URADIPIL	
3.2 Anti-arrhythmic drugs			
Vaughan Williams Class I		CHINIDIN, DISOPYRAMID, AJMALIN, LIDOCAIN, PHENYTOIN, PROPAFON, FLECAINID, MEXITILLINE	
Vaughan Williams Class II, BETABLOCKERS	ATENOLOL, METOPROLOL, BISOPROLOL		
Vaughan Williams Class III	SOTALOL AMIODARON	SOTALOL AMIODARON	In general not acceptable, in selected cases up to AMS after expert's consultation
Vaughan Williams Class IV	VERAPAMIL		
Other anti arrhythmic drugs	DIGITALICS		
3.3 Anticoagulants			
		HEPARINE	After deep vein thrombosis

			a subcutaneous injection of low molecular heparin may be acceptable prior to a long distance flight
		RHENINDIONE	
		ACENO COUMAROL	
		WARFARINE	
	ASPIRIN		
	DIPYRIDAMOL		
3.4 Antianginal medication			
		NITRATES	
		MOLSIDOMINE	
4 Respiratory system			
4.1 Treatment of asthma			
Theophylline derivatives		THEOPHYLLIN	
Oral steroids			not acceptable
Leukotriene receptor agonists			may be acceptable
Respiratory aerosols	SALBUTAMOL		
	OXYTROPIMUM BROMIDE		
	BECLOMETHASONE		
	CROMOGLYCIN SODIUM		
4.2 Antitussive medication			
Antitussive opioids			not acceptable
4.3 Antiallergic medication			
Sedating antihistaminics			not acceptable
Non-sedating antihistaminics			may be acceptable
4.4 Expectorants			
Mucolytic agents	BROMHEXIDINE		
	ACETYLCYSTEINE		
	CARBOCISTEINE		

	<i>Generic International Name</i>		<i>Remarks</i>
	<i>compatible</i>	<i>incompatible</i>	
5 Endocrinology			
5.1 Hypothyroidism	LEVOTHYROXINE SODIUM		
5.2 Hyperthyroidism, Anti-thyroid drugs		CARBIMAZOLE	
		BENZYL THIOURACILE	
5.3 Hormonal treatments of gynecological diseases			
Progestative	MEDROXYPROGESTEONE		
	LYNESTRENOL		
	LEVONORGESTREL		
	NORETHISTERONE		
	NORGESTRIEONE		
6 Metabolic diseases			
6.1 Diabetes			
Insulin		INSULIN	not acceptable
Sulphonylurea			Not acceptable, may be acceptable in selected cases for Class 2
Glinides			Not acceptable, may be acceptable in selected cases for Class 2
Biguanides	METFORMIN		for Class 2, for Class 1

			with an OML
Alpha-glucosidase inhibitors	ACARBOSE		
Glitazones (Thiazolidinediones)	ROSIGLITAZONE		for Class 2, for Class 1 with an OML
	PIOGLITAZONE		for Class 2, for Class 1 with an OML
6.2 Dyslipidaemia	PRAVASTATINE		
		SIMVASTATINE	
	CHOLESTYRAMINE		
	FENOFIBRATE		
	GEMFIBROZIL		
7 Neurology			
7.2 Parkinson's disease		LEVODOPA etc.	Medication for advanced disease not acceptable
	AMANTADINE SELEGELINE		May be acceptable for early, minor symptoms
7.3 Migraine			Beta-blockers may be acceptable for prophylaxis
7.4 Smoking cessation			Bupropion not acceptable.
			Nicotin replacement may be acceptable.
8 Psychiatry			
Sleep disorders		ZOLDIPEM	
		ZOPLICONE	
		MELATONINE	
9 Analgesic and anti-inflammatory drugs			
9.1 Analgesics			
Central analgesics and narcotics morphinics		MORPHINE	
		CODEINE	
		CODETHYLINE	
		COCAÏNE	
		CANNABIS	
Peripheral analgesic	PARACETAMOL		
	ACETYL SALICYLIC ACID		
	DERIVED OF PROPIONIC ACID		
9.2 Anti-inflammatories			
Steroid anti-Inflammatories			all incompatible
Non steroid anti-inflammatories	DICLOFENAC		

	<i>Generic International Name</i>	<i>Remarks</i>
	<i>compatible</i>	<i>incompatible</i>
10 Treatment of infections		
10.1 Antibiotics		

Macrolides		JOSAMYCINE	
Beta-lactamines		PENICILLINE	
Phenicoles		CHLORAMPHENICOL	
10.2 Antiviral treatment			
Antiviral treatment		AZIDOTHIAMINE	In clinically stable HIV infection combination antiretroviral treatment may be acceptable
		DDI	
		INTERFERON	
10.3 Vaccinations			
Vaccinations			all compatible, minimum period of 24 h before next flight
10.4 Anti-malarials			
Anti-malarials	CHLOROQUINE		
	PROGUANIL		
		MEFLOQUINE	
	ATOVAQUONE / PROGUANIL		
11 Dermatology			
Keratolytic treatments		ETRETINATE	
Dermatological topical treatments		ISOTRETINOID	
		CYPROTERONE ACETATE	
		GAMOLENIC ACID	
12 Ear, Nose and Throat			
12.1 Decongestive drugs	CLOBUTINOL		
	OXELADINE		
12.2 Mucolytic agents			see 4.4
12.3 Antihistamines			see 4.3
14 Genito-Urinary			
14.1 Benign prostatic hyperplasia			
Selective alpha-1 blockers			May be acceptable
5-alpha reductase inhibitors			
14.2 Urinary incontinence			
			some anti-muscarinic medications may be acceptable
14.3 Erectile dysfunction			
Phosphodiesterase-type-5-inhibitors		SILDENAFIL etc.	12 - 24 h shall elapse prior to flying
15 Malignant disease			
15.1 Cytotoxic medication			disqualifying
15.2 Immunosuppressants			disqualifying
15.3 Hormones			
Oestrogens			may be acceptable
Progestogens			
Hormone antagonists			
Gonadorelin analogues			may be acceptable
Anti-androgens			