

# Joint Aviation Authorities



# JAA Manual of Civil Aviation Medicine

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Committee.

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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 Part 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 Authorised Medical Examiner (AME) to assess whether the airman is likely to remain fit for the following period of validity of the medical certificate to be issued. If an AME is in doubt about whether a pilot's health condition will allow him to continue flying for that period, 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 certification under certain provisos (as for example shorter intervals between aeromedical renewal examinations or imposing limitations).

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 Part 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 are 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 is obligated to 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 be allowed to 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 excruciating pain within minutes from onset, must clearly disbar 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 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 Authorised Medical 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 heeding the commercial pressures 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 Part 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 or recertificate an airman 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 certificatory authority. 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 certificatory status 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  $10^7$  x 100 or 1 per  $10^5$  flying hours.

If one again considers 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.  $10^{-6}$  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.

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.

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 Class 1 OML requirements may be assessed as fit for Class 2 (unrestricted of OSL / OPL) operations.

#### **Additional factors**

- 1 If more than 10% of the pilot population is assessed as having an incapacitation risk of 1%, then the statistical population will be skewed and present assumptions 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.

## **DIFFERENCES FROM PROVISIONS**

### **Standards**

The physical standards outlined by ICAO in Chapter 6 of Annex 1 to the Convention on International Civil Aviation (8th Edition 1988) 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 or Conditions where such activities were considered compatible with the requirements of flight safety. 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 'waiver' 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, whereas other states showed various degrees of flexibility. In order to minimise differences between JAA Member States, Annex I Chapter 6 was considered inadequate per se. JAR-FCL Part 3 (Medical) was therefore written in a more detailed fashion. AMEs and AMC may assess applicants fit being within the standards of Subpart B (Class 1) resp. Subpart C (Class 2) of JAR-FCL 3, Section 1. Appendices to those subparts outline what degree of flexibility could be considered, at what level and after which investigations by the AMS. 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 Part 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 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.

### **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 the Condition should be placed upon the medical certificate and may be transferred to the licence in the specified format published in JAR–FCL Part 1 (Aeroplane) AMC-FCL 1.075. If an applicant is assessed as requiring correction to meet the visual standards at initial assessment, it is possible that his vision may improve. An AME should not however add or remove that Condition without verifying the position with the AMS and normally a further full refraction will be required before a visual Condition 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 conditions 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'.

## **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.

## **Further Differences**

National Variant:

In contrast to the differences mentioned above the term "national variant" describes differences from JAR-FCL as published in JAR-FCL 1 and / or 3, e.g. age 60 instead of 65 in some member states.

National Difference:

The term "national difference" describes a difference regarding the administrative process, investigated during an audit (MEST = Medical Standardization Team) and published thereafter or reported to CJAA by the NAA, e.g. two pilots with the limitation "OML" flying together on an aircraft registered by the particular NAA or not requiring chest X-ray for initial Class 1 examinations.

## REVIEW PROCEDURES

### The Assessment

As indicated in the section concerning flexibility, JAR–FCL Part 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 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 Part 3 (Medical) Requirements and Appendices provide direction to Authorised Medical Examiners (AMEs) in assessment and also indicate whether decisions should be referred to their national Authority 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 Authorised Medical Examiner is therefore primarily responsible for deciding whether an applicant is within the Requirements (initial Class 2) or remains within the Requirements (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.

### 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 Conditions and 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 FCL Medical Sub-Committee. 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 Conditions or 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.

### **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 FCL Medical Sub-Committee with all supporting data and if favourably assessed may lead to amendment of Requirements, Appendices or JAA Manual of Civil Aviation Medicine.

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## CHAPTER 2 - CARDIOVASCULAR SYSTEM

### 1 INTRODUCTION

Over the past few years attitudes towards medical certification 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 JAA Class 1 cardiovascular requirements are explicitly stated in JAR-FCL 3.130(a). Unrestricted Class 1 certification implies that there is no degradation of these requirements which are not attributable to age alone. It 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. 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) is based on the target risk of major incapacitating event not exceeding a notional 1% per annum (i.e. one event in 8 760x100 or approximately in 1 in 10<sup>6</sup>). This represents the cardiovascular mortality of a 60–65 year old man in Northern Europe. This approach is justified by making certain assumptions relating to a target multi-pilot accident rate from medical cause of one catastrophe in every 10<sup>8</sup> – 10<sup>9</sup> flying hours, with a target overall fatal accident rate of 1 in 10<sup>7</sup> flying hours. It assumes some criticality of the flight envelope persisting for 10% or less of a total flight of average duration (i.e. 100 minutes) with a 1 in 10<sup>2</sup> chance of an incapacitating event during this period leading to an accident. If this incapacitating event occurs not more often than once in every 10<sup>6</sup> 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<sup>9</sup> hours. Accident statistics over the past 20 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 will be 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) and not only 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 approximates 1 in 4 x 10<sup>4</sup> flying hours. For Class 1 operations it has been suggested that only 1 in 10<sup>2</sup> 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<sup>6</sup> (i.e. 1 in 25 x 4 x 10<sup>4</sup>) 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. This is included in the boxed text.

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. These are also dealt with in the boxed text.

Therefore, in the foregoing, ‘Class 1’ refers to the requirements permitting single-pilot commercial operation. Class 1 ‘OML’ deals with the requirements restricting an applicant to multi-pilot commercial operation only. Class 2 (which is essentially equivalent to Class 1 ‘OML’) 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 the health and certificability 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 authorised medical examiners (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.

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 kidneys. Renovascular abnormalities when corrected may not render the subject normotensive, although the blood pressure is sometimes easier to control. Renal investigation may include ultrasonic examination of the kidney and a MAG3 scan with or without captopril. Any difference in function should provoke further investigation, particularly in the young subject. This may include renal angiography. Pheochromocytoma is an extremely rare cause of hypertension and often not diagnosed during life. Other (metabolic) causes such as Conn's Syndrome are also rare.

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), 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-threelfold, and occlusive vascular disease-twofold.

### **2.2 Definition**

Treatment of hypertension has been shown to be beneficial at levels at and above a diastolic pressure of 90 mmHg, measured at the disappearance of the Korotkoff sounds (Phase V). The benefit of treatment at this level is not large. 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 certificatory purposes at least two readings of both systolic and diastolic pressure should be obtained. If the heart rate is increased then these 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. 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 nicking 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. 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 certification purpose are just 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 management but intervention levels based on mean pressures taken over 24-hours are not fully agreed. 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. If the hypertension is unusually severe or difficult to control, or the patient is young (<40 years) then intravenous urography, renal scintigraphy and/or renal angiography and urinary catecholamine excretion measurement may be indicated. Plasma renin concentration, abdominal ultrasonography (for aortic calibre and renal outline) and Captopril MAG3 study may be 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 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. Diuretics have 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. Many 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 is probably the most widely used beta-blocking agent and can be given at a dose of not more than 50mg om. It may be combined with a diuretic agent. 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, disqualify from any form of certification to fly. The sensitive alpha blocking agents such as prazosin should be avoided.

Recently a consensus has developed which suggests that the angiotensin converting enzyme (ACE) inhibitors and the slow channel calcium-blocking agents are acceptable 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 such as 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 but combination with a beta-blocking agent 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. A new group of agents, the sartans (losartan, valsartan, candesartan), which block the angiotensin II AT 1 receptor have a very low side effect profile and are promising new additions in the treatment of hypertension in aviators. Experience is currently being gained.

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. Before the resumption of duties, 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' is 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 not uncommon. 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 ion-exchange resins or fibrates and/or an HMG CoA reductase inhibitor. 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. Minor elevation of triglyceride should yield to weight and/or alcohol reduction. More substantial elevations (>4.0 mmol/L (>350 mg/dL)) will require specialist review. 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 less than 1.0 mmol/L may be associated with additional vascular risk on account of loss of the protective effect of this moiety.

Treatment of a lipid disorder is not a bar to certification and no restriction, per se, is required on the medical certificate unless the overall vascular risk is considered to be too great. 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  $3 \times 10^6$  flying hours but the presence of hypertension, lipid abnormality and/or smoking may increase this to one in every  $2 \times 10^5$  hours. In spite of this, membership of 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 CORONARY ARTERY DISEASE**

### **4.1 General considerations**

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 approaches the number of deaths from all other causes put together. There is, however, evidence of a decline in the death rate from coronary heart disease in a number of countries including some which are JAA signatories. 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 certificatory implications. The recommendations with regard to re-certification following a cardiovascular event or intervention are based on available data, and the current practice by a number of ICAO and JAA signatory nations.

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 entire population, significant numbers dying before reaching age 65. One sixth of new cases of coronary heart disease will die suddenly without symptoms recognised to be premonitory. 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.

Demonstrated coronary artery disease thus has to be treated warily in the certificatory environment. 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. No ischaemic burden is tolerable for certificatory purposes.

Left main stem or triple vessel coronary artery disease disqualifies from certification. Single or two vessel involvement may be considered for Class 1 OML provided the coronary angiogram shows no more than 30% luminal narrowing in any major epicardial vessel in the presence of a normal contrast ventriculogram. There shall also be no demonstrable evidence of myocardial ischaemia on exercise electrocardiography /scintigraphy. Luminal obstruction >30% but < 50% in a minor vessel may be tolerable provided there is no subjective or objective evidence of myocardial ischaemia and provided the contrast ventriculogram remains normal.

## 4.2 **Electrocardiography**

### 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, although with increasing age the overall prevalence of such disease is greater. Nevertheless, in spite of shortcomings, the walking time of the exercise ECG (which should be symptom-limited) is predictive of outcome notwithstanding the appearance of the ECG (see b below).

### b *Exercise electrocardiography*

Exercise electrocardiography should not be used routinely. It is now accepted that the problem of limited specificity of the technique makes the likelihood of a 'false positive' exercise recording several times as great as a 'true positive' one in the average middle-aged asymptomatic pilot. It may, however, still be indicated when the vascular risk factor presence in terms of 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 to certificate without restriction to multi-pilot operation in such circumstances. Furthermore, an abnormal response in hypertensive subjects may not necessarily indicate coronary artery disease.

Exercise ECG should be carried out to a standard treadmill protocol, preferably that of Bruce, although the 20 watt bicycle ergometric protocol equivalent may also be used. The test should be symptom-limited where possible, i.e., taken to exhaustion or onset of other symptom and a 12-lead recording system should be used which is optimally damped. Single lead bipolar or unipolar systems are not acceptable. Dedicated exercise electrocardiographic systems are available which help overcome the problem of muscle induced artefact.

#### 4.3 **Minor coronary disease**

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

For certificatory purposes subjects with asymptomatic minor coronary artery disease are acceptable for multi-pilot operation provided that:

- a A symptom-limited exercise ECG to Bruce stage IV, or equivalent, shows no evidence of myocardial ischaemia. Cardioactive medication (betablocking agents/vasodilators) ideally will have been withdrawn 48-hours beforehand. Scintigraphy/stress echocardiography may be helpful for future reference and/or in the presence of a conduction disturbance in the resting electrocardiogram;
- b echocardiography/radionuclide/contrast ventriculography demonstrates a left ventricular ejection fraction  $\geq$  0.50 without significant abnormality of wall motion such as dyskinesia, hypokinesia or akinesia.
- c no major epicardial artery has a stenosis  $>$ 30% and no minor vessel  $>$ 50%;
- d appropriate intervention against vascular risk factors such as elevated cholesterol and hypertension has been undertaken;
- e follow-up every six months or annually by a cardiologist acceptable to the AMS with symptom-limited exercise electrocardiography is carried out as appropriate;
- f in the majority of cases recertification will be restricted to multi-pilot operation (Class 1 'OML').

***This level of assessment applies also to Class 2. More significant disease is acceptable for Class 2 'OSL' only if symptom-limited exercise ECG/ scintigraphy/stress echocardiography fails to suggest myocardial ischaemia. Evidence of exercise induced myocardial ischaemia disqualifies from all classes of certification to fly.***

#### 4.4 **Angina pectoris**

Angina pectoris, as a potential cause of subtle incapacitation, disqualifies from all classes of certification to fly, 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.

#### 4.5 **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 scintigraphy/stress echocardiography. Coronary arteriography is useful in doubtful cases. 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. Certification 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.

#### 4.6 Myocardial infarction

The early 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 greater than 30% in any major epicardial artery, the 5 year prognosis in terms of coronary event is sufficiently good to permit restricted Class 1 certification. The following recommendations are based upon those data. Thus, although myocardial infarction disqualifies from certification to fly for at least six months following the index event, asymptomatic subjects may be considered for recertification for multi-pilot operation not sooner than six months following the event, provided that

- a A symptom-limited exercise ECG to Bruce stage IV, or equivalent, shows no evidence of myocardial ischaemia. Cardioactive medication (betablocking agents, vasolidators) ideally will have been withdrawn 48-hours beforehand. Scintigraphy/stress echocardiography may be helpful for future reference and/or in the presence of an abnormality in the resting ECG;
- b echocardiography/radionuclide/contrast ventriculography demonstrates a left ventricular ejection fraction  $\geq$  0.50 without significant abnormality of wall motion such as dyskinesia, hypokinesia or akinesia.
- c a 24-hour ambulatory ECG demonstrates no significant rhythm or conduction disturbance (see also paragraph 14);
- d recent coronary angiography (i.e. at least six months after the event and not more than six months prior to review) demonstrates no stenosis in any vessel remote from the myocardial infarction  $>$ 30% and no demonstrable functional impairment of the myocardium subtended by any such vessel. 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 exercise scintigraphy;
- e appropriate intervention against vascular risk factors such as elevated cholesterol and hypertension has been undertaken;
- f annual follow-up by a cardiologist acceptable to the AMS with exercise ECG/scintigraphy is carried out as appropriate. A further angiogram is required no later than five years following the index event unless exercise electrocardiography is impeccable and shows no change on annual evaluation; ECG
- g recertification is restricted to multi-pilot operation (Class 1 'OML').

***[This level of assessment applies also to Class 2. Should post-event coronary angiography not be available, the applicant shall be restricted to Class 2 'OSL' provided that symptom-limited exercise ECG/scintigraphy/stress echocardiography fails to suggest myocardial ischaemia. Evidence of exercise induced myocardial ischaemia disqualifies from all classes of certification to fly.]***

#### 4.7 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. As time goes by, obstructive coronary disease progresses in the native circulation and after 10 years 50% of saphenous bypass grafts will have obstructed. Efforts towards secondary prevention to reduce any risk factor are required. The reduction of elevated levels of cholesterol in particular has been demonstrated to have a beneficial effect on the outcome. Intervention against a low density lipoprotein cholesterol level >4.0mmol/L with a statin (simvastatin, pravastatin) should be undertaken, unless there is any contraindication. 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 better than 90%. However 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.

Asymptomatic subjects may be considered for re-certification not sooner than six months after surgery, provided that:

- a A symptom-limited exercise ECG to Bruce stage IV, or equivalent, shows no evidence of myocardial ischaemia. Cardioactive medication (betablocking agents, vasodilators) ideally will have been withdrawn 48-hours beforehand. Scintigraphy/stress echocardiography may be helpful for future reference and/or in the presence of an abnormality in the resting ECG;
- b echocardiography/radionuclide/contrast ventriculography demonstrates a left ventricular ejection fraction  $\geq$  0.50 without significant abnormality of wall motion;
- c a 24-hour ambulatory ECG demonstrates no significant conduction disturbance, nor complex, nor sustained rhythm disturbance, nor evidence of myocardial ischaemia (see paragraph 13);
- d recent coronary angiography (i.e. at least six months after the procedure and no more than six months prior to the review) demonstrates patent grafts with a good runoff. 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%;
- e appropriate intervention against vascular risk factors such as elevated cholesterol and hypertension has been undertaken;
- f annual follow-up by a cardiologist acceptable to the AMS with exercise ECG/scintigraphy/stress echocardiography is carried out as appropriate. Five yearly coronary angiography should be considered after surgery but may not be necessary if the exercise ECG shows no change on annual evaluation and is acceptable to the AMS;
- g recertification is restricted to multi-pilot operation (Class 1 'OML').

***This level of assessment applies also to Class 2. Should post-intervention coronary angiography not be available, the applicant should be restricted to Class 2 'OSL' provided symptom-limited exercise ECG/scintigraphy/stress echocardiography fails to suggest myocardial ischaemia. Evidence of exercise induced myocardial ischaemia disqualifies from all classes of certification to fly.***

#### 4.8 Percutaneous trans luminal coronary angioplasty (PTCA)

A significant minority 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. Re-stenosis occurs in up to 20%-30% of patients in the first 6 months and

is frequently associated with the recurrence of symptoms. Thereafter the restenosis rate is lower, but still appreciable - 38% overall at 30 months in one study.

A number of international trials have examined whether angioplasty or coronary artery bypass grafting is the procedure of election 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. At present the indications for re-certification following angioplasty are broadly those for coronary artery bypass grafting. Asymptomatic subjects may be considered for re-certification to fly following single vessel (i.e. not a graft) transluminal coronary angioplasty with or without stenting, at least six months following intervention, provided that:

- a A symptom-limited exercise ECG to Bruce stage IV, or equivalent, shows no evidence of myocardial ischaemia. Cardioactive medication (beta-blocking agent, vasolidators) ideally will have been withdrawn 48 hours beforehand. Scintigraphy/stress echocardiography may be helpful for future reference and/or in the presence of an abnormality in the resting ECG;
- b echocardiography/radionuclide/contrast ventriculography demonstrates a left ventricular ejection fraction  $\geq$  0.50 without significant abnormality of wall motion;
- c a 24-hour ambulatory ECG demonstrates no significant conduction disturbance, nor complex, nor sustained rhythm disturbance, nor evidence of myocardial ischaemia (see paragraph 13);
- d recent coronary angiography (i.e. at least six months after the procedure and not more than six months prior to review) demonstrates no stenosis  $>$ 30% in any major epicardial artery and no significant change in the subject vessel when compared with the immediate post intervention angiographic appearance;
- e appropriate intervention against vascular risk factors such as elevated cholesterol and hypertension has been undertaken;
- f annual follow-up by a cardiologist acceptable to the AMS with exercise ECG/scintigraphy/stress echocardiography is carried out as appropriate. Five yearly coronary angiography should be considered after the index intervention but may not be necessary if the exercise ECG shows no change on annual evaluation and is acceptable to the AMS. Particular attention should be paid if multi lesion same vessel and multi vessel coronary angioplasty/stenting was performed.
- h recertification is restricted to multi-pilot operation (Class 1 'OML').

***This level of assessment applies also to Class 2. Should post-event coronary angiography not be available, the applicant shall be restricted to Class 2 'OSL' provided symptom-limited exercise ECG/scintigraphy/stress echocardiography fails to suggest myocardial ischaemia. Evidence of exercise induced myocardial ischaemia disqualifies from all classes of certification to fly. Subjects with demonstrated coronary disease would be expected to be receiving low dose aspirin (75-150 mg) unless there is a specific contraindication.***

## 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, disqualifies from certification to fly.

***Following satisfactory repair of an abdominal aortic aneurysm, a normotensive applicant with a satisfactory exercise electrocardiographic response may be considered for Class 2 certification, with annual review by the AMS, the review to include ultrasonic 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 < 4.0 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/scintigraphy/stress echocardiography. This may be of limited sensitivity if the end point is lower extremity claudicant pain. In that case further investigation including coronary angiography will be warranted. A careful search should also be made for carotid artery bruits and 2D Doppler or digital subtraction studies should be carried out on the carotid circulation (see also section III). Cranial artery disease is disqualifying from all classes of certification to fly.

***This level of assessment also applies to Class 2. Should coronary angiography not be available, the applicant may be issued with a Class 2 'OSL' certificate provided at least three stages of the Bruce protocol can be completed without abnormality in the exercise ECG. Other methods of detecting myocardial ischaemia may be acceptable, such as dobutamine or adenosine stress ECG/echocardiography.***

## **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 abnormality 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 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 certification but subjects with a bicuspid aortic valve need to pay attention to dental hygiene and receive prophylactic antibiotics. Provided there is no known sensitivity, usually 3g amoxicillin 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 <2.0m/sec) is present it may be consistent with unrestricted certification. If the aortic root is 3.8 cms or greater, the applicant should be restricted to Class 1 'OML' and annual review by a cardiologist acceptable to the AMS. An aortic root diameter >4.0 cm is disqualifying all classes.

***This level of assessment also applies to Class 2. Minor degrees of dilatation of the aortic root in the presence of a bicuspid valve may be consistent with Class 2 'OSL'.***

b *Aortic stenosis*

Mild aortic stenosis (Doppler flow rate <2.0m/sec), provided good signals are obtained at echocardiography, is acceptable for Class 1 OML. 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 this restriction 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 nor dilatation is permitted and the free wall and septal thickness shall not exceed 1.1 cm. A history of transient ischaemic attack (TIA) shall disqualify from all classes of certification. Annual review by a cardiologist acceptable to the AMS with 2D Doppler echocardiography is required.

***This level of assessment also applies to Class 2. In the absence of a history of peripheral embolism, applicants with a 2D Doppler flow rate <3.0m/sec without other abnormality of the resting electrocardiogram or echocardiogram, may be considered for Class 2 '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 unrestricted certification to fly but requires regular review by a cardiologist acceptable to the AMS with 2D Doppler echocardiography. The applicant should be capable of exercise to Bruce stage IV without symptoms. Co-existent dilatation of the aortic root (>4.0 cms) disqualifies from certification to fly. 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 continue to be compatible 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 may be consistent with Class 2 'OSL' certification.***

8.3 **Mitral valve disease**

a *Rheumatic mitral stenosis*

Rheumatic mitral stenosis and/or regurgitation, once diagnosed, disqualifies from certification to fly in view of the risk of abrupt onset of atrial fibrillation and of cerebral embolism. 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 edema.

***This level of assessment also applies to Class 2. Applicants with mild mitral stenosis (valve area >2.0cm<sup>2</sup>) 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, 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 electrocardiography, 24-hour ambulatory ECG and echocardiography are indicated together with exercise ECG as required in paragraph 8.4 b. There is a very small risk of cerebral embolus, chordal rupture and sudden cardiac death. Patients with an isolated mid-systolic click need no special restriction but the presence of mitral regurgitation secondary to mitral leaflet prolapse requires restriction to multi-pilot operation (Class 1 'OML'). Significant mitral regurgitation as evidenced by left ventricular end diastolic dilatation of the heart above 6.0 cm and/or systolic dimension above 4.1 cm or left atrial internal diameter above 4.5 cm shall disqualify. Any reduction of left ventricular function should be closely scrutinised or certification denied. 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 disqualifies from all forms of certification. A history of transient ischaemic attack (TIA) shall likewise disqualify from all classes of certification. Annual review by a cardiologist acceptable to the AMS including echocardiography is required.

Other causes of mitral regurgitation (i.e. rheumatic or degenerative) are normally disqualifying. Restricted certification (Class 1 'OML') 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 be restricted to Class 2 'OSL'. Significant mitral regurgitation and/or a history of transient ischaemic attack (TIA) disqualifies from all classes of certification to fly.***

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 disqualify from all forms of certification to fly on account 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 on account of the requirement for continuous anticoagulant treatment.

***This level of assessment also applies to Class 2.***

b *Tissue valves*

Only a prosthesis in the aortic position can be considered, the outcome and embolic risk following the insertion of a mitral prosthesis being incompatible with certification. 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 valve of choice is the unmounted homograft aortic valve in the aortic position. Candidates who have had a Carpentier Edwards, Hancock or similar bioprosthesis inserted into the aortic position may also be considered. A poorer prognosis and a higher thromboembolic risk is associated with mitral valve replacement. Asymptomatic subjects, who have undergone valve replacement/repair with a tissue valve, may be considered for recertification provided that:

- i A symptom-limited exercise ECG to Bruce stage IV, or equivalent, shows no significant abnormality nor evidence of myocardial ischaemia. Cardioactive medication (beta-blocking agents/vasodilator) ideally will have been withdrawn 48 hours beforehand. Scintigraphy/stress echocardiography may be helpful for future reference and/or in the presence of an abnormality in the resting ECG;
  - ii normal valve function is demonstrated by 2D Doppler echocardiography, which demonstrates a left ventricular ejection fraction  $\geq$  0.50 without significant abnormality of wall motion such as dyskinesia, hypokinesia and akinesia;
  - iii there is no significant coronary artery disease as defined in section 4.3. If coronary artery by-pass grafting was carried out at the time of surgery, section 4.7 also applies;
  - iv there is no history of systemic embolus;
  - v a 24-hour ambulatory ECG demonstrates no significant conduction disturbance nor complex, nor sustained rhythm disturbance nor evidence of myocardial ischaemia (see paragraph 13);
  - vi annual follow-up by a cardiologist acceptable to the AMS together with exercise ECG/scintigraphy/stress echocardiography and 2D Doppler echocardiography is carried out as appropriate;
  - vii recertification is restricted to multi-pilot operation (Class 1 'OML').
- c Reconstruction of a floppy mitral valve can achieve good results with a low risk of embolism if the left atrial appendage is resected. This procedure is consistent with recertification to fly subject to the recommendations given above.

***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'.***

- d The results following aortic valvotomy are not sufficiently reliable to permit any form of certification to fly.

#### 8.5 Antibiotic prophylaxis

Subjects with congenital or valvular abnormalities of the heart require antibiotic cover for both dental and urinary tract manipulation in line with current recommendations. This particularly refers to patients with prosthetic valves or a past history of endocarditis. The current recommendation is that 3 gms of amoxicillin 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 gms followed by 0.5 gms 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. Phlebography, ventilation and perfusion (V/Q) scanning and pulmonary angiography may be required. In the event of the diagnosis being made, treatment with anticoagulants is indicated and is disqualifying (see paragraph 5.1, Chapter Haematology). Flying status should be denied until the product has been discontinued. If previous thromboembolism is suspected, it is necessary to ensure that there is no concomitant pulmonary hypertension (>30 mmHg systolic) and full evaluation shall be required. Pulmonary angiography may be justified.

Six-monthly follow up should be required following recertification which shall be restricted to Class 1 'OML' for the first two years. Initial annual follow-up by a cardiologist acceptable to the AMS should be required. Anticoagulation with warfarin or coumarin like substances disqualifies from all forms of certification to fly.

***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 some protection against 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 certification decision, 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. Recertification is possible no sooner than six months following complete recovery from the illness, provided that:

- a A symptom-limited exercise ECG to Bruce stage IV, or equivalent, shows no significant abnormality or evidence of myocardial ischaemia. Cardioactive medication (beta-blocking agents, vasodilators) ideally will have been withdrawn 48 hours beforehand. Scintigraphy/stress echocardiography may be helpful for future reference and/or in the presence of an abnormality in the resting ECG;
- b echocardiography/radionuclide/contrast ventriculography demonstrates a left ventricular ejection fraction ? 0.50 without significant abnormality of wall motion such as dyskinesia, hypokinesia or akinesia;
- c a 24-hour ambulatory ECG demonstrates no significant conduction disturbance nor complex, nor sustained rhythm disturbance, nor evidence of myocardial ischaemia;

- d there is no history of systemic embolus;
- e six monthly follow-up by a cardiologist acceptable to the AMS with exercise ECG/scintigraphy/stress echocardiography and 2D Doppler echocardiography should be carried out until complete stability has been demonstrated;
- f in the majority of cases restriction to multi-pilot operation (Class 1 'OML') will be required for some years, especially 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. Fitness to fly will reflect 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 made temporarily unfit but recertification is possible three to six months following full recovery, provided that:

- a A symptom-limited exercise ECG to Bruce stage IV, or equivalent, shows no significant abnormality or evidence of myocardial ischaemia. Cardioactive medication (beta-blocking agents/vasodilators) ideally will have been withdrawn 48 hours beforehand. Scintigraphy/stress echocardiography may be helpful for future reference and/or in the presence of an abnormality in the resting ECG;
- b echocardiography/radionuclide/contrast ventriculography demonstrates a left ventricular ejection fraction  $\geq$  0.50 without significant abnormality of wall motion such as dyskinesia, hypokinesia or akinesia. No significant echo free space shall be demonstrated;
- c a 24-hour ambulatory ECG demonstrates no significant conduction disturbance, nor complex, nor sustained rhythm disturbance, nor evidence of myocardial ischaemia;
- d coronary angiography is carried out should there be any doubt about the result of non-invasive investigations (see Sub-Chapter 4 above);
- e six monthly follow-up by a cardiologist acceptable to the AMS with exercise ECG/scintigraphy/stress echocardiography and 2D Doppler echocardiography is carried out until complete resolution has been demonstrated;
- f recertification is restricted to multi-pilot operation (Class 1 'OML') for at least two years.

Review by a cardiologist acceptable to the AMS is required six-monthly, at first, with resting ECG and echocardiography. Supervision should continue for at least two years.

***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 recertification, (Class 1 'OML'), may be considered provided the patient is in sinus rhythm and the requirement of 11.1 above can be fulfilled. Annual review by a cardiologist acceptable to the AMS is required.

## 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 impairment of systolic and/or diastolic function. 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 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 dysplasia with associated risk of sudden cardiac death, especially in young adults. Established hypertension (the so-called compensated phase) is associated with concentric hypertrophy of the heart. Very similar appearances may be seen in aortic valve obstruction initially but late stage hypertensive heart disease is also commonly associated with dilatation of the heart. Before the availability of the angiotensin converting enzyme inhibitors (ACEI), in the idiopathic form up to two thirds of the patients died within two years of the diagnosis although a minority continued without evidence of further deterioration for a protracted period. Angiotensin converting enzyme inhibition has had a significant impact on the outcome and patients in whom this product is clinically indicated may be fit for aircrew duties.

Established dilated cardiomyopathy involving the left and/or the right ventricle is incompatible with flying status. The small percentage of patients who appear to make a complete recovery may be considered for multi-pilot operation (Class 1 'OML') not less than six months after recovery has been deemed to be complete, provided that:

- a A symptom-limited exercise ECG to Bruce stage IV, or equivalent, shows no significant abnormality or evidence of myocardial ischaemia. Cardioactive medication (beta-blocking agents, vasodilators) ideally will have been withdrawn 48 hours beforehand. Scintigraphy/stress echocardiography may be helpful for future reference and/or in the presence of an abnormality in the resting ECG;
- b echocardiography/radionuclide/contrast ventriculography demonstrates a left ventricular ejection fraction  $\geq$  0.50 without significant abnormality of wall motion such as dyskinesia, hypokinesia or akinesia;
- c coronary angiography is carried out should there be any doubt about the result of non-invasive investigations (see paragraph 4);
- d a 24-hour ambulatory ECG demonstrates no significant conduction disturbance, nor complex, nor sustained rhythm disturbance, nor evidence of myocardial ischaemia (see also paragraph 13);
- e six monthly follow-up by a cardiologist acceptable to the AMS with exercise ECG/scintigraphy/stress echocardiography, 2D Doppler echocardiography and 24-hour ambulatory ECG is carried out until complete stability has been demonstrated.

***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, septal hypertrophy of the interventricular septum and failure of diastolic function. A number of gene loci have been identified with associated abnormalities of contractile protein function. In general terms, in adulthood, but not in children or young adults, provided there is no family history of sudden cardiomyopathic death, vasomotor instability on exercise or occult or overt ventricular tachyarrhythmia, consideration can be given to certification. Increase in the left ventricular muscle mass may contribute to breathlessness due to loss of compliance but per se does not appear to be predictive of outcome. The resting ECG may be normal or more commonly demonstrates septal vectors, notably in the inferior leads, 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 unassociated with other echocardiographic features of hypertrophic myopathy (i.e., reduction in left ventricular cavity size, 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 acceptable to the AMS and restriction to multi-pilot operation (Class 1 'OML').

Once the diagnosis of hypertrophic cardiomyopathy has been established, because of the excess potential risk of rhythm disturbance, syncope, cerebral embolism and sudden cardiac death, such individuals are unlikely to be fit for any form of certification. Applicants in whom features of hypertrophic cardiomyopathy are detected may be considered for multi-pilot operation (Class 1 'OML') provided that

- a A symptom-limited exercise ECG to Bruce stage IV, or equivalent, shows no significant abnormality, particularly of pressor response to exercise. Cardioactive medication (beta-blocking agents, vasodilators) ideally will have been withdrawn 48 hours beforehand. Scintigraphy/stress echocardiography may be helpful for future reference and/or in the presence of an abnormality in the resting ECG;
- b echocardiography/radionuclide/contrast ventriculography demonstrates a left ventricular ejection fraction  $\geq$  0.50 without significant abnormality of wall motion such as dyskinesia, hypokinesia or akinesia. The interventricular septal diameter shall be  $<$ 2.0 cm;
- c a coronary angiography is carried out should there be any doubt about the result of non-invasive investigations (see Sub-Chapter 4 above);
- d a 24-hour ambulatory ECG demonstrates no significant rhythm or conduction disturbance (see also paragraph 13). Evidence of non-sustained/sustained ventricular rhythm disturbance will disqualify.
- e follow-up by a cardiologist acceptable to the AMS with exercise ECG/scintigraphy, 2D Doppler echocardiography/stress echocardiography and 24-hour ambulatory ECG is carried out as appropriate;
- f recertification is restricted to multi-pilot operation (Class 1 'OML').

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.

***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 and have a poor prognosis due to an excess risk of pulmonary and systemic embolism. In the established condition, or in a patient in whom the presence of  $1 \times 10^9/L$  circulating degranulated neutrophils has been identified, certification to fly is not permissible.

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) levels will help establish active sarcoidosis if they are 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 disqualifies from all classes of certification to fly.

Symptom-free individuals including those with sarcoidosis with radiographic signs only of sarcoidosis involving the hilar nodes may be considered for multi-pilot operation (Class 1 'OML') provided that:

- a A symptom-limited exercise ECG to Bruce stage IV, or equivalent, shows no significant abnormality or evidence of myocardial ischaemia. Cardioactive medication (beta-blocking agents/vasodilators) ideally will have been withdrawn 48 hours beforehand. Scintigraphy/stress echocardiography may be helpful for future reference and/or in the presence of an in the resting ECG;
- b echocardiography/radionuclide/contrast ventriculography demonstrates a left ventricular ejection fraction  $\geq 0.50$  without significant abnormality of wall motion such as dyskinesia, hypokinesia or akinesia;
- c coronary angiography is carried out should there be any doubt about the results of non-invasive investigations (see paragraph 4);
- d a 24-hour ambulatory ECG demonstrates no significant conduction disturbance, nor complex, nor sustained rhythm disturbance, nor evidence of myocardial;
- e six monthly follow-up by a cardiologist acceptable to the AMS with exercise ECG/scintigraphy/stress echocardiography, 2D Doppler echocardiography and 24-hour ambulatory ECG is carried out as appropriate;
- f recertification is restricted to multi-pilot operation (Class 1 'OML').

***This level of assessment also applies to Class 2. Any variation disqualifies from all classes of certification to fly.***

## 13 RHYTHM AND CONDUCTION DISTURBANCES

### 13.1 Rhythm disturbances

Rhythm disturbances give rise to problems with regard to certification particularly when paroxysmal. Some individuals when encountering their first such rhythm disturbance, be it atrial fibrillation, atrial flutter or supraventricular tachycardia (SVT) by whatever mechanism 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, while others who develop chronic atrial fibrillation are equally unaware of any 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 Holter monitoring should be carried out to seek the possibility of sino-atrial disease.

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 but this is less certain. 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. Certification to fly may be considered, provided that:

- i A symptom-limited exercise ECG to Bruce stage IV, or equivalent, shows no significant abnormality (i.e. rhythm disturbance) or evidence of myocardial ischaemia. Cardioactive medication (beta-blocking agents/vasodilators) ideally will have been withdrawn 48 hours beforehand. Scintigraphy/stress echocardiography may be helpful for future reference and/or in the presence of an abnormality in the resting ECG;
- ii echocardiography/radionuclide/contrast ventriculography demonstrates a right and left ventricular ejection fraction  $\geq$  0.50 without significant abnormality of wall motion such as dyskinesia, hypokinesia or akinesia;
- iii a 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);
- iv cardioactive medication apart from beta-blocking agents, verapamil and digoxin shall not be permitted;
- v follow-up by a cardiologist acceptable to the AMS with exercise ECG/scintigraphy, 2D Doppler echocardiography and 24-hour ambulatory ECG is carried out as appropriate;
- vi recertification is restricted to multi-pilot operation (Class 1 'OML') unless the above requirements can be met in full.

***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 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, or it may be established. For the purposes of certification, paroxysmal atrial fibrillation will be defined as more than one attack with no time limit. Any single episode of this disturbance can be associated with problems such as valvular or hypertensive heart disease, myocardial ischaemia, or primary myocardial abnormalities. The

possibility of alcohol abuse and thyrotoxicosis also need to be considered. An airman with any such concomitant diagnosis is likely to be unfit for any form of certification to fly. 'Lone' atrial fibrillation may be present when there is no other demonstrable cause or other cardiac abnormality. In no case shall a Class 1 certificate be issued to a pilot with paroxysmal or established atrial fibrillation once he/she has reached the age of 60 years due to the excess risk of thromboembolic stroke in the absence of treatment with warfarin.

Generally the use of medication in aeromedical certification is not advised. One exception apart from hypertension may be atrial fibrillation when attempting to suppress attacks (i.e. of paroxysmal disturbance of rhythm) or to help control the rate when the rhythm disturbance is established. Permissible medication at present includes sotalol, other beta-blocking agents, 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. 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 restricted certification (Class 1 'OML'), provided that:

- i The resting ECG is within normal limits. 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 a symptom-limited exercise ECG to Bruce stage IV, or equivalent, shows no significant abnormality (i.e. inappropriate rate) or evidence of myocardial ischaemia. Cardioactive medication (beta-blocking agents/vasodilators) need not be discontinued. Scintigraphy/stress echocardiography may be helpful for future reference and/or in the presence of an abnormality in the resting ECG;
- iii echocardiography/radionuclide/contrast ventriculography demonstrates right and left ventricular ejection fractions  $\geq 0.50$  and the 2D Doppler echocardiogram is within normal limits. The left atrial internal diameter shall not exceed 4.5 cm;
- iv 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;
- v coronary angiography is carried out should there be any doubt about the result of non-invasive investigations (see paragraph 4);
- vi following a single attack of atrial fibrillation with a defined cause, an applicant who has satisfactorily completed the above investigations may be certificated fit Class 1 'OML' subject to a review every 6 months by a cardiologist acceptable to the AMS. Restoration of a full Class 1 certificate 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;
- vii following a second or further attack of paroxysmal atrial fibrillation, and following satisfactory completion of the above, the airman may be considered for certification 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, restricted Class 1 certification 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 shall be required;

- viii provided the above requirements can be satisfied in full, established atrial fibrillation is consistent with Class 1 'OML' certification subject to review 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 incompatible with any form of certification to fly. Electrophysiologically demonstrated ablation of a flutter circuit may be an exception no sooner than 6 months following intervention.

c *Sinus node arrest and sinoatrial block*

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

Pauses >2.5 seconds are probably abnormal, although may be provoked by vagal effects including exaggerated sinus arrhythmia. Sinus node dysfunction usually progresses slowly and the outlook is good over many years. Evidence of early sinoatrial node dysfunction may be inferred 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. Salvoes 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. Symptomatic pauses require endocardial pace-making. Those with asymptomatic pauses brought to light by routine resting ECG may be considered for certification, provided that:

- i A symptom-limited exercise ECG to Bruce stage IV, or equivalent, shows no significant abnormality or evidence of myocardial ischaemia. Cardioactive medication (beta-blocking agents/vasodilators) ideally will have been withdrawn 48 hours beforehand. Scintigraphy/stress echocardiography may be helpful for future reference and/or in the presence of an abnormality in the resting ECG;
- ii echocardiography/radionuclide/contrast ventriculography demonstrates a left ventricular ejection fraction  $\geq$  0.50 without significant abnormality of wall motion such as dyskinesia, hypokinesia and akinesia.
- iii a 24-hour ambulatory ECG demonstrates no significant conduction disturbance, nor complex, nor sustained rhythm disturbance, nor evidence of myocardial ischaemia (i.e. pauses >2.5 s);
- iv electrophysiological study, if carried out, shall show a normal sinus node recovery time and normal conduction velocities;
- v follow-up by a cardiologist acceptable to the AMS with exercise ECG/scintigraphy/stress echocardiography, 2D Doppler echocardiography and 24-hour ambulatory ECG is carried out as appropriate;
- vi recertification is restricted to multi-pilot operation (Class 1 'OML').

***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'***

The presence of symptoms is disqualifying.

d *Paroxysmal narrow complex tachycardias (Atrioventricular node reentrant tachycardia and atrioventricular reentrant tachycardia (pre-excitation))*

The most common causes of 'paroxysmal supraventricular tachycardia' include atrioventricular nodal reentry (AVNRT) – 50% of all, and atrioventricular reentry or 'pre-excitation' – 30% of all. Less common are other forms of narrow complex tachycardia including sino-atrial nodal reentry, 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 being increasingly used for ablation of identifiable bypass pathways (i.e. the Kent bundle) and it may be consistent with certification. Rhythm disturbances involving nodal reentry may be less satisfactorily dealt with in this manner.

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), Ganong-Levine (James bundle) and paraspecific Mahaim forms. Such electrocardiographic abnormalities are seen in approximately 0.25% of asymptomatic individuals with a risk of about 2% of significant tachyarrhythmia.

If atrioventricular reentrant tachycardia (AVRT) or atrioventricular nodal reentrant tachycardia (AVNRT) is to develop this commonly occurs in the first two or three decades of life and less commonly as a first event thereafter. Atrioventricular reentrant 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 consistent with certification to fly provided that:

- i A symptom-limited exercise ECG to Bruce stage IV, or equivalent, shows no significant abnormality or evidence of myocardial ischaemia. Cardioactive medication (beta-blocking agents/vasodilators) ideally will have been withdrawn 48 hours beforehand. Scintigraphy/stress echocardiography may be helpful in the presence of a delta wave disturbance in the resting ECG due to the likelihood of significant repolarisation changes in the exercise ECG;
- ii echocardiography/radionuclide/contrast ventriculography demonstrates a left ventricular ejection fraction  $\geq$  0.50 without significant abnormality of wall motion such as dyskinesia, hypokinesia or akinesia;
- iii there is no history of ongoing paroxysmal rhythm disturbance;
- iv a 24-hour ambulatory ECG demonstrates no significant rhythm or conduction disturbance nor evidence of myocardial ischaemia;
- v an electrophysiological study demonstrates an effective refractory period  $>$ 300 ms in an accessory pathway, if present unless a 24-hour ambulatory ECG demonstrates disappearance of the delta wave from time to time;
- vi follow-up by a cardiologist acceptable to the AMS with exercise ECG/scintigraphy, 2D Doppler echocardiography and 24-hour ambulatory ECG, if necessary, is carried out as appropriate;
- vii certification is restricted to multi-pilot operation (Class 1 'OML').

Ablation of an accessory pathway or a slow conducting pathway in nodal reentrant tachycardia, or of an atrial flutter circuit when demonstrated electrophysiologically to have been complete may be consistent with restricted certification (Class 1 'OML') no sooner than 6 months following

intervention. Unrestricted certification may be permitted no sooner than 24 months provided there is no order disqualifying or associated abnormality.

***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'.***

The presence of atrioventricular reentrant tachycardia or paroxysmal atrial fibrillation in the presence of an accessory pathway shall disqualify from all classes of certification to fly.

### 13.2 Conduction disturbances

#### a Atrioventricular block

First degree heart block is not uncommon in fit young men and the PR interval may exceed 0.20 secs not uncommonly 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 0.4 seconds 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 considered for Class 1 certification.

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 evaluation with 24-hour ambulatory monitoring and an electrophysiological study (see paragraphs 13.2 b and c).

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. Certification to fly may be considered, provided that

- i A symptom-limited exercise ECG to Bruce stage IV, or equivalent, shows no significant abnormality or evidence of myocardial ischaemia. Cardioactive medication (i.e. beta-blocking agents/vasodilators) ideally will have been withdrawn 48 hours beforehand. Scintigraphy/stress echocardiography may be helpful for future reference and/or in the presence of an abnormality in the resting ECG;
- ii echocardiography/radionuclide/contrast ventriculography demonstrates a left ventricular ejection fraction ? 0.50 without significant abnormality of wall motion such as dyskinesia, hypokinesia or akinesia;
- iii a 24-hour ambulatory ECG demonstrates no significant rhythm (see paragraph 14.1 b) or conduction disturbance, nor evidence of myocardial ischaemia (i.e. other than short periodicity Mobitz type 1 AV block at night);
- iv electrophysiological study, if carried out, shows normal conduction velocities within the normal range;
- v annual review by a cardiologist acceptable to the AMS with exercise ECG/ scintigraphy, 2D Doppler echocardiography and 24-hour ambulatory ECG monitoring is carried out as appropriate;
- vi recertification is restricted to multi-pilot operation (Class 1 'OML') or refused unless the above requirements can be met in full.

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

Evidence of distal conducting tissue disease on electrophysiological study disqualifies from all classes of certification to fly.

The presence of Mobitz Type II, 2:1 and 3:1 atrioventricular block is incompatible with any class of certification to fly.

Complete congenital atrioventricular block is a rare condition which may become symptomatic during early adult life. As a result it is not consistent with any class of certification to fly.

**b** *Right bundle branch block*

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 certification to fly may be considered, provided that:

- i A symptom-limited exercise ECG to Bruce stage IV, or equivalent, shows no significant abnormality or evidence of myocardial ischaemia. Cardioactive medication (i.e beta-blocking agents/vasodilators) ideally will have been withdrawn 48 hours beforehand. Scintigraphy/stress echocardiography may be helpful for future reference and/or in the presence of an abnormality in the resting ECG;
- ii echocardiography/radionuclide/contrast ventriculography demonstrates a left ventricular ejection fraction  $\geq$  0.50 without significant abnormality of wall motion such as dyskinesia, hypokinesia or akinesia;
- iii coronary angiography is carried out should there be any doubt about the result of non-invasive investigations (see paragraph 4 above);
- iv the co-existent presence of first degree heart block and anterior or posterior hemiblock is evaluated by an electrophysiological study.
- v a 24-hour ambulatory ECG demonstrates no significant rhythm disturbance or higher degree of conduction disturbance;
- vi follow-up by a cardiologist acceptable to the AMS with exercise ECG/scintigraphy, 2D Doppler echocardiography and 24-hour ambulatory ECG is carried out as appropriate;
- vii recertification is restricted to multi-pilot operation (Class 1 'OML') for at least one year when stable. Established complete right bundle branch block may be considered for unrestricted Class 1 subject to satisfactory completion of the above.

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

**c** *Left bundle branch block*

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 scintigraphy/stress echocardiography and/or by coronary angiography on first appearance. In the recently acquired form, the risk of sudden cardiac death in patients above age 45 years is ten times that of the peer group but this has not been seen below age 45 years. The mortality risk ratio in patients with established complete

left bundle branch block appears to be about 1-33. Rate related left bundle branch block should be treated in the same manner. Certification to fly may be considered provided that:

- i A symptom-limited exercise scintigraphy/stress echocardiography to Bruce stage IV, or equivalent, shows no significant abnormality or evidence of myocardial ischaemia. Cardioactive medication (beta-blocking agents/vasodilators) ideally will have been withdrawn 48 hours beforehand;
- ii coronary angiography shows no evidence of significant coronary artery disease (see paragraph 4);
- iii echocardiography/radionuclide/contrast ventriculography demonstrates a left ventricular ejection fraction  $\geq$  0.50 without significant abnormality of wall motion such as dyskinesia, hypokinesia or akinesia;
- iv a 24-hour ambulatory ECG demonstrates no significant rhythm, or higher degree of conduction disturbance;
- v an electrophysiological study shows evidence of an HV interval  $<$ 70ms;
- vi follow-up by a cardiologist acceptable to the AMS with exercise ECG/scintigraphy/stress echocardiography, 2D Doppler echocardiography and 24-hour ambulatory ECG is carried out as appropriate;
- vii recertification is restricted to multi-pilot operation (Class 1 'OML') for at least 3 years. Re-evaluation at that time, if satisfactory, may lead to removal of restriction.

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

d *Left anterior and left posterior hemiblock*

Left anterior hemiblock has a 1–2% prevalence in normal individuals. 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 and requires at least exercise ECG to Bruce stage IV. Stable incomplete left bundle branch aberration (complex  $<$  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 justifies exercise ECG 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. Restricted certification (Class 1 'OML') to fly may be granted 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 acceptable to the AMS 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 following surgical correction. The pulmonary pressures should be normal.
- b An uncorrected small secundum defect with no other abnormality is consistent with Class 1 status provided the right ventricular pressures are normal. The pulmonary systemic flow ratio should be  $<1.5:1$ . In view of the risk of late arrhythmias, certification following surgical correction may need to be restricted to multi-pilot duties (Class 1 'OML'). Pulmonary pressures should be normal. 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 Class 1 'OML' 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 precludes certification (Class 1 'OML') except where repeated ambulatory monitoring has shown there to be no significant rhythm disturbance. Annual review by a cardiologist acceptable to the AMS 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 are fit for unrestricted certification (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. Supra-valvular stenosis is likely to disqualify but corrected infundibular stenosis may be permissible. Provided the pressure difference is  $>30$ mmHg peak to peak and the situation is stable, then the outlook is good. A minor degree of pulmonary stenosis is consistent with unrestricted certification (Class 1) provided there is no evidence of right ventricular hypertrophy on 2D Doppler echocardiography. With a drop  $>20$  mmHg but  $<30$  mmHg Class 1 'OML' status may be granted with annual review by a cardiologist acceptable to the AMS to confirm the stability of the situation. 2D Doppler echocardiographic assessment is acceptable 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. This anomaly may be associated with a bicuspid aortic valve. Following closure no special risks appear to accrue provided the shunt was not large and pulmonary hypertension is not present. A closed defect is consistent with Class 1 certification to fly while a small unclosed defect requires a Class 1 'OML' limitation.

#### 14.6 Coarctation of the aorta

Late correction (i.e., >age 12 years) of a coarctation of the aorta appears to be associated with a higher risk of sudden cardiac death and stroke. If the condition is corrected <age 12 years and the subject is normotensive both at rest and on exercise, then Class 1 certification to fly may be appropriate. Late surgical correction requires Class 1 'OML' 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

QT prolongation is occasionally detected in aircrew although it is probably more commonly missed. Congenital forms associated with deafness may be transmitted as an autosomal recessive characteristic (Jervell, Lange Neilsen) and in the absence of deafness as an autosomal dominant characteristic (Romano Ward). Often the QT interval is significantly prolonged (>550ms) and the T waves bizarre. There is a risk of ventricular tachycardia and sudden cardiac death. When identified, these syndromes are not consistent with any form of certification to fly.

Less obvious changes in the QT interval in an asymptomatic individual (arbitrarily >440ms) expressed at the interval itself, or as its derivative the Qtc (the correction applied by Bazett by dividing the QT interval in ms by the square root of the RR interval expressed in seconds) are occasionally encountered in the absence of medication which might provoke such features. Under these circumstances, a full evaluation with particular attention to family history, structural abnormality of the heart and electrophysiological characteristics of the myocardium is indicated.

### 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. Applicants may be considered for certification for multi-pilot operation (Class 1 'OML') three months following an insertion, provided that:

- a there is no other disqualifying condition;
- b a bipolar lead system has been used;
- c the applicant is not pacemaker dependent;
- d a symptom-limited exercise ECG to Bruce stage IV, or equivalent, shows no abnormality or evidence of myocardial ischaemia. Scintigraphy/stress echocardiography may be helpful in the presence of a conduction disturbance/paced complexes in the resting ECG;
- e 2D Doppler echocardiography shows no abnormality;
- f a 24-hour ambulatory ECG shall demonstrate no tendency to symptomatic or asymptomatic tachyarrhythmia;
- g six monthly follow up by a cardiologist acceptable to the AMS with a pace-maker check and 24-hour ambulatory ECG is carried out as appropriate;
- h recertification is restricted to multi-pilot operation (Class 1 'OML').

***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 not permitted.

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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 a requirement for the initial assessment of Class 1 applicants.

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

There is no further mandatory requirement for repeat x-rays to be undertaken unless there are clinical indications on subsequent examination or local epidemiological factors which might suggest that such an investigation is necessary.

#### 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, at the first revalidation/renewal examination after age 30, every 5 years until age 40 and every 4 years thereafter for Class 1 applicants; and at initial examination and at the first revalidation/renewal examination after age 40 for Class 2 applicants. Class 2 applicants who are over 40 years of age also require pulmonary function testing 4 yearly.

The initial pulmonary function testing for Class 1 applicants is to be performed by the use of a spirometer. All other routine mandatory testing is by use of a peak flow meter. When pulmonary function testing is indicated on clinical grounds, spirometric testing is the preferred method.

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). At least three acceptable forced expiratory volume manoeuvres are required and the results should be within 7% 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 improved 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. 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 respiratory 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 of fitness on such ratios.

A peak flow meter (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 respiratory physician is required.

## **2 CHRONIC OBSTRUCTIVE AIRWAY DISEASE AND ASSESSMENT GUIDELINES**

All applicants with chronic obstructive airways disease COAD from 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 reversible obstruction 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 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.

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 provided that the applicant demonstrates:

- a A minimum period of five years since last acute attack;
- b acceptable pulmonary function tests (FEV1/FVC ratio >75% and normal home peak flow monitoring);
- c treatment limited to inhaled cromoglycate or inhaled corticosteroid or inhaled beta agonist or any combination of two;
- d absence of bronchospasm on clinical examination;
- e absence of bronchospasm associated with mild respiratory infection;
- 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 and may be restricted to multi-crew operations 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 Minimum period of two years since last acute attack;
- b Acceptable pulmonary function tests (FEV1/FVC ratio >75% and normal home peak flow monitoring);

- c Treatment limited to inhaled cromoglycate, inhaled corticosteroid or inhaled beta agonist or any combination of two;
- d Absence of bronchospasm on clinical examination;
- e Bronchospasm associated with mild respiratory infections easily controlled.
- 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 certification but may also be subject to 'Safety Pilot 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, will jeopardise their continuing certification.

## **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 recertification 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 certification 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 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 commonest 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 for certification 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 xray, 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 Certification restricted to multi-pilot operations.

These investigations should be repeated annually and provided regression has occurred unrestricted certification 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 multi-pilot operations certification by the AMS provided that all

the criteria listed above in a, b and c are met. Annual screening as in a, b and c is essential and indefinite restriction to multi-pilot operations is mandatory due to late potential cardiac involvement.

Applicants with known cardiac sarcoid shall be denied certification.

***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 consequent 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 may be 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 A restriction to multi-crew duties for one year from the original occurrence is applied.

Following a second pneumothorax, certification must be denied in view of the recurrence rate. Recertification 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 and if large can compress the surrounding lung tissue producing respiratory impairment. 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 as a spontaneous pneumothorax. Recertification is usually justified 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 certification or recertification may be considered by the AMS. This period may need to be] increased in accordance with the underlying pathology. Certification 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 when 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 precipitate further symptoms. Because of such risks it is often necessary to confirm recovery or healing by additional testing of an apparently asymptomatic and recovered individual.

### 2 OESOPHAGUS

The oesophagus is the first part of the alimentary tract, as such, any expanding gases associated with altitude can equalise through the mouth and are unlikely to cause discomfort. Any restriction or discomfort associated with food transit however, 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 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. The acid produced in the initial digestive process 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, means a temporarily unfit assessment until recovery has been demonstrated. Endoscopic or radiological confirmation of healing must be shown and only minimal dosage of prophylactic treatment can be acceptable to the AMS for issue of a certificate. If surgical treatment of a bleeding or perforated ulcer is required, the individual must be asymptomatic three months later with demonstrated healing before flying may be considered. Recurrent peptic ulceration may require detailed evaluation before certification or re-certification 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 conditions 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 Part 3 Appendix 3 para 3 before considering recertification.

**2, 3 and 4 – these assessments apply to Class 1 and Class 2**

#### **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 condition has recovered.
- b Crohn's disease. Acute and chronic small intestinal inflammation diagnosed as Crohn's disease is of concern due to its unpredictable nature. Initial applicants for Class 1 medical certificates with a confirmed history of Crohn's disease are unfit. Re-certification may be considered if in full remission on low doses of acceptable medication. Close follow-up and supervision by the AMS will be required. A Class 2 certificate may be issued to individuals who are in remission, fully stable, and with no sign of complication (adhesion/obstruction).
- 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 peripatetic 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 be associated with diarrhoea, haemorrhage or even perforation.

Conditions which give rise to chronic colonic symptoms are disqualifying. Individual cases should be assessed by the AMS to ensure full recovery before certification or re-certification can be considered. Colonic conditions of note are:

- a Irritable bowel syndrome. This may be incompatible with certification. Individuals with symptoms controlled by diet or acceptable medication may be considered for certification.
- 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.

Single episodes or isolated areas which have been treated surgically may be considered for Class 1 and Class 2 certification 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. Colitis treated surgically by colectomy with a satisfactory ileostomy may also be considered by the AMS.

Any history or clinical diagnosis of ulcerative colitis will require assessment by the AMS. A single acute episode if satisfactorily recovered for more than a year without symptoms or medication may be considered fit.

Re-certification may be considered after three months without symptoms and with minimal use of non-steroid medication. 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 consideration can be given for flying.

**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 certification, providing 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 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, will be assessed as temporarily unfit and may be re-assessed for certification 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 certification can be considered.
- 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 so likely to be associated with secondary conditions such as oesophageal varices. If however, transplant function is normal, immunosuppressive medication minimal and there is no increased risk from secondary conditions, certification (Class 2) and re-certification for multi-pilot operations (Class 1 'OML') 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 assist in the digestion of fat. Aeromedical concerns arise in association with calculus formation which can cause sudden painful incapacitation:

- 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 must be considered by the AMS at Class 1 and Class 2 level.

Gallstones small enough to enter the bile duct are potentially incapacitating and require specialist assessment. While awaiting assessment or treatment a multicrew 'OML' or safety pilot 'OSL' limitation may be appropriate after consideration by the AMS.

- b Cholecystectomy. Cholecystectomy, whether performed via intra-abdominal or laparoscopic surgical procedures, requires adequate recovery appropriate to the procedure before certification can be considered. Individual cases should be reviewed at the discretion of the Aeromedical Section.

## 11 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.

## **12 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. Any that may be associated with strangulation are disqualifying until repaired. Certification 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 incapacitating condition that will preclude flying. Nutritional and endocrinal 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 the certification decisions that are required.

### 3 THYROID DISORDERS

Disease of the thyroid gland can cause goitre and/or important disturbances in function.

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

#### 3.1 Hyperthyroidism

This condition usually occurs in connection with diffuse goitre (Graves Disease) and has an immunological basis. Mediation is by antibodies against the TSH receptor which stimulate the autonomous over-production of thyroid hormone. Toxic nodular goitre 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 goitre, 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;
- ii determination of total serum T4/free T4;
- iii determination of serum T3/free T3 levels.

##### c *Treatment*

Propyl thiouracil, methamizole or carbimazole, will control symptoms but the effect is slow, taking some four to six months. Propranolol may be used for quicker control of symptoms. Anti thyroid drugs should be continued for twelve months and then withdrawn but only 50% of patients so treated may remain euthyroid .

Partial thyroidectomy is practised much less frequently now and is reserved mostly for cases with large and/or nodular goitres.

*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 Certification*

A hyperthyroid pilot is unfit for flying and must remain so until a stable euthyroid state has been attained. Certification 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 certification. Where eye involvement has occurred, the pilot must be 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*

Thickening and drying of the skin, hoarseness, constipation, bradycardia, apathy, depression, 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 for life.

*d Certification*

Florid hypothyroidism requires a temporarily unfit assessment. The candidate may be considered for certification in any capacity while euthyroid and taking prescribed medication. Annual endocrinological supervision is required by the AMS. Some hypothyroid patients cease taking medication because they feel entirely well, recurrence of the condition may not be obvious and the typical apathy may lessen the chance of recognition. Annual review is therefore 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 Certification. Applicants with acute Cushings Syndrome are unfit for flying and must be assessed 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. Certification by the AMS is dependent on satisfactory reports from, and supervision by, an endocrinologist.

b *Over-production of prolactin*

Usually from an macro- or microadenoma of the pituitary, is now recognised as the most common hormonal abnormality of 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.

- 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 a prolactin secreting adenoma.
- 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 Certification. 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 certification by the AMS. Continued treatment will presumably have to be lifelong so far as present experience indicates. Annual review must include ophthalmic and endocrinological examination.

c *Growth hormone*

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 choice of treatment. Irradiation and/or somatostatin analog treatment may also be required.
- iii Certification. Any pilot with a GH secreting tumour producing symptoms is unfit (also see the Oncology Chapter 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 Class 1 or 2. Specialist ophthalmological and endocrinological review will be required before consideration by the AMS. Annual review is necessary of any cases 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 secretion by the posterior pituitary).

b *Diagnosis*

Fluid deprivation tests are diagnostic. If dehydration raises the serum osmolality to 295 mOsm/kg but the urine remains dilute, the diagnosis is diabetes insipidus.

c *Treatment*

Desmopressin (DDAVP), is effective and convenient. The dose must be individualised.

d *Certification*

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 initial Class 2 certification and Class 1 and 2 re-certification with regular specialist follow up.

### 5 **DISEASES OF THE SUPRARENAL GLAND**

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

a *Aethiology 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 relapse.

e *Certification*

Fully stabilised cases may be considered by the AMS for re-certification. 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 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 the important levels. WHO agreed levels are outlined below.

|                                 | <b>Fasting</b>                 | <b>2 hours post</b>             |
|---------------------------------|--------------------------------|---------------------------------|
| <b>Normal</b><br><120 mg/100 ml | < 6.7 mmol/l<br>< 120 mg/100ml | < 7.8 mmol/l<br>< 140 mg/100ml  |
| <b>Diabetes Mellitus</b>        | ≥ 6.7 mmol/l<br>≥ 120 mg/100ml | ≥ 10.0 mmol/l<br>≥ 180 mg/100ml |

These results are valid for venous whole blood glucose. 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:

|  |   |
|--|---|
| <b>Type 1</b><br>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.   |
| <b>Type 2</b><br>Non-insulin dependent (NIDDM) | Related to obesity and familial tendency. 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 aethiology and family aggregation. |

### 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 certificated 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

Reduction of carbohydrate and total calorie intake in the obese may be sufficient in many cases to reduce blood glucose levels acceptably. 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<br>HbA1           | control appropriate to diabetes management<br>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 hypoglycaemic drugs may be acceptable:

[

| Medication                   | Class 1 'OML'                               | Class 2   |
|------------------------------|---|---|
| Biguanides                   | Yes, unrestricted                           | Yes, unrestricted   |
| Alpha-glucosidase Inhibitors | Yes, unrestricted if used as single therapy | Yes, unrestricted if used as single therapy                         |
| Sulphonylureas               | Not acceptable                              | Yes, only restricted 'OSL'  |
| Thiazolidinedione            |   |   |
| Rosiglitazone                | Not acceptable                              | Yes, when combined with a biguanide or sulphonylurea, with an 'OSL' |
| Pioglitazone                 | Not acceptable                              | Yes, when combined with a biguanide or sulphonylurea, with an 'OSL' |
| Repaglinide                  | Not acceptable                              | Not acceptable  |

## 6.6 Long term monitoring of Type 2 diabetes

- 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 ophthalmoscopy after pupillary dilation to check for retinopathy and lens or vitreous opacities;
  - ii CNS examination for evidence of neuropathy;
  - iii periodic blood tests including biochemistry, 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 Certification

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 fit unrestricted Class 1 and Class 2, subject to detailed follow-up at periodic medical examinations or at least annually. Those requiring biguanide or alpha-glucosidase inhibitors treatment in addition may be acceptable for Class 1 'OML' and unrestricted Class 2 certification but the follow-up would need to be more stringent, namely 6 monthly. The use of sulphonylureas is unacceptable except for Class 2 (OSL) certification.

***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 continue medical certification.

## 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 urate concentration;
- 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 conclusion 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 indomethacin, 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. No sequelae ensue 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 per cent never have an attack, approximately 60 per cent 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 seldom a bar to flight duties.

### 7.5 Certification

- a Asymptomatic hyperuricaemia is not disqualifying.

- b Acute gout and the associated treatment require an assessment of temporarily unfit 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 nephrolithiases 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 aircraft reduces such effects the airman must also be able to respond normally to the emergency loss of pressurisation.

### 2 ANAEMIA

Applicants with a low haemoglobin are temporarily unfit and should be investigated as clinically indicated. Final assessment is dependent on the diagnosis and response to treatment.

#### 2.1 Iron deficiency

If the cause can be identified and is not disqualifying, treatment must lead to a haematocrit greater than 32% when re-certification 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 certificate may be issued subject to, at least, 6-monthly follow-up.

#### 2.3 Sideroblastic anaemia

Only carriers of the familial type can be certificated and only when the haematocrit is greater than 32%.

#### 2.4 Haemolytic anaemia

If acquired the underlying conditions must be evaluated and treated. Congenital haemolytic anaemia that is not due to a haemoglobinopathy and with haematocrit above 32%, may be considered for certification.

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.

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%, certification may be considered by the AMS. Annual review is required.

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

## **4 HAEMOGLOBINOPATHIES AND THALASSAEMIAS**

### **4.1 Sickling disorders**

Certification should be denied when sickling can be demonstrated at reduced oxygen tension.

Haemoglobin SC disease is associated with a high incidence of retinal haemorrhage and splenic infarction. Certification should be denied.

### **4.2 Thalassaemia**

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

Simple, uncomplicated Beta -thalassaemia trait is acceptable.

### **4.3 Haemoglobin AS (sickle cell trait)**

In the absence of conditions such as splenic infarction, this is acceptable.

### **4.4 Haemoglobin S**

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.

## **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 are considered unfit.

#### **a *Haemophilia***

Applicants with Factor VIII deficiency are unfit. The AMS may consider certification 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 denied certification. Individuals without therapy or without a history of significant bleeding episodes may be considered fit by the AMS.

#### **c *Deep vein thrombosis***

A history of deep vein thrombosis requires full investigation for underlying conditions. The individual is considered temporarily unfit.

#### **d *Pulmonary embolism***

Applicants with a history of pulmonary embolisation, not associated with chronic deep venous thrombosis, are considered 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 emboli***

Applicants with more than one episode of pulmonary embolisation documented by radio-isotopic or angiographic methods are unfit, even if the candidate is asymptomatic. If associated with recurrent injury or special circumstances, certification may be possible at the discretion of the AMS.

f *Arterial emboli*

A single episode is disqualifying 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, certification 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, dipyridole 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 safety pilot ('OSL') certification after consideration by the AMS. Cardiovascular requirements also refer (see JAR-FCL 3.150(c), JAR-FCL 3.270(c), paragraph 11 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.

## 5.2 Thrombotic disorders

Applicants with idiopathic thrombocytopenic purpura (ITP) previously treated by splenectomy and with stable platelet counts for six months after therapy has been discontinued, may be considered. 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 denied certification permanently.

Persons with thrombocytopenia below  $75\,000/\text{mm}^3$  should be disqualified. Some temporary episodes of thrombocytosis can occur in persons with underlying iron deficiency anaemia or other temporary disorders such as recovery from alcoholic bone marrow suppression.

If there is a temporary, secondary thrombocytosis that has been resolved and platelet counts have been consistently normal, the AMS may consider certification. Applicants with "essential" thrombocytosis without apparent explanation, who continue to have platelet counts above  $750\,000/\text{mm}^3$ , should be assessed by the AMS.

## 6 HAEMATOLOGIC NEOPLASIA

Applicants with a haematologic neoplasia should be denied certification. 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 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 not be certificated. Applicants with a medical history of acute lymphocytic leukaemia in childhood may be certificated 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 for certification 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 certificated.

### 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 denied certification 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 certificated. 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 certificated 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 could 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 certificated. Persons with Stage I and II-A who have had no evidence of disease for two years after completion of treatment may be certificated.

Persons with Stage II-B through IV-B should be free of disease and therapy for at least five years before consideration for certification and they should be re-evaluated every six months for ten years. After ten years there should be annual appraisals.

### 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 Bcell, 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 certificated with re-evaluation 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 certificated because of the high degree of malignancy of these disorders and their unpredictability. Cases of Burkitt's lymphoma are usually disqualifying, but may be certificated at the discretion of the AMS.

### c *Plasma cell dyscrasia*

Applicants with multiple myeloma, Waldenstrom's macroglobulinaemia or multiple plasmocytomas should not be certificated. These disorders are not curable, require frequent therapy that is toxic, 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 more than three years after therapy has been discontinued, they may be considered for certification 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 of osteolytic lesions, may be certificated 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 dyscrasia should not be certificated 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 certificated. 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 certificated because of the risk of sudden haemolysis.

Applicants with cryoglobulinaemia associated with myeloma and persons with the mixed cryoglobulinaemia syndrome should not be certificated 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 certification where 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 certificated 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 should 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 asymptomatic and the urine 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 rejection at initial examination. After full renal assessment and demonstrated recovery, certification and re-certification 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 certification.

#### 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**

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 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 certification. 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 ml/min. Below these levels, certification will only be permitted at the discretion of the AMS and in exceptional circumstances. Each individual will require careful follow-up and assessment. The requirement for dialysis will normally preclude all forms of certification to fly.

#### **6 RENAL TRANSPLANT**

An individual with a good response to transplantation may be considered for restricted re-certification if renal function is normal, there is no hypertension and the immuno-suppressive 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 of restricted certification. After a period of stability certification 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 muscle in the tract wall. Calculi vary in size, consistency, composition, shape and texture as do the dimensions of the renal tract. Any movement 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 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 recertification with a multi-pilot limitation (Class 1 'OML') or safety pilot limitation (Class 2 'OSL') for one year. After this period of

documented freedom from symptoms unrestricted certification may be considered by the AMS both for Class 1 and Class 2. A regular follow-up with echography 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 minimised and the applicant may be considered fit for multi-pilot operations (Class 1 'OML'), safety pilot (Class 2 'OSL') or unrestricted 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. Certification of individuals may be considered at an earlier stage for Class 2 than Class 1. Urological follow-up with radiological examination 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 full re-certification can be approved by the AMS. Follow up is important in all cases.

**7 – These assessments apply to Class 1 and Class 2**

## 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 initial Class 1 certification. If symptomatic, restricted recertification 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 2 certification following investigation and follow-up.

### 8.2 Medullary sponge kidney

Medullary sponge kidney may vary in severity and presents 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 consideration 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 - 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. Thirty to forty per cent of pregnant women bleed or have cramping pains some time during the first twenty weeks of pregnancy. Twenty per cent 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 certification 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 certification of pregnant air crew for multi-pilot (Class 1 'OML'), single-pilot (Class 2) 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 re-certification 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 9 - 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)

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 a positive serologic or virologic test for HIV with non-specific known cause, a history of opportunistic infections and Kaposi's sarcoma. HIV serological testing of individuals for certification 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 pO<sub>2</sub> 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 (helper) and T8 (suppressor) lymphocytic ratio with a frequency of at least every three months. Restricted re-certification 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.

Progressed stages 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 certified 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 clearly disqualified from aviation duties.

#### **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. Certification or re-certification 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 the Chapter on Tropical Medicine.

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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 employed in the treatment of musculoskeletal disorders must be assessed in accordance with JAR–FCL 3.115.

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. trauma or infection that could impair with this function. Painful foot or ankle injuries caused by sporting activities are common problems. 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 a 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 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 for 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. 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 if

he/she wishes to carry passengers. 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 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 were it to 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 to be restricted to flying with a "safety pilot" 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**

A careful examination by inspection, palpation and xray (when required) should be included in every assessment of the entire spine.

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 portural limitations 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**

The spine consists of a column of vertebral bodies with inter vertebral discs capable of taking heavy loads. Any deformity of a vertebral body caused by spondylolysis or trauma (fracture) or the deformity of the column (scoliosis 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 scoliosis.

The compression of a nerve root by a prolapsed 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. 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 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 incapacitation 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 should only be performed after convalescence 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 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 disorder will be used and where classification indices are shown these are from ICD10.

| <b>Basic Classification of Mental Disorder</b>           |
|--|
| Personality disorder                                     |
| Mental retardation                                       |
| Neurotic, stress-related and somatoform disorders        |
| Organic psychoses  |
| Functional psychoses, schizophrenia, affective psychoses |
| Mood disorders   |
| Disorders of adjustment                                  |
| Other disorders  |
| Disorder 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 disorder (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 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 distortions 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 distractibility. 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 (F 32)

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 NERVOUS 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:

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

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 (F60-69)**

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 (F602)***

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, asocial 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 the ones referring to the phobias, panic attacks, obsessive-compulsive disorders, post traumatic stress disorder and generalized anxiety disorder.

There are also included the various forms of clinical depression of mild or moderate degree excepting those with psychotic features such as delusions (see paragraph 11 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 diagnosis purposes.

Somatoform disorders include somatization disorder, hypochondrial disorder, somatoform autonomic dysfunction.

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 anxiety 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 caused 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 (depersonalizations or derealization).

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. There is usually a startle of 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 chemotherapy.

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 (conversive) 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 identify 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 afonia, disphonia; dissociative convulsions, dissociative anesthesia and sensory loss;
- ii dissociative reactions as an alteration of consciousness such as loss of memory usually of important recent events (dissociative amnesia) or dissociative fugue, dissociative stupor, a.s.o.

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

g Somatoform disorders (F45)

The main feature is a repeated claim of some presentation assumed physical symptoms together with persistent requests for medical investigations, inspite 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; and that behaviour is common with the individuals having an acute feeling of the 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 of the body parts nevertheless most of the common sensations are the gastrointestinal ones (pain, feeling bloated and full of gas, regurgitation of food, nausea, vomiting) and also the skin symptoms (unpleasant numbness or tinkling, burning sensations, itching) the sexual and menstrual complains 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 Hypochondriacal 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 manifest persistent somatic complaints or a persistent preoccupation with their physical appearance. Normal

or commonplace sensations are often considered by these individuals as normal and distressing, and attention is usually focuses 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 complains 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 or the organ or system concerned. Firstly there are complains 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 complains 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 syndrom, 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 wellbeing.

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.

What is characteristic for dysthymia is that the depressive mood episodes do not have a 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 **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 rejected for both commercial flying and air traffic control duties. (Referral for formal psychiatric assessment may allow a private pilot licence to be issued in certain circumstances.)

In all cases it is important that the consultant psychiatrist should be familiar with the aviation environment when 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 of fitness.

**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 licence 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 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 is required the licence must 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 loss of flying status.

## **11 THE PSYCHOSES**

The psychotic disorders are those presenting 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 flying licence, 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 disbarring.

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 is between 17 - 25 years for the young men and 25–35 years 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 a permanent bar to the holding or acquisition of any class of flying licence.

2 Schizotypal disorder (F21)

A disorder characterized 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 considered as fit to hold any class of flying licence.

4 Acute and transient psychotic disorders (F23)

There are a heterogenous group of disorders characterized by the acute concept of psychotic symptoms such as delusions, hallucinations and perceptual disturbances and by the severe disruption of behaviour. Acute onset is defined as a crescendo development of a clearly

normal clinical picture in about 2 weeks or less. There is possible an abrupt concept (onset within 48 hours).

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 may be made. The dilemma facing the AMS is to identify those who will make a full recovery and never relapse.

When the patient has hitherto been free of excessive mood swings and then 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 lead to a denial of any form of flying status, 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)

This is the manic-depressive illness or the 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 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 anticipated in all classes of pilots' licence. 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, cerebral space occupying lesions may also cause dementia and produce a similar psychiatric picture.

In none of these progressive dementing disorders may medical certification be agreed or maintained for any class of pilot licence.

## 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**

Disordered 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, not permit any class of medical certification.

#### **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 medical certification 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 medical certification 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. Certification should be limited to that of a multi-crew role only.

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

- 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/cuml
- iv earliest functional immunological deficits are seen
- v candidiasis
- vi other opportunistic infection (PCP etc.).

It would seem reasonable to suggest that with such regular surveillance, informed psychiatric/psychologic assessment and monitoring of disease markers, that restricted medical certification 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 difficulty 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. In other cases the pilot may well have tried his best but finds insuperable difficulty in learning new techniques – or indeed may have lost his motivation. In such cases medical re-certification will require very careful evaluation.

Further difficulty can arise when the ageing pilot fails to master the handling techniques of a new aircraft. The pilot will have tried his best but finds insuperable difficulty learning the new techniques – or may indeed have lost his motivation to fly. In such cases medical re-certification cannot be supported for re-licensing.

## 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 14 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**

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. This 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 as 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 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.

## 18.2 Medical Validation

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 with 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/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 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 AS of the licensing Authority before the individual may be considered 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 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. Where the diagnosis is considered by the AP not to constitute "alcohol, psychotropic drug or substance abuse with or without dependency" ( and it will be noted that this terminology does not conform to ICD 10 diagnostic terminology ), but where there is still a degree of concern regarding an alcohol related matter, then the AP and AS, but an unambiguous diagnosis of "alcohol abuse" clearly

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 (notably 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 AS/AP as being sufficient. It might be noted that the 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 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 retires. 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 Revalidation

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 multicrew capacity. A period of at least two years multicrew limitation (Class 1 "OML" or Class 2 "OSL") is required, assuming good progress. Failure to enter the programme or to maintain the protocol must lead to continued suspension of the licence.

f Relapse

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

### **18.3 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 against aircrew. However, when they are identified they are potentially a very serious concern and should always be assessed by an 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.

Prescribed drug use (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 AP.

### **18.4 Medical Validation**

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 airman/woman 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 necessary respect of 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.

## CHAPTER 12 - AVIATION NEUROLOGY

### 1 INTRODUCTION

Neurological assessment for aviation fitness, as with other systems, must include the present physical fitness, but also the likely natural history of a particular condition and the future risk to flight safety.

### 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.
- b Impair assessment, judgement and decision making.
- c Affect the motor skills necessary for good piloting. Effects of such pathology may be episodic, 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 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 a single event, or recurrent, static, or 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 predicted to be maintained throughout the defined period of medical certificate validation.

### 4 CONGENITAL NEUROLOGICAL PATHOLOGY

In congenital disorders of the nervous system each case must be considered individually, and the decision on fitness should be based on present physical fitness and the risk of incapacitation in the future.

### 5 ACQUIRED NEUROLOGICAL PATHOLOGY

This area may be considered under the headings of trauma, infection, metabolic, vascular, neoplastic, auto immune, allergic and degenerative.

#### 5.1 Traumatic pathology

##### a *Trauma*

Any blunt head injury is associated with a risk of permanent damage to the brain. Brain damage occurs following a penetration brain injury, depressed skull fracture particularly with a torn dura, or in a severe blunt head injury. 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 severity of head injury should be assessed by:

- i duration of unconsciousness;
- ii duration of post traumatic amnesia (PTA);
- iii the presence of a skull fracture, particularly a depressed fracture and whether it is associated with a torn dura;
- iv the presence of a demonstrable neurological deficit.

Professional aircrew who have suffered minor brain injury (loss of consciousness or amnesia < 30 minutes) associated with concussion may be returned to flying after a minimum of four weeks.

A moderate head injury (loss of consciousness or amnesia for 30 minutes to 24 hours or a skull fracture), but with full apparent recovery may require longer periods of temporarily unfit assessment usually associated with full neurological assessment. A full neurological assessment should include neurological examination, EEG, CT scan, MRI, and neuropsychological examination, as needed.

Severe head injury (loss of consciousness or amnesia > 24 hours, subdural haematoma or brain contusion) including perforation of the meninges must be assessed individually and usually requires extended observation (minimum two years) before consideration for recertification, and there should frequently be an initial restriction to multi-pilot operations. One of the main concerns is the risk of post traumatic epilepsy, the risk of which falls off progressively with time to some extent.

***This assessment applies to Class 2 however Class 2 'OSL' may be appropriate initially.***

b *Spinal Injury*

In the absence of major neurological deficit the results can be assessed operationally after stabilisation has occurred, normally at least 6 months post injury. Minor degrees of functional loss may be accepted.

## 5.2 **Cerebral infection**

Acute infection, abscess, acute meningitis or encephalitis are disqualifying. Each recovered case will require individual assessment for return to flying with primary consideration being given to long term sequelae.

Acute symptomatic seizures associated with acute cerebral inflammation or infection are not necessarily permanently disqualifying, although demonstrated full recovery over an extended period of time with a satisfactory EEG may be required. In some conditions such as cerebral abscess, the risk of epilepsy is so high that a long term unfit assessment will result.

Approximately 20% of HIV positive individuals present with neurological symptoms (including dementia). However such a presentation is usually gradual with little chance of acute, sudden incapacitation. From this point of view it would therefore seem unreasonable to assess as temporarily unfit the asymptomatic HIV positive individual however, restriction to multi-pilot operation with at least 6 monthly review is necessary. Once symptoms of the AIDS-related complex have appeared a long term 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 is recommended 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.***

### 5.3 **Metabolic cerebral disorders**

The problems here are normally secondary, i.e. hyper and hypoglycaemia, acidosis associated with renal failure, or hepatic failure, and are therefore already disqualifying. Cerebral symptoms associated with hyper- or hypothyroidism may fully recover and so be returned to flying after stabilisation and operational assessment (see metabolic chapter). Alcohol abuse, both acute and chronic can produce cerebral problems (for assessment see psychiatric notes). The alcohol withdrawal convulsion is an excellent example of a toxic convulsion which may have a good subsequent prognosis when associated with successful rehabilitation, but note the pilot who may have a constitutional predisposition to epilepsy which is made overt by alcohol. Acute decompression and hypoxia are further causes of metabolic disturbance that may recover fully in due course.

### 5.4 **Cerebrovascular disorders**

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. In thromboembolic atherosclerotic vascular disease there is a high risk of recurrence, or of other vascular disease such as myocardial infarct.

Lesions may be:

- a Haemorrhagic (aneurysms, arteriovenous malformation (AVMs) and spontaneous (intracerebral) bleeds.
- b Vaso-occlusive (thrombo-embolism).

Clinically all such conditions are potentially incapacitating, because of the risk of sudden unpredictable onset.

Transient Cerebral Ischaemic Attacks (TIAs) carry an increased risk (approximately 5% per annum) of stroke, CVA and also sudden death (approximately 5% per annum usually myocardial infarction). If the diagnosis is confirmed, the risk of recurrence or of other vascular disorders is unacceptably high and results in long term loss of medical certification.

Cerebro Vascular Accident (CVA) requires immediate grounding. 5% per annum will recur, and in addition there is an increased risk of other vascular disease, particularly myocardial infarction .

Spontaneous Subarachnoid Haemorrhage is associated with:

- i aneurysm (80%)
- ii arteriovenous malformation (15%)
- iii unidentified cause (<5%).

When a diagnosis of (i) or (ii) is confirmed and if the abnormality is supratentorial, the high risk of epilepsy would make revalidation unlikely. Surgical repair of an aneurysm is associated with an additional risk of epilepsy due to craniotomy. In certain circumstances, where the risk of epilepsy eventually falls to less than 1% per annum, class 1 recertification may be considered with an 'OML' restriction.

Aneurysms which are located below the tentorium cerebri (i.e. basilar aneurysms) are not associated with a risk of epilepsy, and provided they are successfully treated surgically and the person has made a full recovery, recertification is possible.

Where no structural disease is identified after angiography as the cause of the subarachnoid haemorrhage, and after a complete recover, multi-pilot certification may be considered after 9 months. Restricted (multi-pilot) certification is likely to be required long term.

***Class 2 'OSL' assessment is also appropriate. Class 2 may be considered after 2 years.***

## 5.5 Tumour/neoplasia

Intracerebral tumours may be benign or malignant, primary or secondary. They may be associated with progressive focal deficit, as well as increased incidence of epilepsy. The diagnosis is incompatible with certification.

Potential exceptions are:

- a Hamartoma are dysplastic rather than neoplastic, and each case must be considered on its merits but the potential risk of epilepsy in intracerebral abnormalities may be high and prevent certification.
- b Benign extracerebral neoplasms presenting with cerebral distortion but not epilepsy. Commonly meningiomata, may be considered for recertification two years post-operatively as there is a significant risk of post operative epilepsy.
- c 'Cured' neoplasia. The 'benign' tumours of childhood reticulosos and haemangioblastomata. Each may be considered on its merits after exclusion of late complication, multiple tumours, recurrence and systemic involvement.
- d Benign extramedullary spinal or nerve neoplasms. These are neurofibromata or meningiomata. Recertification can be considered after full recovery, but again the potential risk of epilepsy must be considered if the tumour was adjacent to the cerebral hemispheres.

Whenever recertification is considered the pilot must have undergone a neurological assessment by a consultant neurologist and the AMS must be satisfied that any neurological deficit is compatible with pilotage (medical flight test), and that the risk of epilepsy is minimal (less than 1% per annum). Certification should be limited to multi-pilot (Class 1 'OML') operation for an extended period. Reference should also be made to the oncology chapter.

***This assessment also applies to Class 2.***

## 5.6 Auto-immune and allergic conditions

Peripheral neuropathies and fitness to fly is dependent on the underlying pathology, present neurological deficit, and prognosis. The Guillain-Barre syndrome often recovers completely and applicants can be assessed purely by their functional ability. Recurrences occur rarely. Myopathy with significant weakness and myasthenia gravis are incompatible with certification.

## 5.7 [Neuro]degenerative diseases

Neurodegenerative disease is progressive and therefore usually incompatible with certification.

### a *Motor Neurone Disease*

The disease usually progresses rapidly, and the applicant must be grounded. The more benign spinal muscular atrophy may be compatible with continuation of flying subject to regular neurological assessment and flight simulator checks.

b *Parkinson's Disease*

In the very early stages, mild symptoms may allow continuation of certification with a multi-pilot (Class 1 'OML') restriction, but as the condition progresses loss of certification becomes inevitable. Most medication for Parkinson's Disease is incompatible with flying, exceptions being amantadine and selegiline. Frequent follow-up by an accepted neurologist is required. A practical flight test or simulator check may be necessary.

***This assessment applies to Class 1 and Class 2.***

c *Dementia*

A confirmed diagnosis of dementia is incompatible with fitness to fly.

d *Spinal Spondylosis/Degenerative Disc Disease*

This is a common condition and flight crew are not excluded, particularly those who may have experienced ejection seat trauma, whilst escaping from military aircraft. Poor posture, vibration and adverse ergonomic factors are likely to exacerbate any tendencies towards back problems.

Spinal root compression caused by cervical or lumbar (intravertebral) disc degeneration and protrusion are a further common cause of back pain. Aircrew developing such problems should be treated in the normal clinical fashion. However, before returning a pilot to flying duties due consideration must be given to the possibility of emergency asymmetric rudder in the event of engine failure of a multi-engine aircraft. 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 pilots will usually remain unfit for about 3 months.

## 5.8 **Cerebral decompression sickness**

Cerebral decompression sickness is due to the formation of bubbles of nitrogen in body organs 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 aircrafts are flying above 15 000 feet, although it can even occur at lower cabin altitudes when flying immediately 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.

## 6 **EPISODIC NEUROLOGICAL PROBLEMS**

### 6.1 **Migraine**

Migraine is a common constitutional disorder which is unpredictable and potentially disabling. The symptoms vary in severity, from the classical triad of visual aura, cephalgia and nausea (migraine with aura) to a recurrent vascular type of headache with nausea but without neurological symptoms (migrain without aura). Migraine is frequently disabling and unpredictable, frequently associated with visual disturbances which may be severe, and is therefore a potential flight hazard. Anyone with a history of migraine should not be selected for Class 1 certification due to the unpredictability and disabling nature of the condition but those who present after qualification should be neurologically assessed. If no underlying disease is found and the individual remains

free of further attacks for a period of 3 to 6 months, a return to flying may be approved in a multipilot (Class 1 'OML') role but should be considered unfit solo. Exceptions would be if the migraine attacks are infrequent and due to a specific precipitant, and avoidance of this precipitant results in no further migraines for a period of more than 2 years. Class 2 certificate holders may be allowed to fly solo if their attacks are mild and very infrequent (no more than two attacks per year). Frequent migraines are incompatible with any form of flying.

## 6.2 Cluster headache

Cluster headache is temporarily disabling and incompatible with flying until the person has been in remission and off treatment for at least 3 months. Recertification (Class 1 and Class 2) may then be allowed.

## 6.3 Neuralgic Syndromes

Trigeminal neuralgia and other neuralgic syndromes are extremely painful and unpredictable, and require neurological assessment. Medical treatment is incompatible with fitness to fly but following surgical treatment or after a natural remission if the person has been off treatment for more than 3 months without recurrence then they could be considered fit for recertification.

## 6.4 Excessive daytime drowsiness

Conditions causing excessive drowsiness while awake are either due to natural sleep loss, narcolepsy, idiopathic hypersomnia, or sleep apnoea. Daytime episodic drowsiness of whatever cause, except transient poor sleep hygiene, is unacceptable. Narcolepsy, even when treated successfully, is incompatible with fitness to fly.

## 6.5 Sleep Apnoea Syndrome

The sleep apnoea syndrome is primary (central) or obstructive. The latter most commonly affects overweight males, especially between the ages of 40 and 60 years. The syndrome results from frequent apnoeas during sleep, associated with loud 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 airways obstruction. 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 whose sleep is often already disturbed by disruption of circadian rhythm.

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 temporarily unfit until all aspects of the recovery and treatment can be considered by the AMS. (See the Respiratory System Chapter).

## 6.6 Demyelinating diseases of the Central Nervous System

Episodic neurological symptoms, often with full recovery, give rise to suspicion of multiple sclerosis. Any part of the central nervous system may be affected, however optic neuritis is a frequent presentation. Over 70% of such cases subsequently develop multiple sclerosis. There are no screening tests for MS but a family history does increase the risk. The disease profile is variable – over 20 years some will progressively deteriorate and die whereas others may have a single episode with remission over 20 years before further symptoms. Initial applicants with an established history must therefore be refused certification although it may be possible to continue certification of established aircrew in the multipilot role (Class 1 'OML' or Class 2 'OSL'). In

exceptional circumstances, with a long disease-free interval, unrestricted certification may be possible. Review and review intervals will be determined by the AMS.

Any neurological event of any note requires specialist neurological assessment. If multiple sclerosis is considered a strong possibility investigation may include cerebrospinal fluid (protein bands) MRI scans and evoked potentials (visual, auditory and somatosensitive). Should the probability remain high but symptoms are fully recovered an individual may be considered for multipilot operations after six months. 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). Individuals who are certificated in this fashion require six monthly review:

- a visual acuity, visual fields and colour perception;
- b operationally (simulator) to assess attention overload and judgement;
- c neurological review.

Any individual who is left with a significant neurological deficit after an exacerbation must be considered unfit.

***A similar assessment is appropriate for Class 2 'OSL'.***

Peripheral nerve lesions e.g. entrapment syndromes and mononeuropathies must be clearly diagnosed and their individual deficit assessed against operational criteria.

#### **6.7 Epilepsy [and other causes of loss of consciousness]**

A diagnosis of epilepsy is disqualifying because of the high risk of the recurrence and the risk of a generalised seizure in the cockpit being unacceptable. A diagnosis of epilepsy cannot be made until at least two seizures have occurred, but a single unprecipitated afebrile seizure carries an unacceptably high risk of recurrence, and will result in loss of certification for a minimum period of 10 years. If after that time, in the opinion of a consultant neurologist, there is no continuing evidence of an increased risk of recurrence of seizures, recertification may be possible, Class 1 multipilot "OML" or Class 2 without limitation.

Although the majority of genetically determined epilepsies become apparent earlier than the age of 20, a significant minority occur in the third and sometimes fourth decade. The risk of recurrence of a single seizure is initially 50% and the increased risk does not fall to that of the general population until at least 10 years have elapsed.

#### **6.8 Benign febrile seizures of childhood**

Benign febrile seizure of childhood occurring before the age of 5 are compatible with certification.

#### **6.9 Benign Rolandic epilepsy of childhood**

This is a specific type of epileptic syndrome occurring children associated with a characteristic abnormality on the EEG. Seizure cease after the age of 15 with a very low rate of recurrence, and if the diagnosis is well documented and confirmed by a consultant neurologist, and the applicant has been free of seizure for 10 years then certification is possible.

#### **6.10 Pharmacological control of epilepsy**

Although epileptics who appear well controlled on medication may recover driving privileges, this approach is not considered acceptable in flying. Pharmacological response varies and even apparently stable individuals have a seizure recurrence rate far higher than the nominal aeromedical risk of 1% per annum.

## 7 THE ELECTROENCEPHALOGRAPH (EEG) IN AVIATION NEUROLOGY

The EEG is a clinical tool useful in epilepsy and, despite its limitations, is used to screen aircrew applicants for latent predisposition for epilepsy. Its sensitivity and specificity under such circumstances remains ill-defined. Nevertheless, the risk to safety occasioned by in-flight convulsion is such that an EEG is required for all initial Class 1 medical examinations.

*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 tracings are read centrally.

*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 3 minutes of hyperventilation;
- f photic stimulation should be carried out in a darkened room with at least 10 exposures between 1 and 30 flashes per second of 10 seconds duration starting with eyes open for 5 seconds followed by eye closure during the stimulus and thereafter for 5 seconds. Photic stimulation should start with 16 flashes per second, and then sequences between 1 to 21 flashes per second should be recorded as above, followed by flashes at 25 and 50 per second;
- 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 epilepsy. There is general agreement that epileptiform paroxysmal phenomena (spike-wave), a photoconvulsive response and spike-and-wave complexes (2–4 Hz, irregular, generalised or focal) are significant and associated with an increased risk of epilepsy. Although such cases appear to be only 0.5% of apparently normal applicants, the published data indicate an increased risk of epilepsy above that acceptable for professional aircrew. A qualified private pilot, disqualified as above for Class 1 but with no significant history may be considered for Class 2 'OSL'.

## 8 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, but there is a small though significant increased risk of epilepsy. Epileptic paroxysmal spike wave at 3Hz

have been shown to be associated with transient diminution in cognitive function and should be regarded as seizures.

*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 if these consist of spike wave paroxysms, but not other paroxysmal slow wave activity which correlates less clearly with the predisposition to epilepsy.

*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: 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.

*3 Hz spike-and-slow-waves.* Characteristic paroxysm consisting of a regular sequence of spike-and-slow-wave complexes which: (1) repeat at 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 1 000  $\mu$ 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.

[Amdt. 2, 01.06.02]

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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 and air traffic control personnel are to carry out their 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.

At the first aeromedical examination (see JAR–FCL 3.215(b) Ophthalmological Requirements and paragraph 2 of Appendix 12 to this subpart), a comprehensive ophthalmological examination shall be carried out by or under the guidance and supervision of a specialist in aviation ophthalmology acceptable to the AMS.

At subsequent aeromedical renewal examinations a routine ophthalmological examination must be performed at certain intervals (see JAR–FCL 3.215(d) Ophthalmological Requirements and paragraph 4 of Appendix 12 to this subpart).

At each aeromedical renewal examination, an assessment of the visual fitness of the pilot must be performed and the eyes must be examined with regard to possible pathology (see JAR–FCL 3.215(c) Ophthalmological Requirements and paragraph 3 of Appendix 12 to this subpart). All doubtful cases should be referred to a specialist in aviation ophthalmology.

### 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, viz.:

- 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 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 (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 size deprive the examiner of the complete acuity testing.

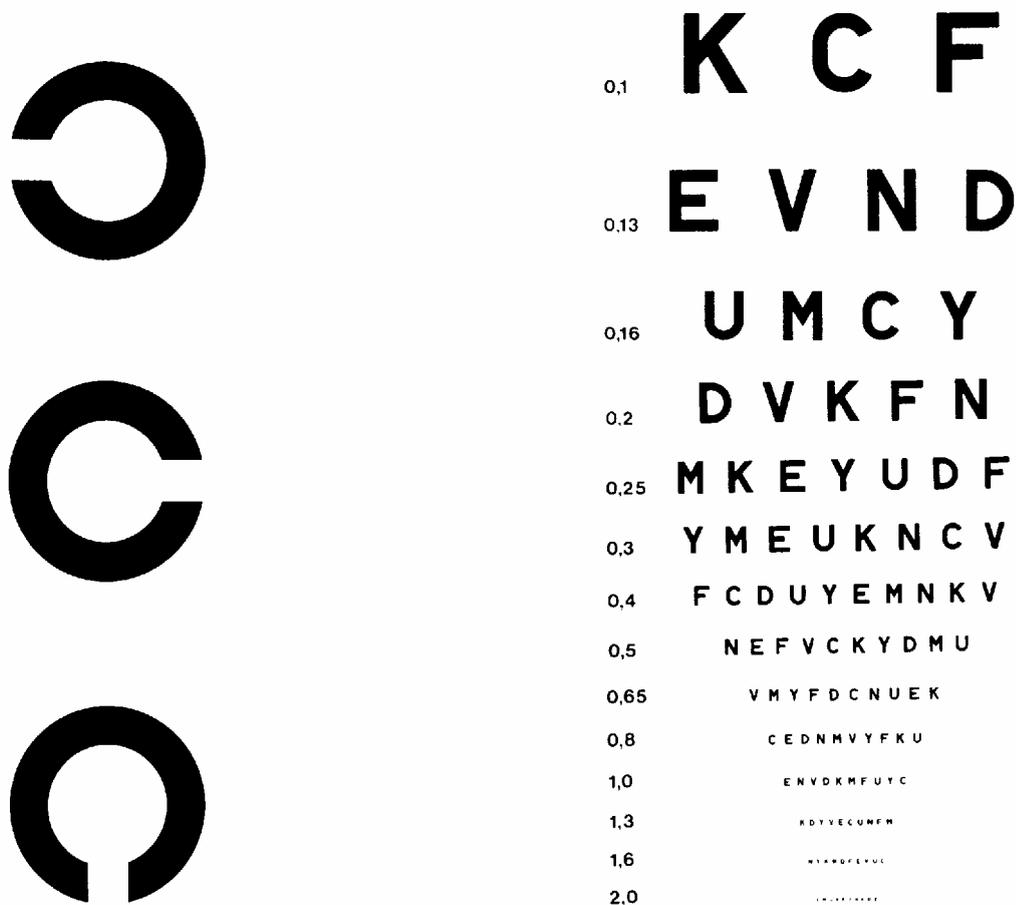
## 2.2 Factors affecting the visual acuity

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**

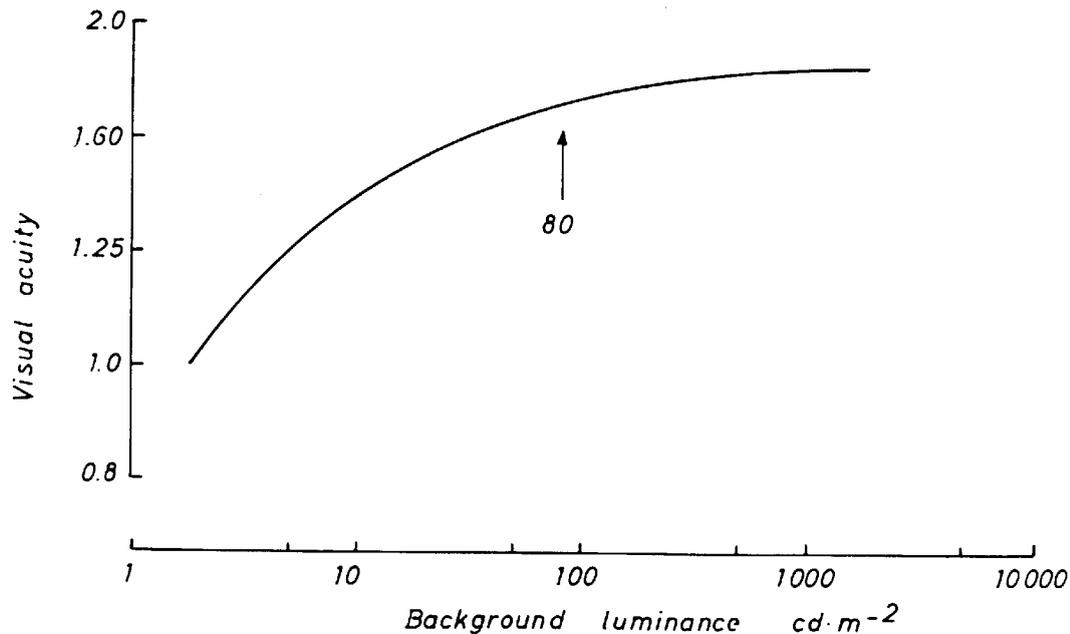
Visual acuity decreases with reduced object contrast. A significant decrement does not occur, however, until the contrast decreases below 85%; the luminance of the black print therefore shall not exceed 15% of that of the white background. It is essential that no dirty or yellow charts be used. If a 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/m<sup>2</sup>.

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,  $\text{cd/m}^2$ ). Numerous other units for luminance exist, often creating confusion. With white paper reflecting about 75%, 1 lux roughly gives  $0.24 \text{ cd/m}^2$ .



**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  $28 \text{ cd/m}^2$ . 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  $100 \text{ cd/m}^2$ .

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*

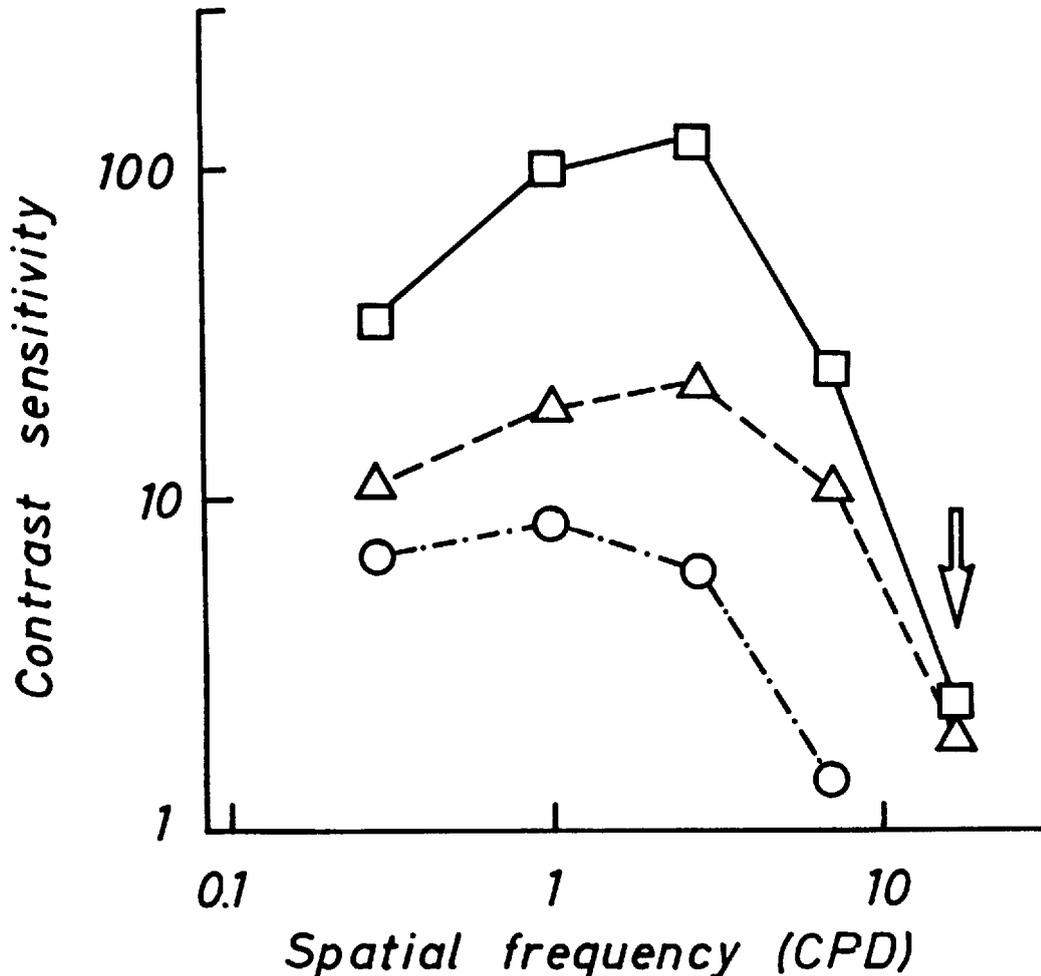
Under certain circumstances, especially when the ambient illumination corresponds to a mesopic state of adaptation, the ability to identify/resolve objects of low contrast is of importance. Apparatuses and charts for this purpose have been constructed. Unfortunately, knowledge of the normal capacity 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 for  $-1.0$  dioptre and 6/60 for  $-2.5$  dioptrics 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'.

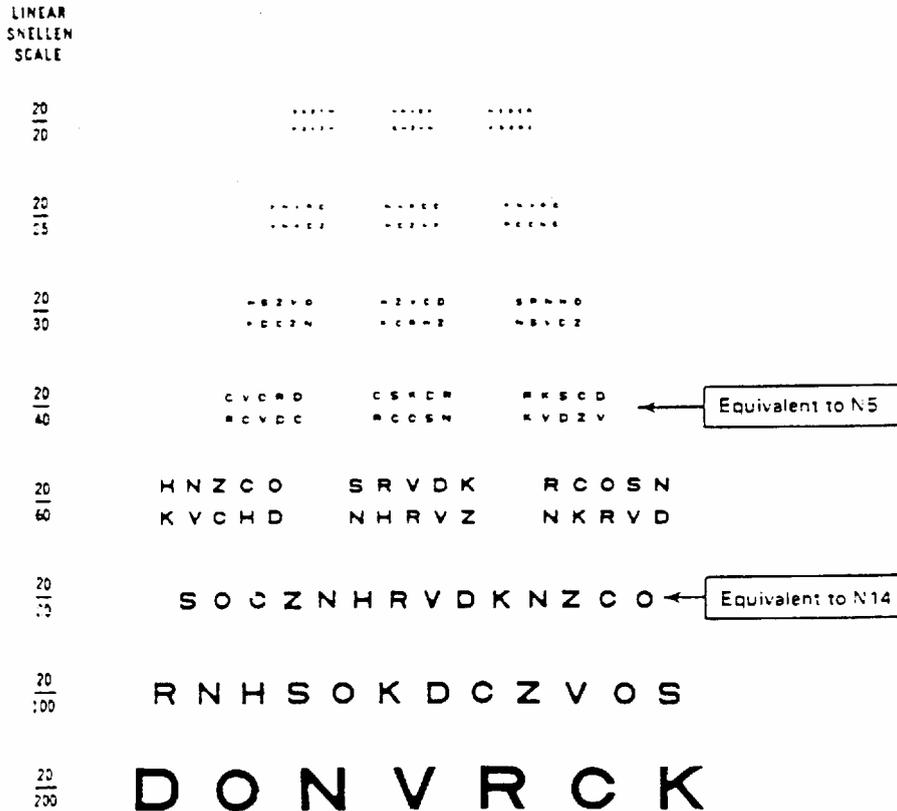
In order to measure the reading capacity, the Jaeger text types were constructed. These were never standardized, however, and texts with the same number vary greatly in different editions. No international agreement exists for reading texts. Those that best fulfil modern demands are the British N-types (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).



# 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]



## AERONAUTICAL CHART READING

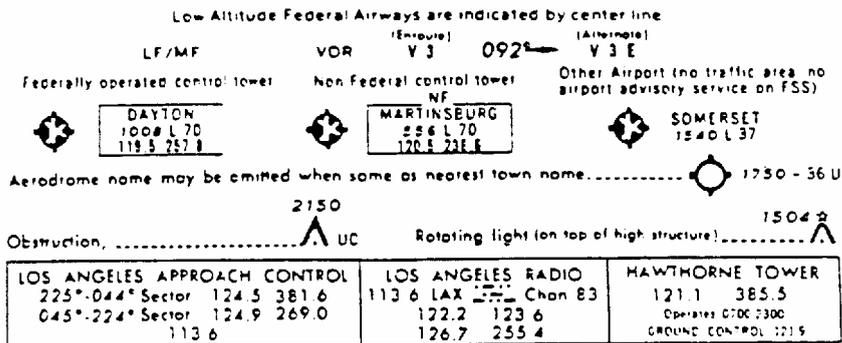


Figure 5 Example of a near vision test provided with aeronautical symbols. Observe that this chart tests near acuity and not reading capacity.

### 3.2 Examination techniques

Near visual capacity should be determined and recorded both with and without correcting lenses. 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.

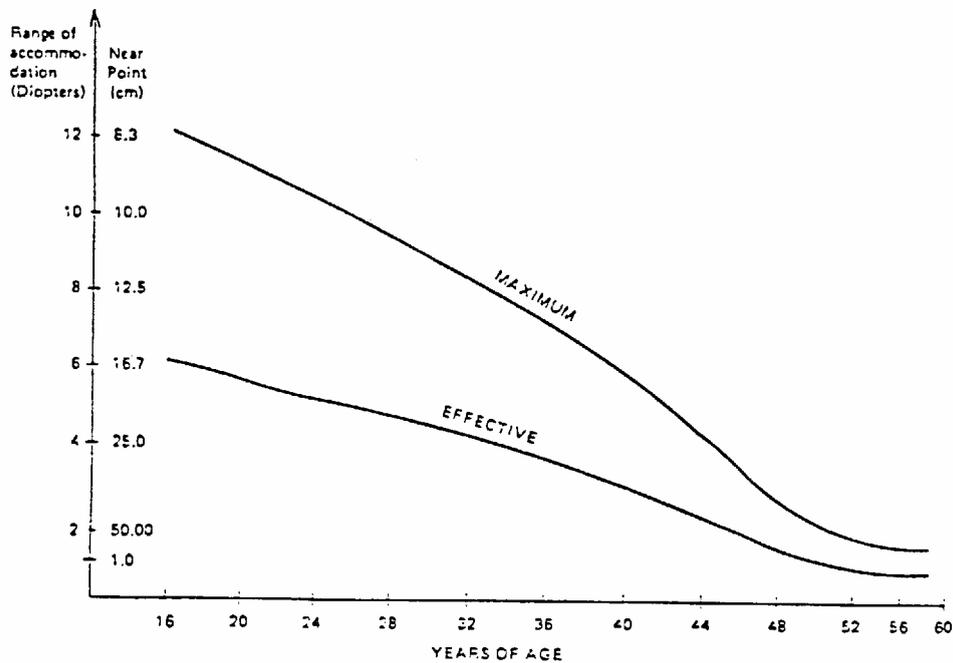
In order to measure this capacity – the range of accommodation (difference, measured in dioptres, between the refractive powers of the eye at maximal accommodation and maximal relaxation) and the near point of accommodation (focal distance, measured in centimetres, at maximal accommodation) are established. 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.

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| 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           |

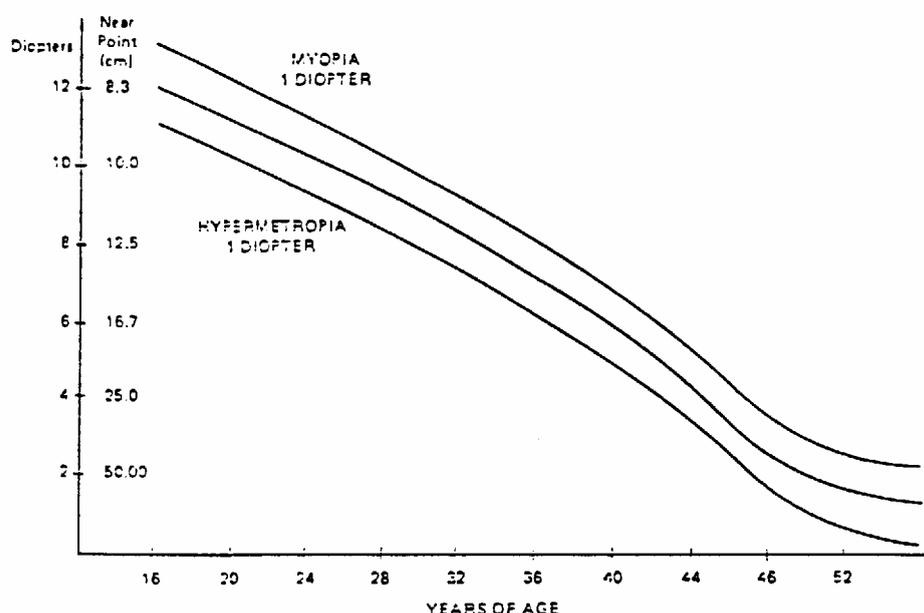
**Table I Near-point variation by age**



**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 dioptries), 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 drops is necessary for retinoscopy and when, in subjective refraction, an accommodative spasm is suspected.

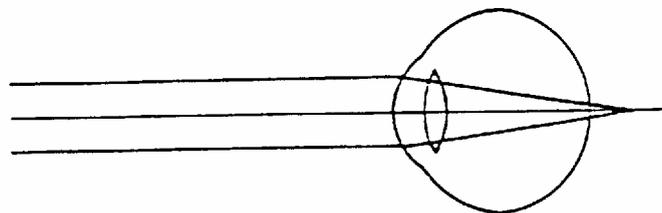
In emmetropia, rays of light from infinity are focused on the retina. This is a relatively uncommon condition.

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.

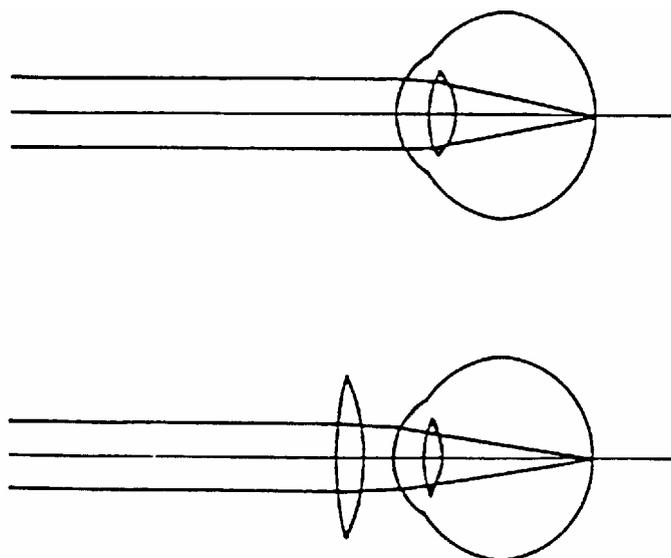
##### 4.1 Refractive errors

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.



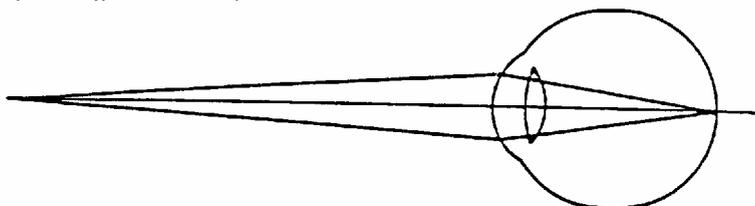
**Figure 8b** To compensate for this accommodation in the non-presbyopic eye (upper), a convex lens (lower picture) could be used.

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.

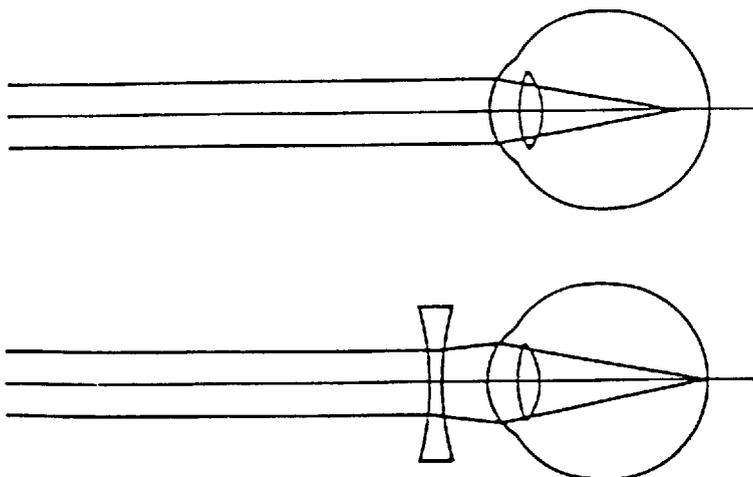
A slight or moderate degree of hypermetropia needs no correction in young persons. Higher degrees of hypermetropia demand a constant accommodation which can give rise to eyestrain. Due to the association between accommodation and convergence, it also induces a tendency to latent squint inwards (esophoria) or a proper squint in subjects with a weak fusion lock (esotropia).

**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.



**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).

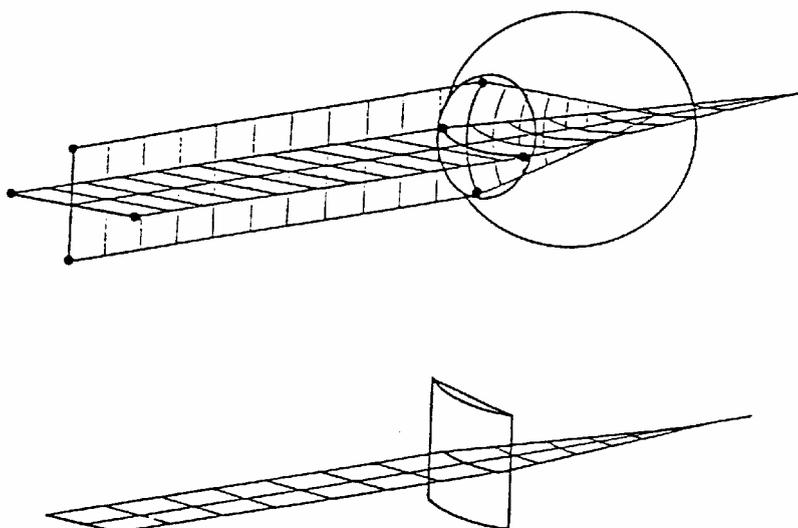
**c** *Astigmatism*

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 cylindrical 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.

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.

#### 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 retinoscopy or with the aid of manual or automatic refractometers. 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

In the Visual Requirements JAR-FCL 3.220 the maximum acceptable refractive error is stated to be  $\pm 3$  dioptres. One of the reasons for setting an upper 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  $\pm 5.0$  dioptres.

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.

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.

**Table II Flight deck visual distances**  
*Sample reading distances measured for individual pilots*

| <i>Aircraft</i>                       | <i>Reading distances (cm)</i> |                 |             | <i>Mean in diopters</i> |
|---------------------------------------|-------------------------------|-----------------|-------------|-------------------------|
|                                       | <i>Closest</i>                | <i>Furthest</i> | <i>Mean</i> |                         |
| <b>DC8</b>                            |                               |                 |             |                         |
| Instrument approach and landing chart | 40                            | 53              | 45          | 2.2                     |
| Artificial horizon                    | 66                            | 73              | 71          | 1.4                     |
| Overhead instruments                  | 45                            | 53              | 48          | 2.1                     |
| <b>DC9</b>                            |                               |                 |             |                         |
| Instrument approach and landing chart | 37                            | 51              | 44          | 2.3                     |
| Artificial horizon                    | 65                            | 80              | 80          | 1.4                     |
| Overhead instruments                  | 38                            | 59              | 47          | 2.1                     |

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 dioptre 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 dioptre 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.

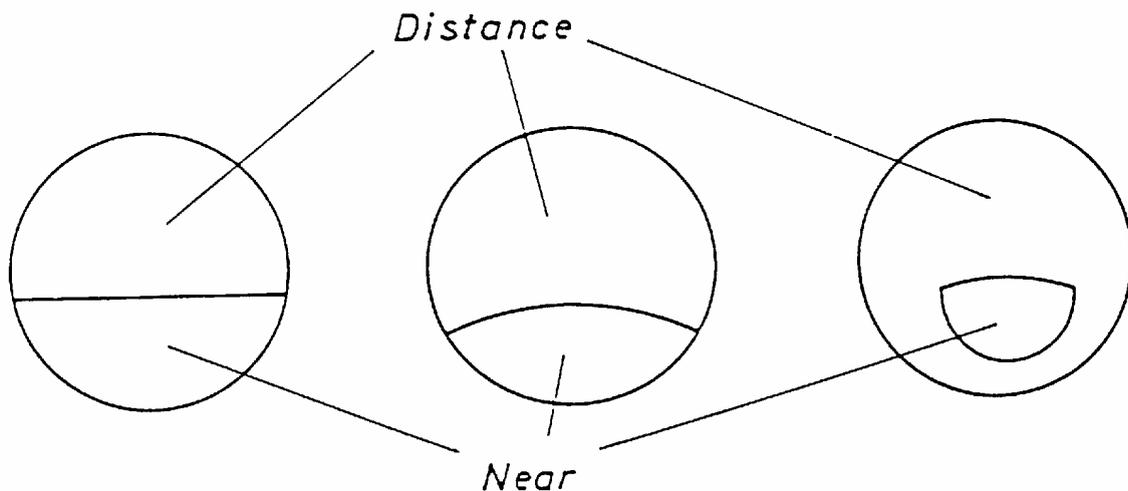
Myopia should always be corrected when it interferes with sharp distant vision. It should be remembered that the myopic refractive error may successively increase up to the age of 25–30 years.

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 and air traffic controllers 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.

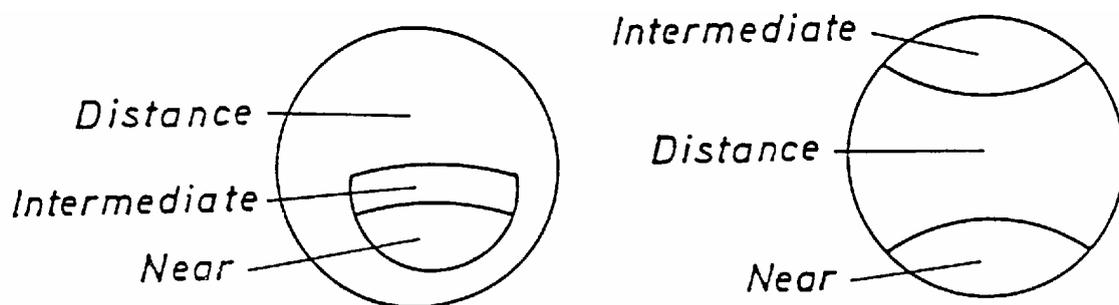


**Figure 11** Three examples of bifocal lenses.

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.

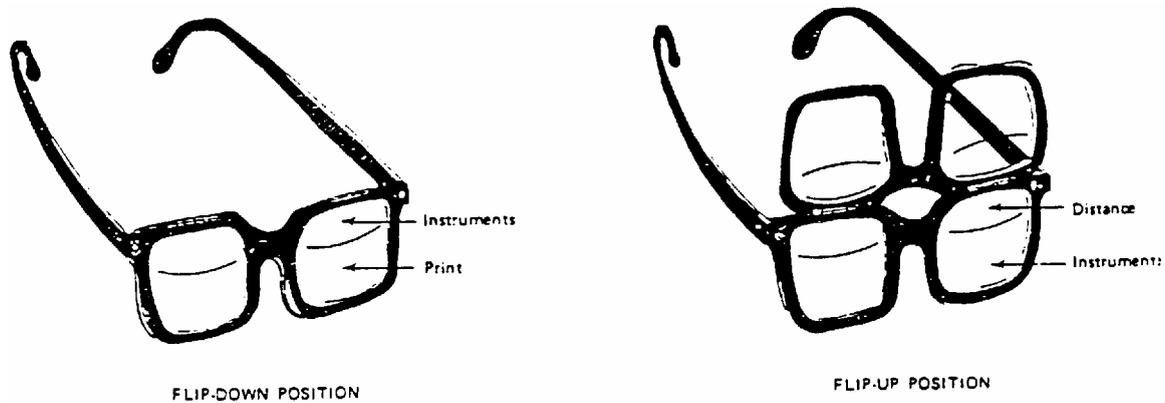
There are also glasses with a continuous increase in power from the upper to the lower part of the lens. These progressive glasses enable the selection of proper focusing by tilting of the head. The earlier generation of these glasses created an annoying and possibly dangerous distortion to the right 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. Another solution to the problem is the 'flip-type' glasses (fig. 13). The fix lenses are ground for distance (above) and intermediate vision (below). The moveable lenses add a plus correction on both thereby transferring the glasses to intermediate and near vision respectively. Any combination of lens powers is possible, and the flipping up and down can be done so fast that the shift is no hindrance to operational activities.



**Figure 13** Examples of flip-type frames suitable for aviation duties.

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.

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.

In recent years, different types of bifocal contact lenses have been introduced. 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.

c *Hard contact lenses*

Hard contact lenses are normally produced by solid methyl methacrylate. 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 oxygenation 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.

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.

## **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 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 knowledge has led to the conclusion that subjects operated with radial keratotomy should not be considered fit for aviation duties since the function of the eyes is not normal. Subjects with myopia exceeding 3 or 5 dioptres should be warned against this way of fulfilling the visual requirements.

### **6.2 Photorefractive keratectomy**

In photorefractive keratoplasty, laser radiation is used to alter the anterior curvature of the cornea by ablation of stromal substance. So far, subjects with myopia and astigmatism have been treated; the experience is greatest for lower degrees of myopia. The results are far more predictable and stable than with radial keratotomy and there seems to be few complications. 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 to certification.

### **6.3 Certification**

In cases where the pre-operative refractive error was less than 5 dioptres a return to flying duties may be possible after 12 months, 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 dioptres. 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.

### **7.4 Recertification**

In selected cases a return to flying duties may be possible 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)

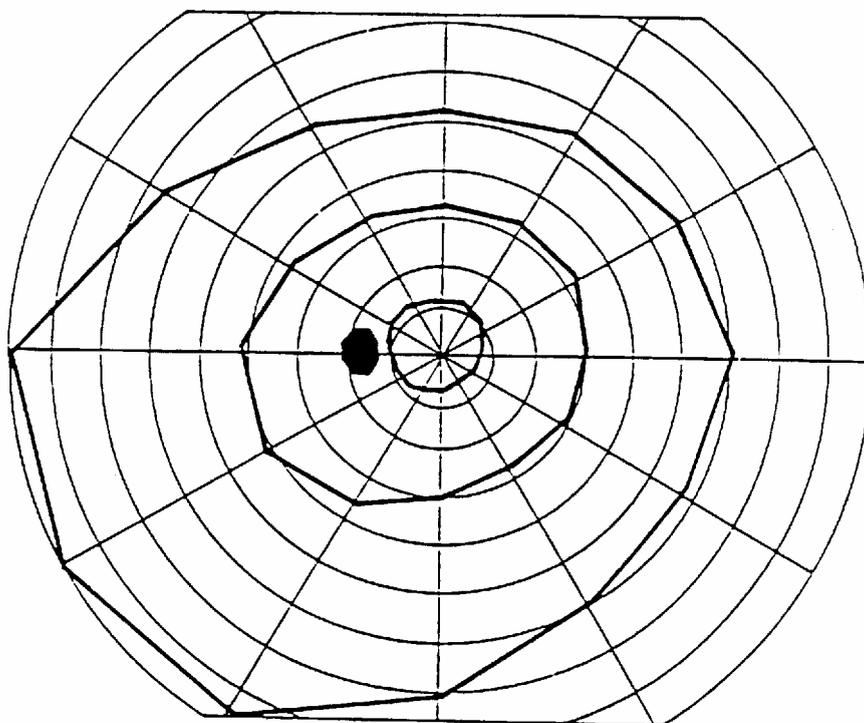
Of practical importance are the progressive proliferations in the posterior lens capsule which give rise to increased glare sensitivity, impaired contrast sensitivity etc. This is quite common (up to 50%) after the procedure currently used, i.e. extracapsular cataract extraction and motivates regular 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).

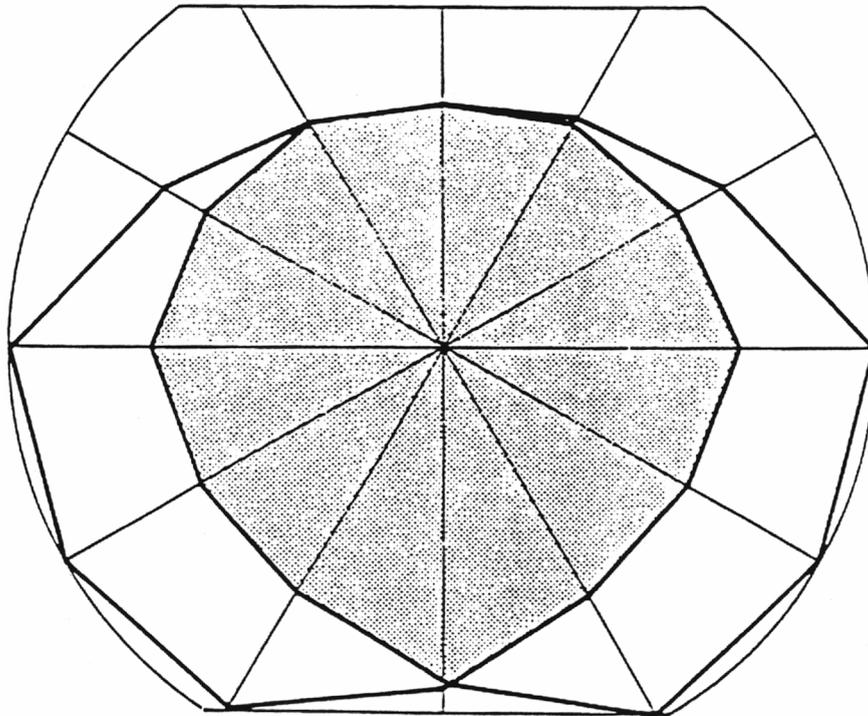


**Figure 14** A normal left eye visual field with three isoptres. The outermost shows the outer limit of the field: the two smaller are produced with objects of lower brightness or size. The black area is the blind spot. The circles show the two-dimensional projection of every 10° of a hemispherical 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<sup>2</sup>). 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.

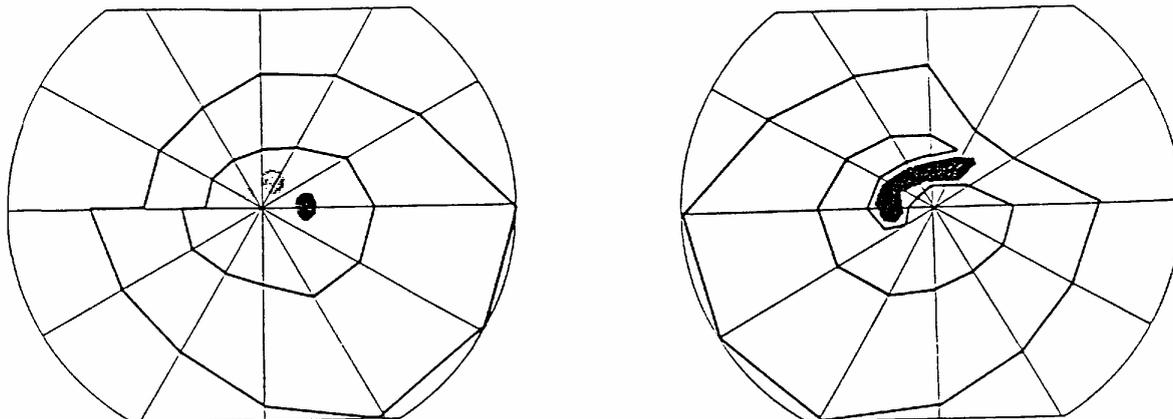
#### 8.4 **Visual field defects**

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 retrochiasmal 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.

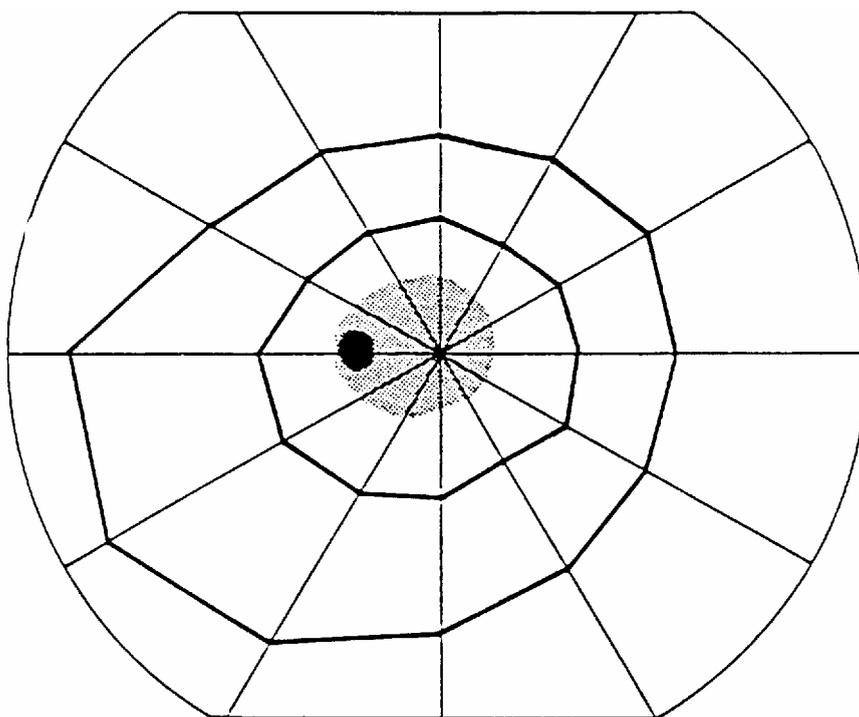
Retino-choroidal disorders cause reduced sensitivity in the area affected. Examples are retino-choroiditis and retinal detachment. If the function of a nerve-fibre bundle is likewise affected, wedge-shaped defects may ensue. In retinitis pigmentosa, an annular scotoma is characteristic in the early phase.

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.



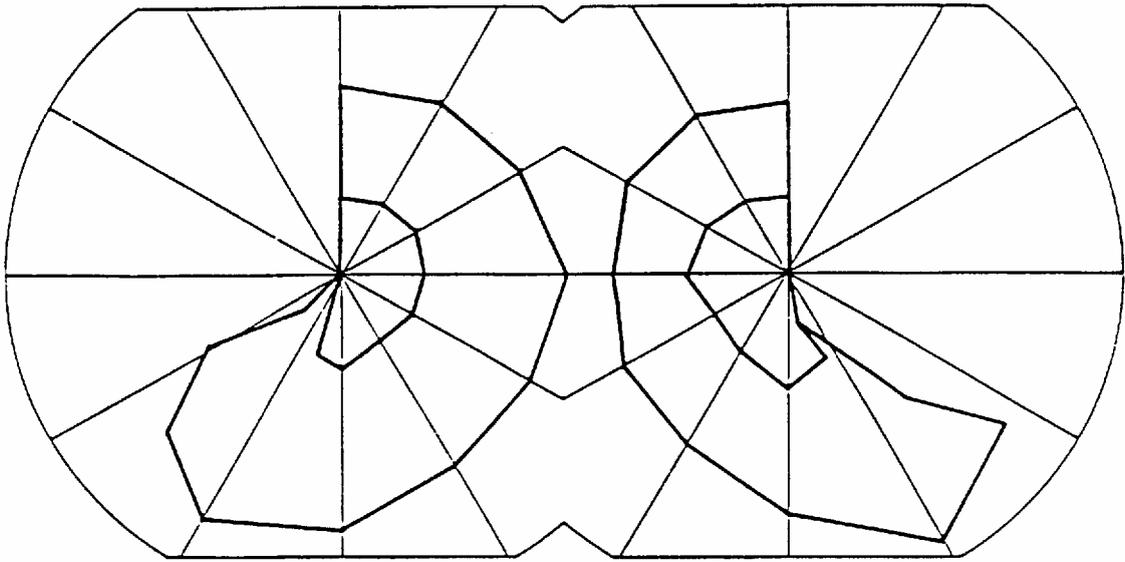
**Figure 16** To the left early glaucomatous visual field defects; nasal steps in the upper field and two paracentral relative scotomas. To the right a Bjerrum scotoma with an absolute scotoma inside (dark area).

Optic nerve disease most often gives central/paracentral defects (fig. 17). The central lesion also typically affects visual acuity and colour vision.



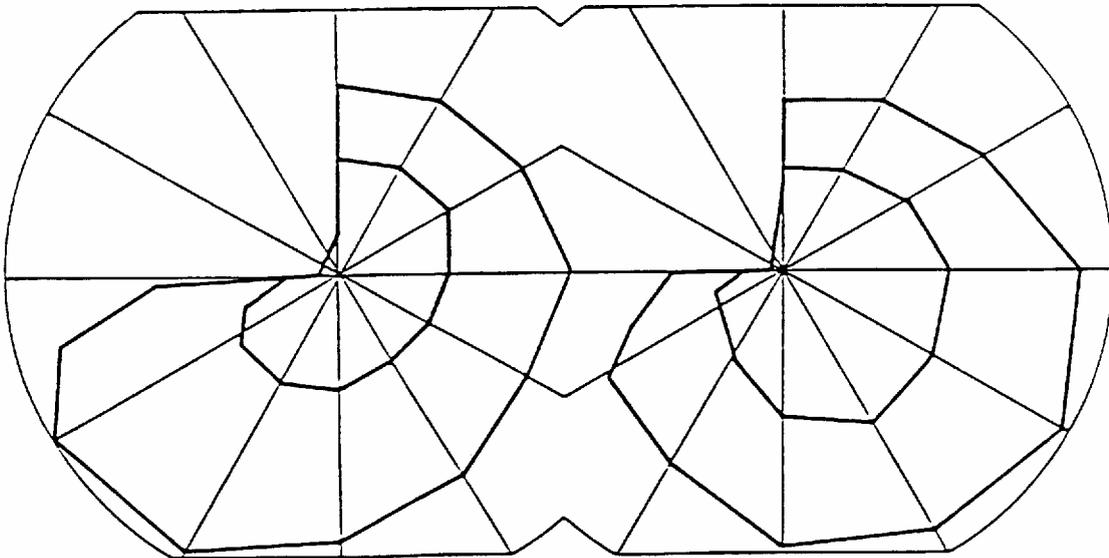
**Figure 17** A caecocentral scotoma , i.e. a depression in the visual field including the fixation point and the blind spot.

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 30 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, parallactic 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. It is then worth trying to correct the heterophoria with orthoptic treatment and later, possibly, with an operation of the ocular muscles. The addition of (small-angle) prisms to spectacles is controversial in aviation.

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(f) – *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.

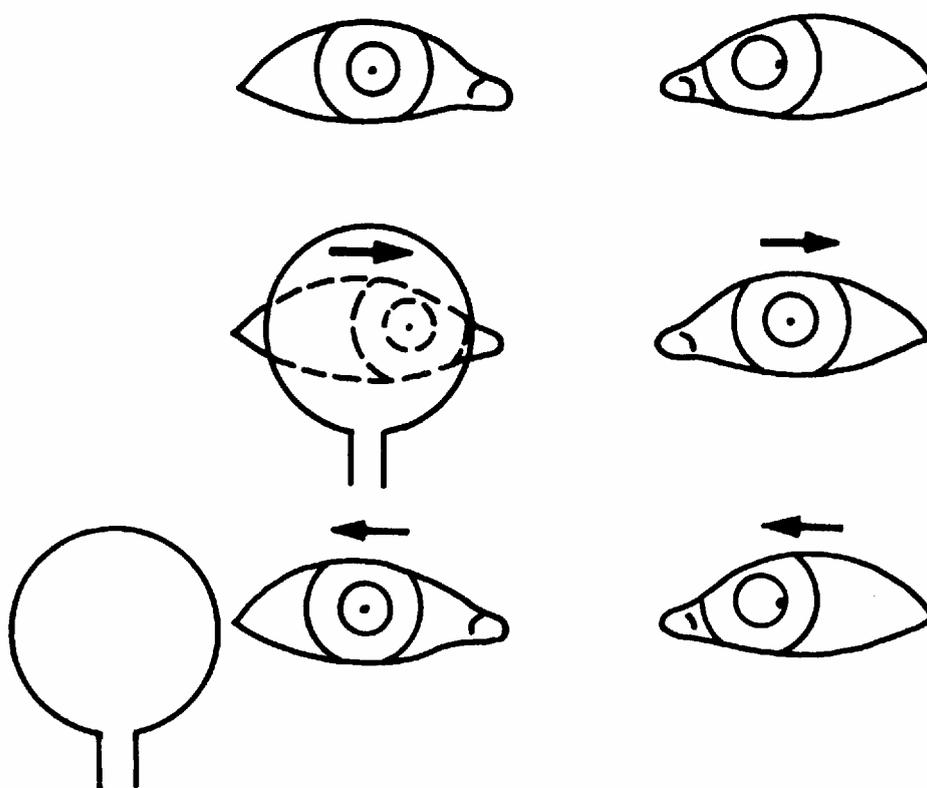
#### 9.5 **Examination techniques**

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).

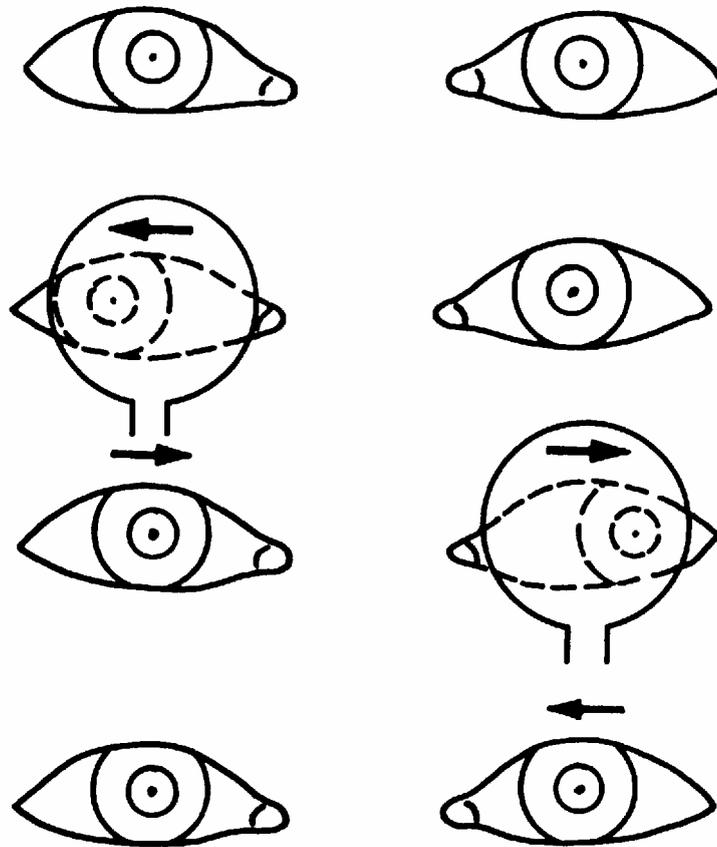


**Figure 20** In the simple cover test, one eye is occluded and the other eye is watched. If it moves, it was not aligned before covering. (A case of esotropia of the left eye is shown.)

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<br>Deuteranopia | Protanomaly<br>Deuteranomaly |
| Yellow-blue defects | Tritanopia                 | Tritanomaly (?)              |

The red-green defects are inherited as Xlinked 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.

The exact qualitative and quantitative diagnosis is given by the anomaloscope. Looking into this instrument, the subject compares two juxtaposed fields and judges when they appear identical. Red-green deficiencies are studied with the 'Rayleigh match' where one field is yellow and the other an additive mixture of red and green. The examination demands a thorough knowledge of colour vision physiology and large experience. Most widely known and used is the Nagel anomaloscope, but equally efficient other apparatuses have recently been put on the market (e.g. Heidelberg Anomaloscope from Oculus). All dichromates should be rejected as they are colour unsafe. When examining an anomalous trichromate with Nagel's anomaloscope, different scale readings are used to express the result. The colour matching range is defined as the difference between the maximum and the minimum scale reading accepted by the examinee as identical to the test colour. If the colour matching range exceeds four scale units, the applicants must be considered *colour unsafe*. The relation between the mean scale reading for colour identity and the standard scale reading is expressed by the anomaly quotient. This quotient has diagnostic value, but provides no guidance in assessing colour safety. The anomaly quotient per se is thus irrelevant in the assessment of an applicant's fitness for flying.

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 and of Beyne 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 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  $\mu$ -candelas for demonstration, 200  $\mu$ -candelas for daylight testing and 20  $\mu$ -candelas for testing in complete darkness. The lantern is easy to use. The examinee is placed in front of the lantern at a distance of 6 metres. Five different colours are presented: two red, two green, and one white light stimulus in nine different combinations, each presenting two colours (which may be identical in some of the presentations). The 2 x 9 fixed stimuli are presented for two to three seconds each and the examinee must identify the colour of each without delay. If all colours are correctly identified, the lantern test has been passed. If the examinee makes two or more errors, the lantern test has not been passed and the examinee is classified as colour unsafe. If the examinee makes one mistake or shows uncertainty during the test run, the lantern test is re-performed by executing two consecutive runs of the nine presentations. No errors or mistakes are allowed during this second run.

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.

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
- 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. Recertification 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. Recertification 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, recertification may be considered 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. Recertification 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. Before surgery pilots may continue active flying if the visual requirements are fulfilled with use of corrective spectacles or contact lenses suitable for aviation purposes.

The pilot should be re-examined semi-annually by an ophthalmologist. After surgery, vide infra.

f *Corneal transplants*

Following a corneal transplantation, the refraction remains very unstable for a period of six to 12 months. Recertification 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.

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.

## 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 accepted as fit for flying. If the visual acuity in one eye is reduced to 6/24 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.

Recertification may be considered in professional pilots with functional monocularity i.e. reduced central vision but normal binocular visual fields, whereas qualified private pilots may be considered for recertification 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. In both cases the underlying pathology must be assessed as acceptable following examination by accredited specialist in ophthalmology and the good eye should fully meet all requirements. Furthermore, the pilot should demonstrate his flying ability by a medical flight test prior to final assessment.

For professional pilots, the certificate should be restricted to multi-crew only ('as or with qualified co-pilot only'). For private pilots with only one eye, goggles are recommended; for those pilots flying aircraft with open cockpit, goggles or better a flying helmet with visor should be mandatory.

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## KEY TO OPHTHALMOLOGICAL EXAMINATION PROCEDURES

| CLASS 1  | EXAMINATION |           |                | MANUAL REFERENCE |
|--|-------------|-----------|----------------|------------------|
|  | A           | B         | C              |                  |
| Distant visual acuity (the appropriate Snellen's chart or equivalent ) corrected if required.      | 3           | 3         | 3              | 2.3              |
| Refractive state (subjective dilated refraction, assessment of own spectacles)                     | 3           | 3         | As indicated   | 4 and 4.2        |
| Accommodation, amplitude of (near point rule)  | 3           | 3         | 3              | 3, 3.1 and 3.2   |
| Convergence, nearpoint of (near-point rule)  | 3           | 3         | 3              | 9.4 and 9.5      |
| Near and intermediate vision at 30-50 and 100 cms (N-system) with and without correction           | 3           | 3         | 3              | 3                |
| Visual fields (confrontation)  | 3           | 3         | 3              | 8 and 8.3        |
| Colour vision (Ishihara unilaterally), Nagel's anomaloscope, lantern test when indicated           | 3           | 3         | As indicated   | 10.4             |
| Eyelids, external eye (objective examination)  | 3           | 3         | 3              | 1.3              |
| Eye position and movements (pencil light, cover test/hess screen)                                  | 3           | 3         | 3              | 9.5              |
| Heterophoria at 5 or 6 metres and 30 cms. (cover test, variable prism, maddox cross, maddox wing). | 3           | 3         | As indicated   | 9.2 and 9.5      |
| Pupillary reflexes   | 3           | 3         | 3              | 1.3              |
| Exterior part of the eye, conjunctiva, cornea, pupil, iris, lens, etc                              | Slit lamp   | >50 2yrl  | Ophthalmoscope |                  |
| Fundus of the eye (ophthalmoscopy) with dilation if necessary to gain an adequate view             |             | 3         | 3              |                  |
| Intra-ocular tension (tonometry)   | 3_          | >50 2yrly |                | 12.1             |

- comprehensive initial aeromedical examination for first issue of medical certificate
- comprehensive renewal ophthalmological examination depending on age : 5-yearly to age 40 then 2-yearly to age 65
- routine renewal aeromedical examination

The usual or recommended method of examination is mentioned in brackets

**On indication and where equipment available tests may include**

campimetry, auto-perimetry, auto-refraction, retinoscopy, binocular fusion (prism test, worth 4-dot test, synoptophore, stereotests), contrast sensitivity

\* NOTE: Ishihara charts only unless change from initial assessment

**KEY TO OPHTHALMOLOGICAL EXAMINATION PROCEDURES**

| <b>CLASS 2</b>   | <b>INITIAL EXAMINATION</b> | <b>RENEWAL EXAMINATION</b> | <b>MANUAL REFERENCE</b> |
|--|----------------------------|----------------------------|-------------------------|
| Distant visual acuity (the appropriate Snellen's chart or equivalent)                              | 3                          | 3                          | 2                       |
| Refractive state (subjective refraction, assessment of own spectacles) autorefraction retinoscopy  | 3                          | 3                          | 4 and 4.2               |
| Accommodation amplitude of (Raf near-point rule)   | 3                          | 3                          | 3, 3.1 and 3.2          |
| Convergence, near point of (Raf near-point rule)   | 3                          | 3                          | 9.4 and 9.5             |
| Near and intermediate vision at 30–50 and 100 cms (N-system, glasses)                              | 3                          | 3                          | 3                       |
| Visual fields ( <u>confrontation</u> method a.m. Donders) campimetry auto-perimetry)               | 3                          | 3                          | 8 and 8.3               |
| Colour perception (Ishihara unocularly) (Nagel's anomaloscope, colour lantern test when indicated) | 3                          | *                          | 10.4                    |
| Eyelids, external eye (objective examination)  | 3                          | 3                          | 1.3                     |
| Eye position and eye movements (pencil light, cover test)  | 3                          | 3                          | 9.5                     |
| Heterophorias at 5 or 6 metres (cover test, prism rod, maddox Cross, worth 4-dot test)             | 3                          | 3                          | 9.2 and 9.5             |
| Pupillary reflexes   | 3                          | 3                          | 1.3                     |
| Fundus of the eye (ophthalmoscopy)   |                            | 3                          |                         |

\* NOTE: The requirements for each renewal examination are the same with the exception of colour perception, which should only be repeated when indicated.

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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 |                  |
| Impedance tympanometry<br>Including valsalva manoeuvre  | 3           | – | – | 3.5              |
| Pure tone audiometry                                    | 3           | 3 | – | 4.3              |
| Anterior rhinoscopy                                     | 3           | 3 | 3 | 6.3              |
| Spoken voice test                                       | –           | – | 3 | 4.6              |
| <b>On indication tests may include</b>                  |             |   |   |                  |
| Pneumatic otoscopy                                      |             |   |   | 3.3              |
| Speech audiometry                                       |             |   |   |                  |
| Eog spontaneous<br>& positional nystagmus               |             |   |   |                  |
| Differential caloric test<br>Or vestibular autorotation |             |   |   |                  |
| Posterior rhinoscopy                                    |             |   |   |                  |
| Mirror or   |             |   |   |                  |
| Fibre laryngoscopy                                      |             |   |   |                  |

- A Comprehensive initial examination by, or under supervision of, a specialist in aviation otorhinolaryngology acceptable to the AMS
- B Comprehensive renewal examination by, or under supervision of, a specialist in aviation otorhinolaryngology acceptable to the AMS
- C Routine renewal examination (JAR-FCL 3.230 and 3.235 refer)

| CLASS 2  | EXAMINATION |   | MANUAL REFERENCE |
|--|-------------|---|------------------|
|  | A           | B |                  |
| Spoken voice test                                      | 3           | 3 | 4.6              |
| Pure tone audiometry *                                 |             |   |                  |
| <b>On indication tests may include</b>                 |             |   |                  |
| Pneumatic otoscopy                                     |             |   | 3.3              |
| Impedance tympanometry<br>Including valsalva manoeuvre |             |   |                  |
| Speech audiometry                                      |             |   |                  |
| Barany chair test                                      |             |   |                  |

A At first issuance by an authorised medical examiner

B Subsequent renewal examinations

\* When an instrument rating is to be added – for frequency see JAR-FCL 3.350 and 3.355

### 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 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 for 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 Vshaped 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 H<sub>2</sub>O 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 *Certificate 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 not be accepted, except for a simple mastoidectomy in childhood and grommet insertions.

#### b *Certificate holders*

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 the pilot cleared for duty 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 the pilot cleared for duty 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

Applicants and certificate holders 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.

*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 a certificate applicant or holder is suspected of this disease, he should be warned of the high risk of being rejected 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.

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 demanded 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) operative restrictions, such as flying as or with co-pilot for two years, should be observed.

**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 before certification.*

## 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). This is materialised in different requirements at the first issue of licence and at later renewals (JAR-FCL 3.235(c) & (d)).

### 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. 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 accepted. 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 opine 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 restrictions concerning 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 Procure 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.

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 certification**

The requirements (JAR-FCL 3.235 & 3.355) and the interpretation above describing additional speech audiometry tests offer sufficient guidance concerning the fulfilment of the hearing requirements. It is essential to realise that any hearing loss caused by a disease, which can be included in the requirements, 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. A deterioration of the hearing is always a sign of disease and cannot be analogised to reduced visual acuity in a simple abnormality of the ocular refraction.

#### 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 at the first issue, 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. 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. They have proven themselves sensitive to noise and the almost inevitable progression of their hearing loss can only be delayed by a proper protection. 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, certification with reasonable restrictions may be considered 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  $9.8 \text{ m/s}^2$  (= 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.

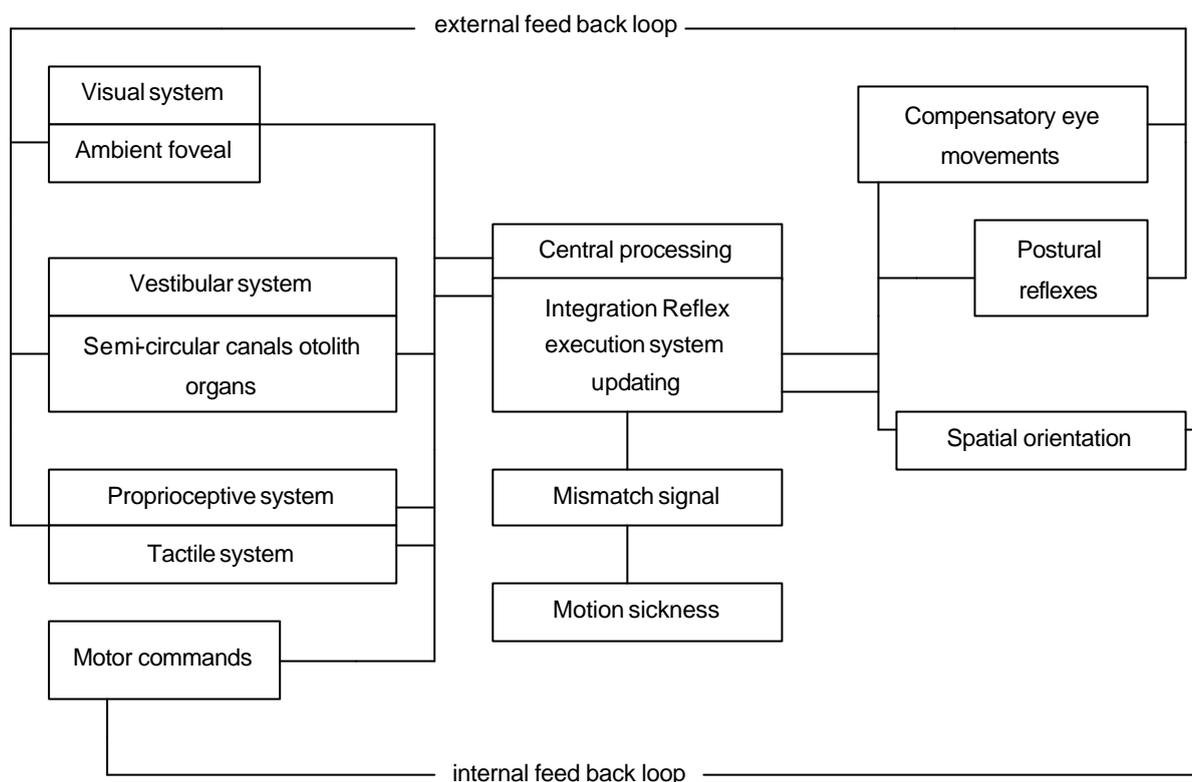
*Spatial disorientation* can be defined as a false orientational percept. Since both eye movements and orientation are based on the integrated sensory product, there is an intimate correlation between inexpedient eye movement responses and spatial disorientation.

*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.

*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*, *pale ness* and various degrees of *mental depression* or *apathy* develop. This is accompanied by the development of an *awareness of the stomach* into *epigastrical 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 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 considered unfit for flight 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.

*Somatogavic 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.

If, for some reason, the pilot is able to visually fixate a light source outside the aircraft when experiencing a somatogavic illusion it will appear to move according to the illusion; this phenomenon is called an *oculogavic* illusion.

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.

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.

*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.

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.

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 has committed a crime against 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°/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°/s = 1 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

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  $\mu$ 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 persons 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  $^{\circ}/s$  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  $6^{\circ}/s$  are considered clinically insignificant – for aviation medical purposes, a  $4-5^{\circ}/s$ -limit seems more reasonable.

In order to detect vestibular threshold asymmetries at the issue of the licence, 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.

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.

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

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. The *finger-to-nose test* is performed by letting the examinee place his finger on his own nose with his eyes closed. 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 certification

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 licence 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.

At the first issue of a licence, 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 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 accepted. 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 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 certification

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 warranted. 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; low mental or psychomotor problems 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 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. The evaluation shall be 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.

### 4 PSYCHOLOGICAL CRITERIA

The complete psychological evaluation includes a collection of biographical data, the administration 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 Logical 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 Motivation and, for Class 1, work orientation
  - ii Decision making
  - iii Social capability
  - iv Stress coping

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 Logical reasoning**

#### *a Definition*

The ability to find rules and to apply them in various task situations using verbal, mathematical and other abstract material.

#### *b Description*

Reasoning is a cognitive process which refers to finding general rules or analogies on the basis of observed instances and using them to make judgements. Test items may include syllogisms or judgements like 'A does not preclude B': BA (true or false).

### 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 and solving more complex arithmetical problems.

### 5.4 **Memory function**

#### a *Definition*

The ability to memorise and retrieve from memory visually and/or verbally coded information.

#### 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.

#### 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 for a long time in order to detect and respond to certain specified, infrequently occurring events in a stream of 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**

The ability to perceive information, auditory and visual, in an effective and efficient way. Relevant aspects of perception are: perceptual speed and perceptual 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 *Perceptual closure*

i Definition

The ability to recognise incomplete forms, i.e. to form 'Gestalts' from Description incomplete material (synthesis).

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.

## 5.8 Psychomotor function

Two aspects of psychomotor function should be assessed, namely, psychomotor co-ordination and choice reaction time.

a *Psychomotor co-ordination*

i Definition

Psychomotor co-ordination can be defined as the capability to co-ordinate the movement of arms, hands and feet in response to visual 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 *Choice reaction time*

i Definition

Choice reaction time can be defined as the interval between the onset of a stimulus (taken from a set of different stimuli) and the subjects correct response.

ii Description

In contrast to simple 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**

The personality factors which are important for the psychological evaluation of pilot applicants or licence holders are presented below. Work orientation, social capabilities and stress coping have to be considered, particularly in respect of crew resource management and crew co-ordination. Most of these traits are well known and can be measured by conventional assessment tools (e.g. questionnaires). 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.

### **6.2 Motivation and work orientation**

#### *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*

Important indicators of this attitude are need of achievement, vitality, mobility, readiness to acquire new knowledge and skills and acceptance of responsibility.

##### *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 Vitality

The positive attitude towards physical activities like sports, hiking, mountaineering.

iii Mobility

The readiness to accept and practise new activities, to move, to travel, to take risks.

iv Readiness to acquire new knowledge & skills

Readiness and open-mindedness to acquire new knowledge and skills which are necessary for the successful conduct of new tasks and responsibilities.

v Acceptance of responsibility

The readiness to accept formal roles, tasks and duties and to behave accordingly.

6.3 **Decision making**

a *Definition*

The capability to properly choose responses in complex situations where several reactions are possible.

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.

6.4 **Social capability**

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.

Well established personality traits which are related to social capability are explained below:

i Extroversion-Introversion

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 extroverts 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/Assertiveness

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 Aggression

Aggression 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.

## 6.5 Stress coping

Stress coping is the capability to cope with external and/or internal stressors in such a way that efforts can be effectively directed in order to maintain control and reach the objective. Contributing factors of stress coping are emotional stability, readiness to bear privations, flexibility and stress management.

a *Emotional stability*

i Definition

The disposition to control, regulate, moderate and express emotional reactions appropriately without interfering with an efficient performance and/or without impacting other people.

ii Description

Emotional stability is characterised by calm, thoughtful behaviour, even temper, constant mood, freedom from cares and from emotional problems like anxiety and irritability. It depends on factors like self acceptance, focus of control and defence mechanisms.

b *Readiness to bear privations*

i Definition

The disposition to accept, tolerate and adjust oneself to physical discomforts and/or psychological hardships.

ii Description

Physical discomfort, psychological hardship, lack of privacy, sleep deprivation and separation from family.

c *Stress management*

i Definition

The capability to develop and implement cognitive and behavioural strategies in order to master stressful situations.

ii Description

Stress management includes identification and evaluation of stresses and an active approach towards altering the sources of stress.

## 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 above. 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 validation 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 personality 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.

## CHAPTER 16 - DERMATOLOGY

### 1 INTRODUCTION

There are a number of dermatological conditions which are disqualifying initially from an Aviation Medicine point of view.

Most of the conditions are treatable to a level where Class 1 and 2 certification is possible. There are a few specific lesions which are disqualifying.

Some skin conditions are a manifestation of a more serious medical disorder which must be identified and treated before certification can be considered.

There are some acute dermatological conditions that are caused by infection. This can be bacterial, viral or mycotic. Some acute conditions 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 summer 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.

The one condition which occurs 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. 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 these guidance notes.

The AMEs/AMCs/AMs 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 POMPHOYLX)

#### 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

ekzeim meaning to boil over or break out, and in this chapter eczema will be used in preference to dermatitis.

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 as temporarily unfit the pilot 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.

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.

### 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 (dyshydrotic eczema, prickly heat)*

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 and heavy sweating.

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

#### 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 comes the commoner skin complaints, continual 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 commonest 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 so that eczema occurs. Why some patients develop an allergy to chemicals and others do not is as yet unknown. The number of known skin allergens is now so numerous that mention will be made only of the commoner substances likely to cause contact eczema. Such allergy can be tested for by patch testing. Hence small samples of suspected items and of common offending allergens in pure form are applied under standardised conditions onto the patient's back. The carefully marked areas are then read at 2 and 4 days. Interpretation of such results is not always straight forward and patch testing is best performed in a specialised developing 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 sensitivity, and is most frequently found in suspenders, jewellery clips and brassiere 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 not infrequently 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 easily obtainable from a chemist, there are many dermatologists who consider that there are no indications for their use. Antihistamines applied topically have a high incidence of sensitisation and 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 commonest 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.

a *Topical therapy*

Only bland and non-sensitising substances should be used. Topical antihistamines and local anaesthetics should be avoided. Most severe cases should be referred.

b *Systemic therapy*

c *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.

d *Antibiotics*

Not infrequently acute eczema becomes secondarily infected. If so a broad spectrum antibiotic should be given by mouth.

e *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.

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 as temporarily unfit the pilot until the acute phase is over.

## **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 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 as temporarily unfit the pilot or crew member 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 condition 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 deep vein conditions. A previous thrombophlebitis may predispose to this type of eczema. The commonest 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 breakdown 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 the condition and see if there has been any change in any early varicose vein development.

## 4.3 Seborrhoeic eczema

### a *Symptoms*

Eczema is confined to areas of maximal grease secretion – the scalp, eyebrows, moustache, naso-labial folds and ears. More rarely 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 enough population.

This is an endogenous type of eczema. 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.

The problem in professional aircrew is that it can disturb other crew and passengers.

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.

### 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.

When the condition 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 chaffing. 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 breakdown.

##### b *Treatment*

This will require a temporarily unfit assessment until the condition 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 type of condition 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. In those aircrews who need anti malarials, questions should always be asked about any skin conditions.

The commonest 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 condition at pre-employment or first licensing medical examination.

What can be a minor condition can develop into a severe discoid type which 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. When 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, despite appearances, have permanently lost their licence as a result of having psoriasis.

## 5.3 Psoriatic arthritis

Five percent 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.

Treatment is non-specific in using NSAID's. A diet high in oily fish can give modest benefit.

There are a few cases on record when the arthritis was bad enough to have to stop flying. In those cases treatment would have to be seen to produce normal hand or leg function.

Physiotherapy would also be needed to restore normal function.

It must also be stated that rarely 'Psoriatic Arthropathy' can occur without the skin lesions of Psoriasis.

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.

## 6 PITYRIASIS ROSEA

### 6.1 Symptoms

This annoying skin condition 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 condition may be unacceptable for a few weeks.

### 6.2 Lichen Planus

This condition is another of the papulosquamous eruptions of unknown aetiology. Whilst not as common as psoriasis, it does account for one per cent 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.

### 6.3 **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 commonest 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**

These are very common in aircrew, more so in long range crews visiting exotic places on a regular basis.

Disorders of the skin, hair and nails caused by fungus have become more prevalent in the last twenty years.

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.

The common fungal infections include a number of similar organisms which target specific areas.

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 to ground and treat in the acute phase.

### 7.2 **Treatment**

Specimens of scrapings of skin toe nail clippings or plucked hairs should be sent to a good laboratory for culture. 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**

(Pityriasis Versicolor) is a fungal condition caused by *Malassezia Furfur*.

It appears as fawn 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. 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 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.

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 condition 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 reason.

#### b *Treatment*

A temporarily unfit assessment is necessary until the condition 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 conducive for treatment so the person must be

assessed as temporarily unfit until the condition begins to improve and is comfortable. Remember this condition can be the presenting feature in Diabetes Mellitus.

## **9 VIRAL INFECTIONS**

### **9.1 *General considerations***

The commonest 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 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 condition has increased in its numbers over the last twenty years. It is characterised by a small group of blisters.

The commonest 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 after 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 of Zoster 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 may be necessary as the crew member may 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 can be the pain. Strong analgesics 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 commonest 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. This latter infection can give rise to renal and cardiac complications.

It is therefore important to ground these cases, investigate and treat 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 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 crops of 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 syphilitic 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 DRUG ERUPTIONS**

Almost any drug/medication can produce a skin eruption. This may mimic most skin conditions or produce bizarre patterns of reaction in the skin. Any member of aircrew or cabin crew presenting

with any skin condition no matter how obvious, must as a part of the history taking, be asked about having taken any medication, in the immediate past or at present. Laxatives, tonics, pain killers, anti malarials all count as drugs/medication as well as any prescription drugs.

Some drugs/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 when a drug/medication may be the cause.

- 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 condition 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.
- 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 B 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 drug/medication has been suspected of causing a skin reaction, it should be avoided if possible. It may be necessary to assess as temporarily unfit the crew member 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 but 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**

These lesions can present aircrew and the AMS with a number of problems.

Up until now, there were no separate rules and regulations to cover this group of conditions. 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 will always be confirmed by biopsy.

## 13.2 Basal Cell Epithelioma

### a *Symptoms*

This condition is sometimes referred to as a Rodent Ulcer. It is the commonest '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 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 commonest 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 overlying 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 are no reasons for assessing as temporarily unfit aircrew with this condition, providing the biopsy shows complete excision. If excision is not complete, further surgery is required.

## 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 have 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'.

### b *Prognosis*

Early 'thin' lesions are cured by surgery, but a percentage of patients with older 'thicker' lesions may develop distant spread (Metastases) (see Oncology Chapter).

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 is usually no need to assess as temporarily unfit the aircrew for more than it takes the excision or graft wound to heal. The AMS must be informed. If secondary deposits occur, then a temporarily unfit assessment is mandatory. The treatment will vary if secondary deposits occur according to each particular case. The AMS must be notified in all cases and any decision about recertification should only be made by the AMS.

**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 condition 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 conditions 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, 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.

Recertification for Class 1 or 2 may be considered where 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 recertification may be considered where appropriate.

## 16 URTICARIA

This is an acute dermatological response often to some extraneous cause. 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 asphyxiate.

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.

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.

Recertification may only be considered after the condition has settled down. A careful history must be taken to exclude a possible precipitating factor such as a particular drug which should be avoided in the future.

## 17 CUTANEOUS PRESENTATIONS OF SYSTEMIC DISORDERS

These conditions 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 conditions 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 xanthalasmata 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. Recertification may be considered when the condition has settled down if a cause can be identified.

e *Sarcoidosis*

This condition 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 recertification.

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 before recertification.

## 18 PARASITIC INFESTATION AND INSECT BITES

There are a number of conditions of the skin 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, totally curable. It is caused by an insect mite (*Sarcoptes Scabei*) which can be passed from person to person in a close environment, such as crew bunks.

The presenting symptom is nearly always irritation, with tiny tracks on finger webs, wrists, elbows, groins etc. It can be 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. Gamma Benzene Hexachloride, or pyrethrum should be applied to all the skin from the neck to the soles of the feet. It is important to repeat this procedure 24 hours later. Irritation may continue for a week or two.

Any member of aircrew should be assessed as temporarily unfit and treated, as should any close friend or relative.

### 18.2 Lice

There are three forms of this condition, head, body and pubic lice. It is a socially unacceptable condition especially in aircrew. It can cause intense embarrassing irritation. It can be passed from persons to persons living or working in close proximity to each other. The diagnosis can be made by visual sighting of the lice.

Modern treatment can eradicate the condition within 24 hours.

### 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

This term is used to describe an abnormal response to UV irradiation. The commonest condition seen in aircrew, which can give rise for concern is sunburn. This can cause great pain and discomfort. Care and education are very necessary for all aircrew where travel between extremes of climate occur with increasing regularity. The desire to get a 'tan' can overcome knowledge that to prevent sunburn, exposure must be graduated. 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. 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. Regular indoctrination is necessary of all crew members to avoid sunburn. Over exposure over a long period of time can initiate wrinkling and atrophy of the skin, plus a number of associated conditions. Exposure to UV light can initiate more malignant skin conditions as described earlier. 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.

## 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 condition is that it can take weeks or even months to develop. The aircrew affected may not recall where the condition may have started. Insect bites usually on the face or limbs, lead to long lasting nodules which grows and ulcerates. 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 condition caused by a Mycobacterium 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 the condition completely.

## **21 DISORDERS OF THE HAIR**

Anyone who suffers from acute hair loss should seek medical advice, as it can be manifestation of a more systemic problem. This is to be distinguished from normal ageing hair loss. (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***

The commonest disorder of pigmentation. Where there are symmetrical patches of complete depigmentation e.g. eyelids, backs of hands, genitalia, knees etc. Whilst this condition 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. Recertification may be allowed when the condition is fully understood and under control.

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## CHAPTER 17 - ONCOLOGY

### 1 INTRODUCTION

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 a method of assessing the risk to flight safety from air crew who have received treatment for malignant disease, and then apply that method to the four commonest tumours seen in a pilot population, malignant melanoma, colorectal carcinoma, testicular tumours and lymphoma.

### 2 PRIMARY TREATMENT FOR MALIGNANT DISEASE

#### 2.1 Surgery

Surgery is the commonest primary treatment for malignant disease, and is often 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 (taken from the tumours presented later) are shown in the table below.

| Operation    | Example                               | Minimum time assessed as temporarily unfit |
|--------------|---------------------------------------|--|
| Minor        | Excision of mole<br>Lymph node biopsy | 1 week                                     |
| Intermediate | Orchidectomy for testicular tumour    | 4 weeks                                    |
| Major        | Hemicolectomy for carcinoma of colon  | 12 weeks                                   |

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 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

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 and prostate cancer treatment may be acceptable if there are no side effects.

## 3 CERTIFICATION AFTER PRIMARY TREATMENT OF A HYPOTHETICAL TUMOUR X

### 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 or the air traffic controller is controlling an aircraft.

The concept of 'acceptable risk' has been discussed elsewhere, and much work in aviation cardiology has defined a 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 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 the purposes of these calculations a 3–5% annual incapacitation risk has been taken as the upper limit.

| 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')<br>Class 2 unrestricted | 2 crew professional<br>Solo private            |
| Greater than 1%                 | No Class 1<br>Possible Class 2 restricted ('OSL')  | No professional<br>Private with 'Safety Pilot' |

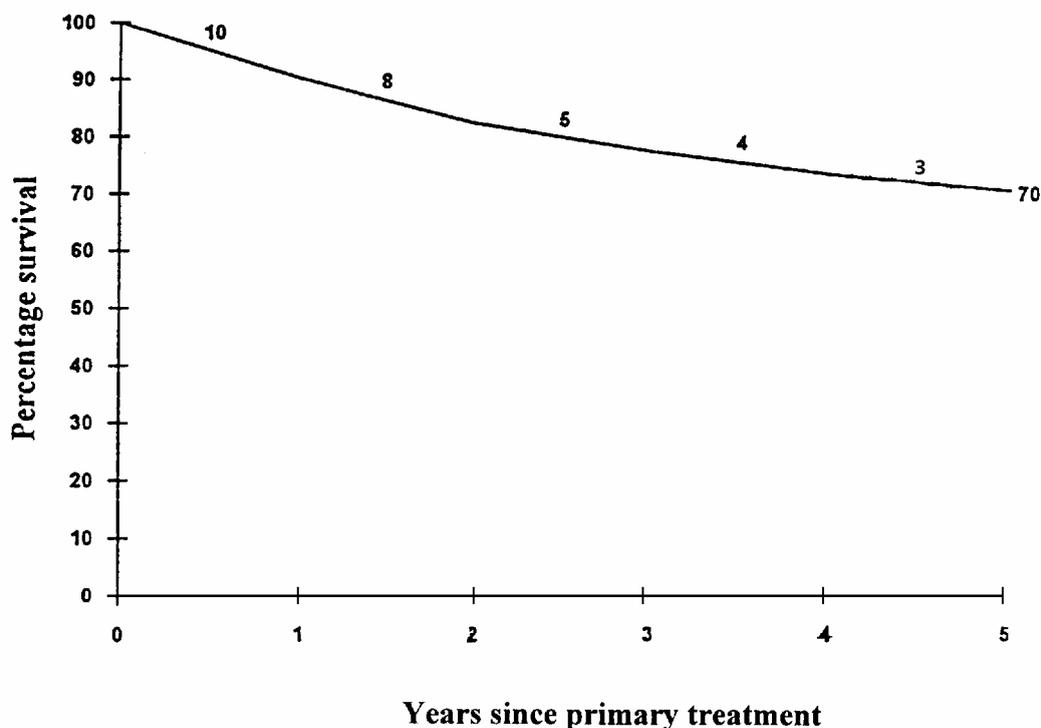
Thus if an incapacitation rate per year can be derived for tumour X at any particular time away from its original treatment, then an acceptable level of certification for that pilot, at that time, can be calculated from the table above.

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.

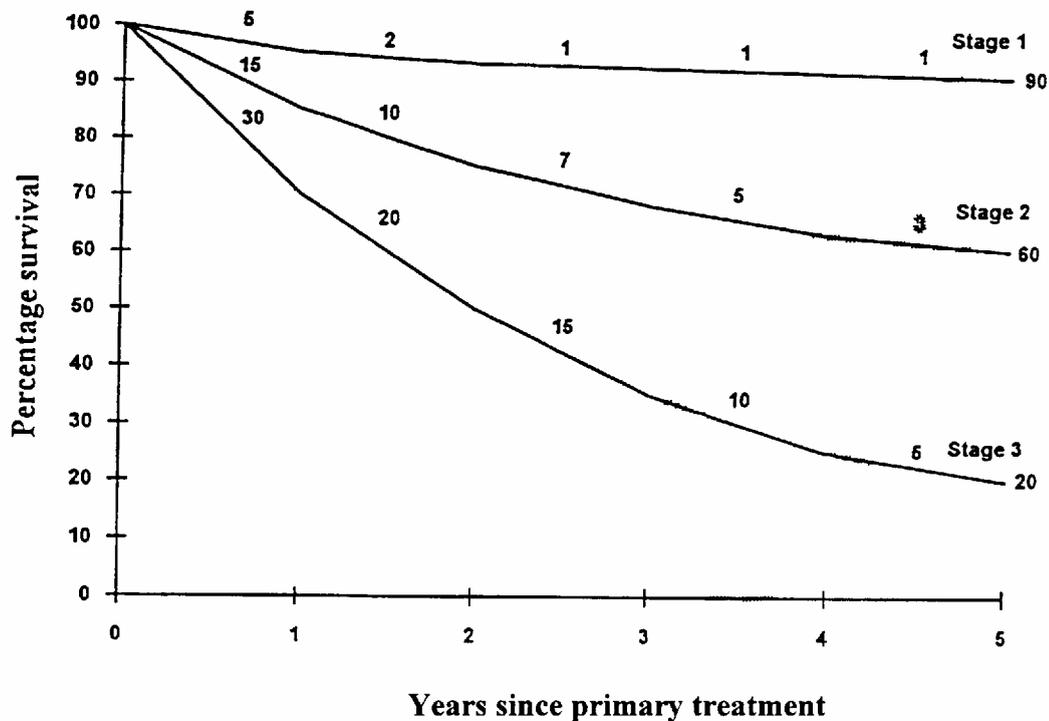


**Figure 1: Overall five year survival after primary treatment for tumour X.**

The graph represents the recurrence rates for all cases of tumour X. This data however, includes a large spectrum of recurrence rates from very low (early stage disease) to very high (late stage disease). Tumour X lesions can be divided into three types, or stages, based on the pathological examination of the resected specimen. Using the TNM classification, these can be described as stages 1, 2 and 3 as shown in the following table:

| TUMOUR X – PATHOLOGY |         |                                 |
|----------------------|---------|---------------------------------|
| Stage                | TNM     | Description                     |
| 1                    | T1 N0   | Small tumour, no nodes          |
| 2                    | T2 N0   | Larger tumour, no nodes         |
| 3                    | T1/2 N1 | Any size tumour, nodes involved |

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 7%.

### 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 pathology textbooks were first written. Although metastases can occur in any part of the body, the majority are found in the organs listed in the following table.

| Sites of metastatic disease |
|-----------------------------|
| Local and lymph nodes       |
| Liver                       |
| Lung                        |
| Bone                        |
| Bone marrow                 |
| Brain                       |

Study of the appropriate pathology textbooks shows that tumour X tends to metastasise to the following sites, at the rates below:

| Site                  | Incidence |
|-----------------------|-----------|
| Local and lymph nodes | 60%       |
| Liver                 | 20%       |
| Lung                  | 5%        |
| Bone                  | 5%        |
| Bone marrow           | 0%        |
| Brain                 | 10%       |

Ideally this 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, must carry a 100% potential for sudden incapacitation in the form of a fit or seizure. 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 or controllers to some extent.

Thus a table of 'incapacitation weighting' can be constructed to give a measure of the potential for sudden and subtle incapacitation by a recurrence at each metastatic site. This is shown in the table below.

| Site                  | Incapacitation<br>'weighting' | risk |
|-----------------------|-------------------------------|------|
| Local and lymph nodes | 1%                            |      |
| Liver                 | 5%                            |      |
| Lung                  | 5%                            |      |
| Bone                  | 5%                            |      |
| Bone marrow           | 20%                           |      |
| Brain                 | 100%                          |      |

### 3.5 Defining the total risk of incapacitation

Three parameters are now known about tumour X, and these can be used to calculate 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 fraction).
- The risk that a metastasis in a particular organ will cause incapacitation (as a fraction).

A formula can now be derived to calculate the total risk of a particular metastasis causing incapacitation. The example below is for brain metastases.

|                                    |   |                                     |   |   |   |  |
|------------------------------------|---|-------------------------------------|---|---|---|--|
| Tumour X<br>recurrence<br>rate (%) | X | Incidence of<br>brain<br>metastases | X | Risk of a<br>brain metastasis<br>causing incapacitation | = | Incapacitation risk<br>for brain metastases<br>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 10/100 X 100/100 = 0.5% risk of incapacitation

Year 1 / Stage 2 : 15% X 10/100 X 100/100 = 1.5% risk of incapacitation

Year 1 / Stage 3 : 30% X 10/100 X 100/100 = 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 the table below.

| 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'        |

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 10/100 X 100/100 = 0.1% risk of incapacitation

Year 5 / Stage 2 : 3% X 10/100 X 100/100 = 0.3% risk of incapacitation

Year 5 / Stage 3 : 5% X 10/100 X 100/100 = 0.5% risk of incapacitation

In the fifth year the risk of incapacitation has now fallen to between 0.1 and 0.5%. The range of certification has also improved, as shown in the following table.

| YEAR 5 – BRAIN METASTASES |                     |                            |                       |
|---------------------------|---------------------|----------------------------|-----------------------|
| Stage                     | Incapacitation risk | Professional certification | Private certification |
| 1                         | Unrestricted        | Unrestricted               | Unrestricted          |
| 2                         | 0.3%                | 'As or with co-pilot'      | Unrestricted          |
| 3                         | 0.5%                | 'As or with co-pilot'      | Unrestricted          |

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.

### 3.6 Presenting the total risk of incapacitation

The performance of commercial aircraft (the weights that can be carried in the ambient atmospheric conditions with given runway lengths) are often presented in a series of graphs which take account of the various parameters by altering the slopes and distances (factoring) on the charts. These are called performance charts. Thus one might enter the chart with aircraft weight, traverse various sub-graphs (air temperature, aerodrome altitude, runway slope, headwind component etc), and come out at the other end with the runway length required to take off at that weight.

The same techniques can be used to depict data about tumour recurrence and the risk of incapacitation. The graph can be entered with the time from the original treatment, factored for stage, grade or any other pathological prognostic variable, and then exited with the appropriate certification. This means that individual calculations as done above for each year and stage of tumour X would not be necessary, as they would all be incorporated into the graph. We have called this a 'certification assessment' graph.

### 3.7 Using certification assessment graphs

It should be emphasised that these charts are derived from morbidity and mortality statistics. They cannot predict what will happen in an individual pilot or controller. When a medical test is developed which can accurately pinpoint metastatic or recurrent disease, then these charts will be obsolete. Until then they can act as a guide to the aeromedical examiner who is faced with the certification of a pilot who has been treated for malignant disease.

**Figure 3** shows a certification assessment graph for tumour X, and the normal 'movement' through the graph. Starting on the left hand axis with years since the end of the primary treatment, we move horizontally left to the REFERENCE LINE. If the tumour is stage 2, we move straight across to the right hand axis to read off the appropriate certification. If, however, the tumour is stage 1 or stage 3, the path through the graph has to be 'factored' to reflect better or worse prognosis and risk than stage 2. Stage 3, a worse risk, moves up and left before crossing to the right axis, and this greater risk is reflected in a lower certification. Stage 1, however, with the best prognosis, moves down and right before crossing to the right axis, where unrestricted certification is possible.

If we wish to assess when a pilot becomes a low enough risk for unrestricted certification, it is necessary to move from right to left in the graph. In **Figure 4** we wish to know when a pilot who has had treatment for a stage 1 lesion could become eligible for an unrestricted Class 1 certificate. By moving back through the graph from the junction between Class 1 Restricted/Unrestricted line we find that it is 1 year after treatment has finished.

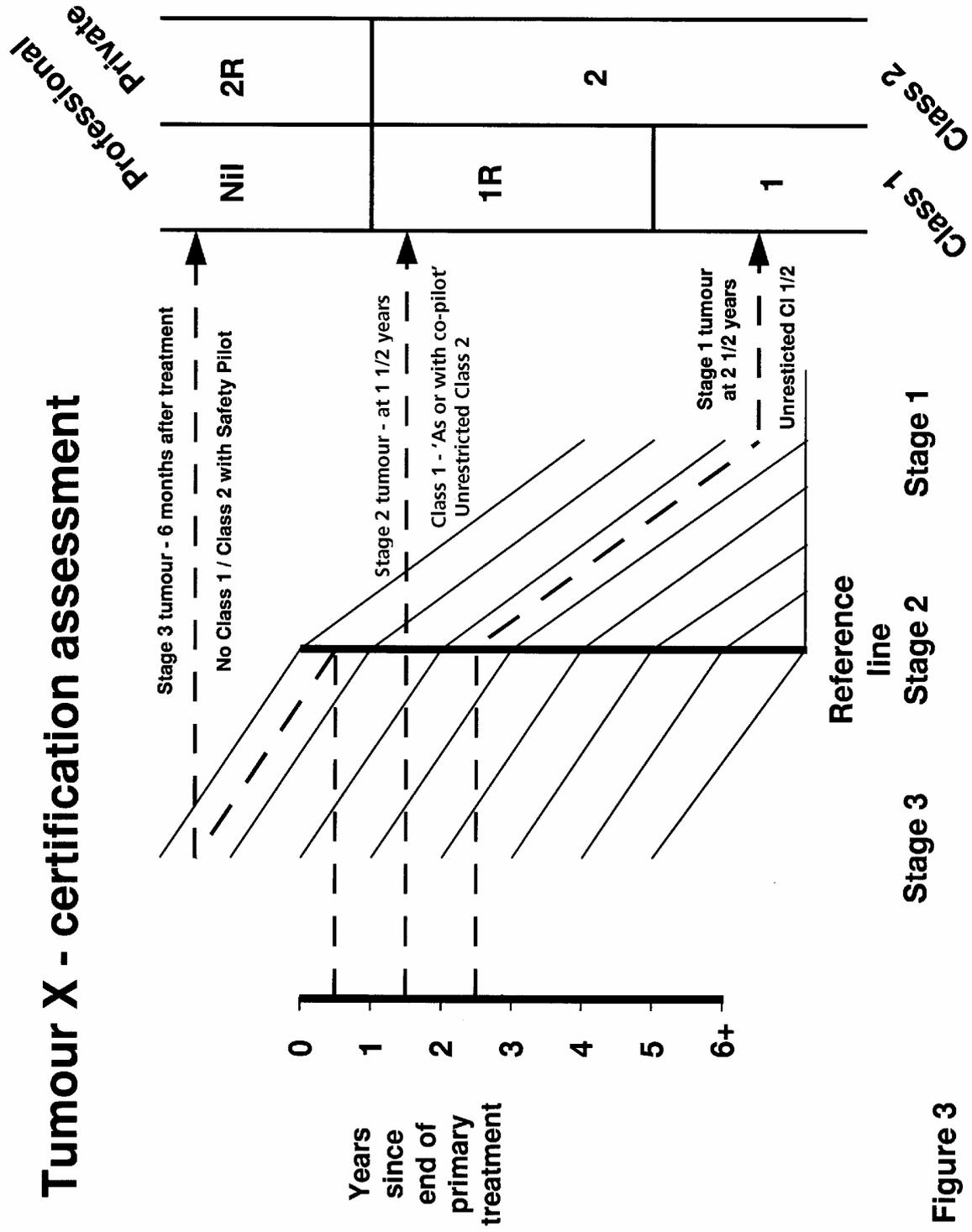
Similarly in **Figure 5** we would like to know when it becomes possible to certificate a pilot with a stage 3 tumour. We move from the No certificate / Class 1 Restricted junction backwards (right to

left) in the graph, but going now to the STAGE 3 column first and then to the REFERENCE LINE. We then move to the left hand axis and read that a pilot with a stage 3 lesion will not reach a low enough risk of incapacitation for Class 1 Restricted certification (1% per year risk of incapacitation) until 3 years have passed from the initial treatment.

The rules, therefore, for moving through a 'certification assessment' graph depend on whether we start with a 'time from treatment' on the left hand axis, or from a 'certification level' on the right. Moving left to right we go to the REFERENCE LINE first, then to the appropriate stage (which may be on the reference line) and then across to the certification columns. Moving right to left, we go first to the appropriate stage, and then to the REFERENCE LINE, before moving left to the 'time from treatment' axis. Once it has been used a few times it becomes simpler, just as you found that your aircraft performance charts suddenly made sense.

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# Tumour X - certification assessment



**Figure 3**

# Tumour X - certification assessment

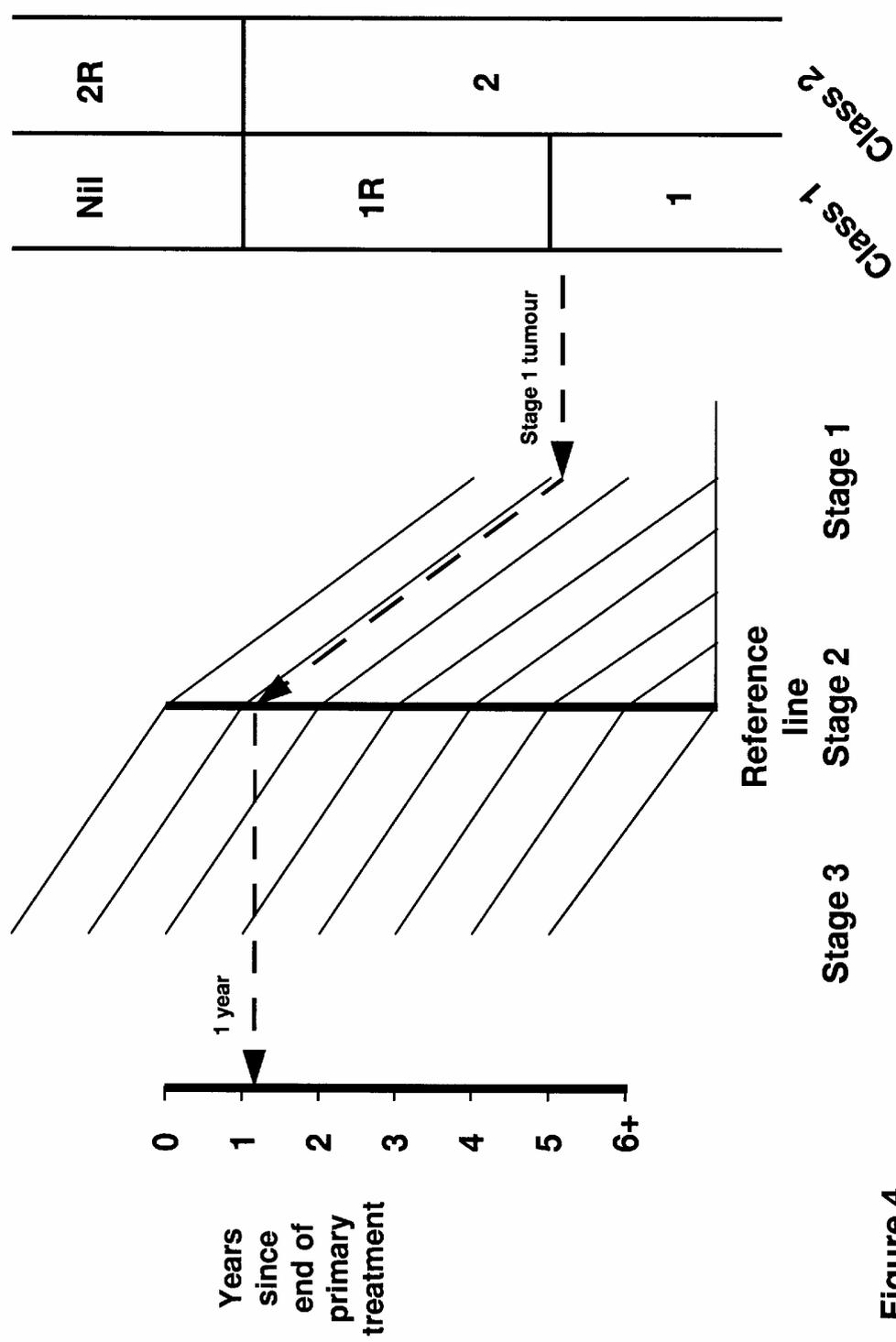


Figure 4

# Tumour X - certification assessment

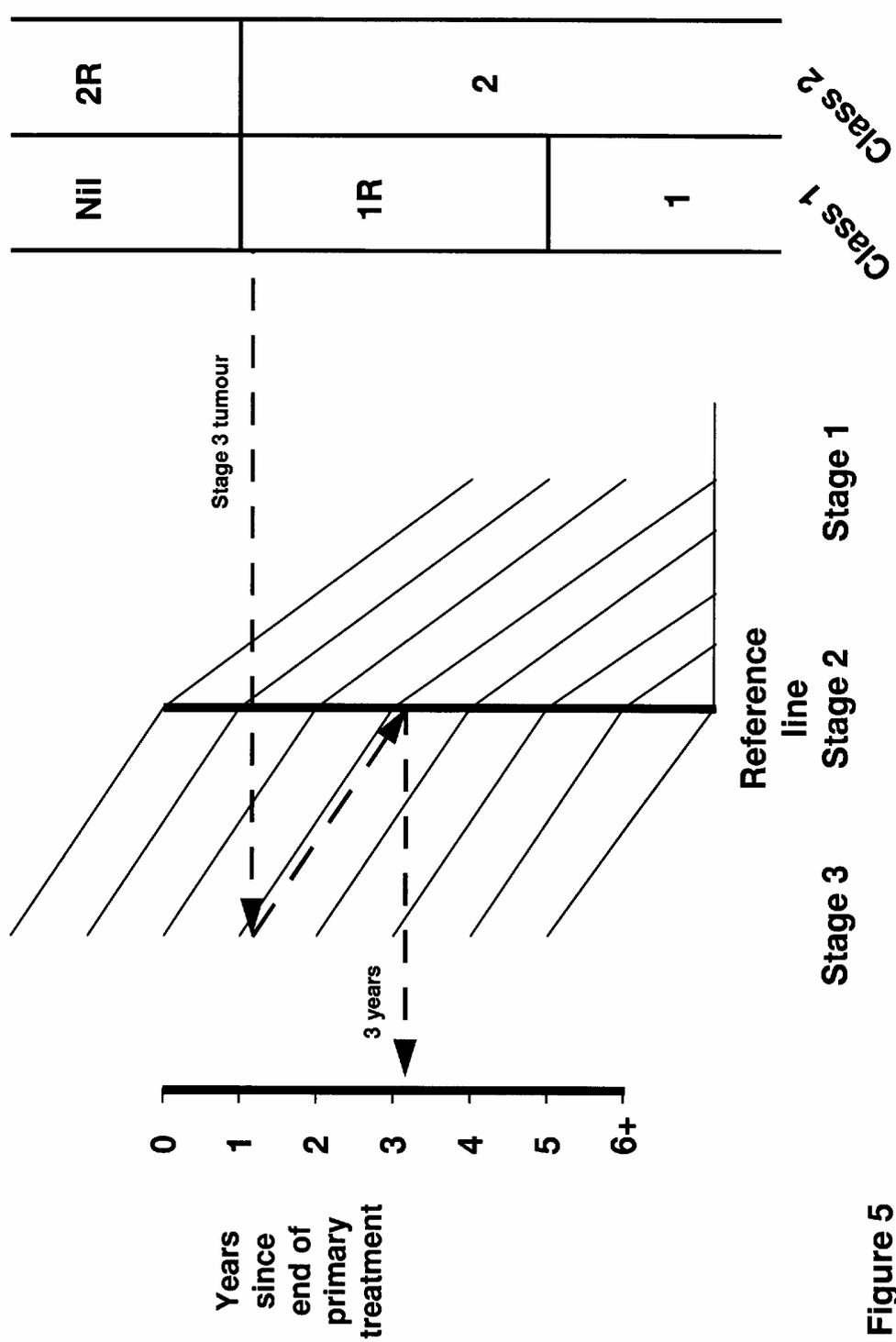
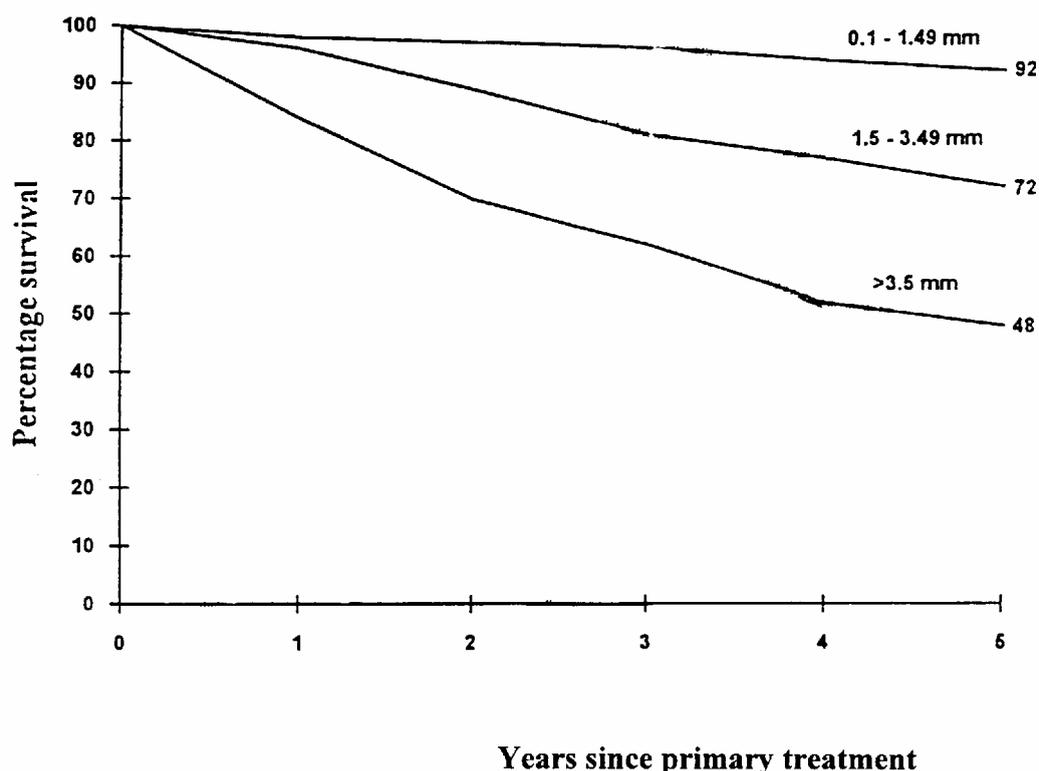


Figure 5

#### 4 MELANOMA

Most pilots will present for recertification after excision of a stage 1 (no lymph nodes involved) primary lesion. If lymph nodes are involved, or become so, the prognosis is much worse, and an individual assessment in conjunction with oncology specialist advisors will be necessary. The best indicator of prognosis in melanoma is the vertical thickness of the excised lesion (Breslow thickness). This will be used as the main prognostic factor in recertification. The five year survival curves for three levels of thickness are presented in **Figure 6**, and have been obtained from a recent survey of 1 600 patients in Scotland.



**Figure 6: Five year survival after excision of Stage 1 melanoma.**

The commonest site of recurrence of a melanoma is in the draining lymph nodes. This will not pose a significant incapacitation threat, but there is a small but significant incidence of cerebral metastases presenting as the first sign of recurrence. This has been estimated at 8% in a large Australian series, and similar figures were found in USAF personnel developing melanomata.

**Figure 7** is an 'assessment' graph showing certification after primary excision of stage 1 melanoma based, as with the hypothetical tumour X, on the five year survival data in **Figure 6**, an 8% chance of the first metastasis being in the brain, and a 100% chance that a brain metastasis will cause an incapacitation. This can be used to assess certification after primary excision of a melanoma in air crew, provided the thickness of the lesion is known.

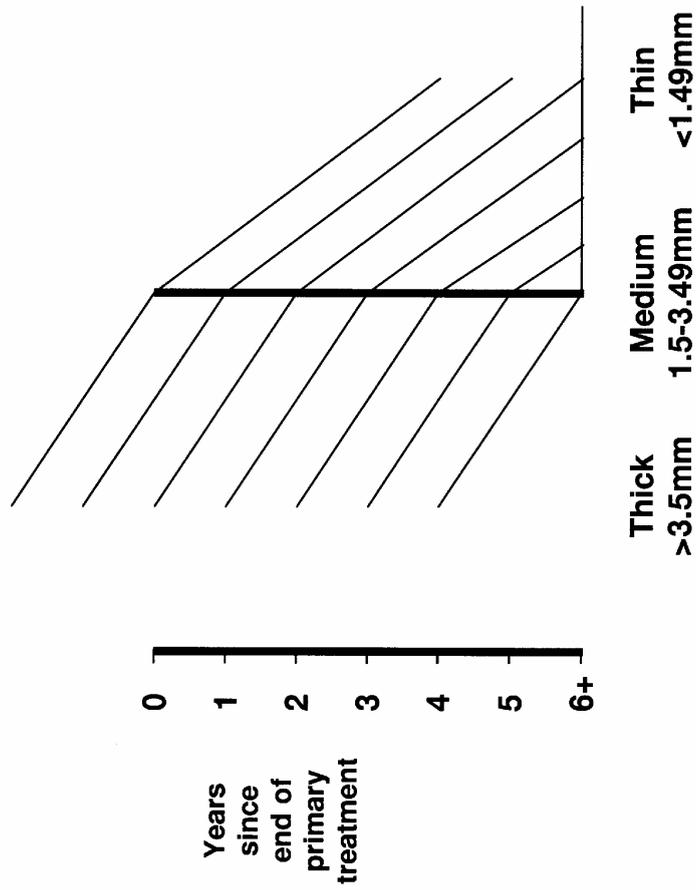
As an illustration of the use of an actual 'certification assessment' graph, **Figure 8** shows assessments of three thicknesses of tumour at various times from primary treatment. The upper line is the assessment of a thick tumour (greater than 3.5 mm), six months after the finish of primary treatment, which is likely to be wide excisional surgery. No Class 1 certificate is possible for another 18 months, though a Class 2 certificate, with a safety pilot limitation ('OSL') can be granted.

The middle line shows the assessment of a medium thickness tumour (between 1.5 and 3.49 mm) a year after surgery. Here a restricted Class 1 ('OML') certificate is possible, but the 'as or with

co-pilot' ('OML') limitation will not be removed, assuming there is no recurrence, until five years have passed from the surgery.

The lower line shows certification following the excision of a thin tumour (0.1 to 1.49 mm) 18 months after the operation. Although the professional pilot had a multi-pilot ('OML') limitation for a year, this has now been removed, and both unrestricted Class 1 and Class 2 certification is possible.

# Malignant melanoma



|              |     |    |   |         |
|--------------|-----|----|---|---------|
| Professional | NII | 1R | 2 | 2R      |
|              |     |    |   |         |
|              |     |    |   | Class 1 |
|              |     |    |   | Class 2 |

Figure 7

# Malignant melanoma

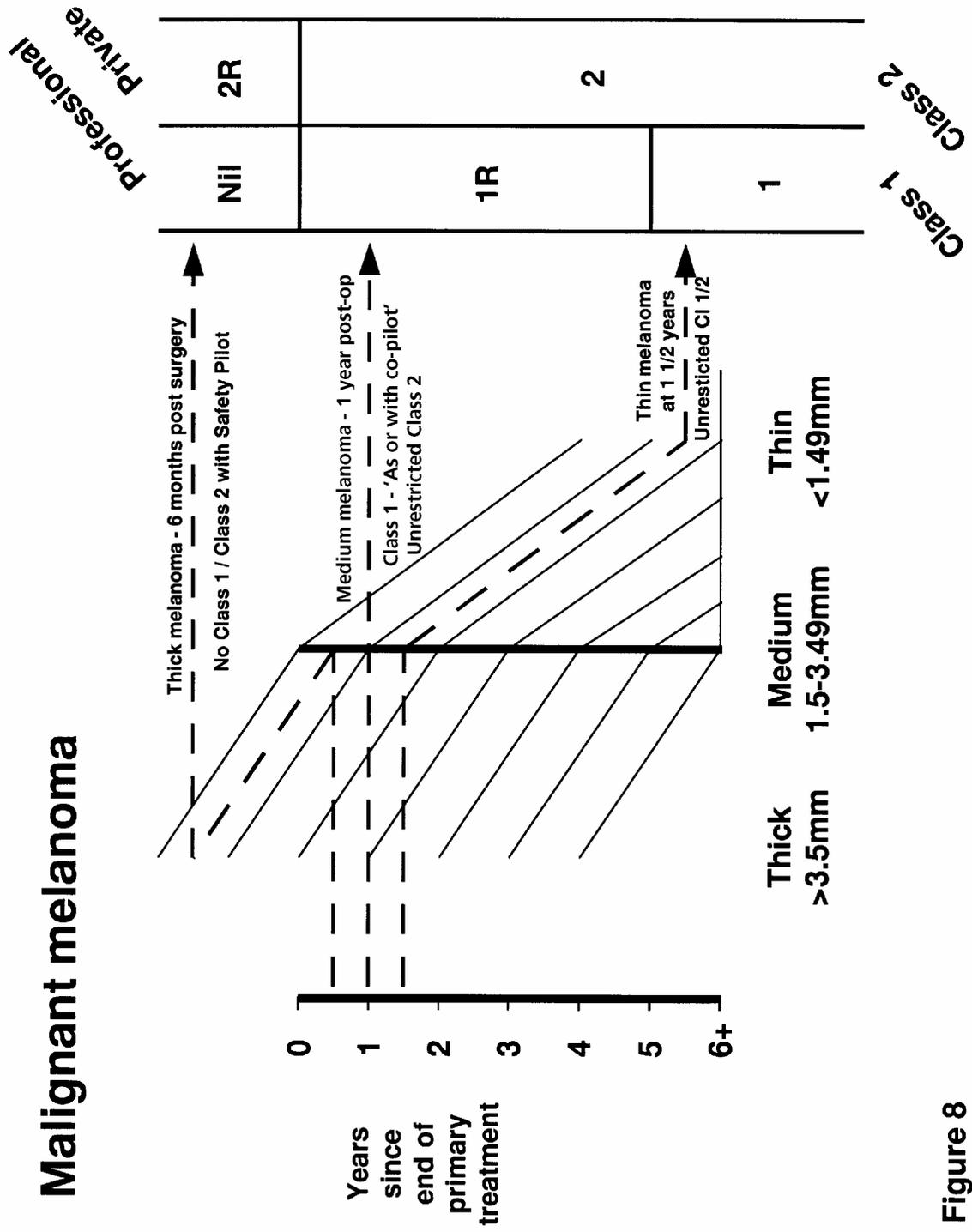
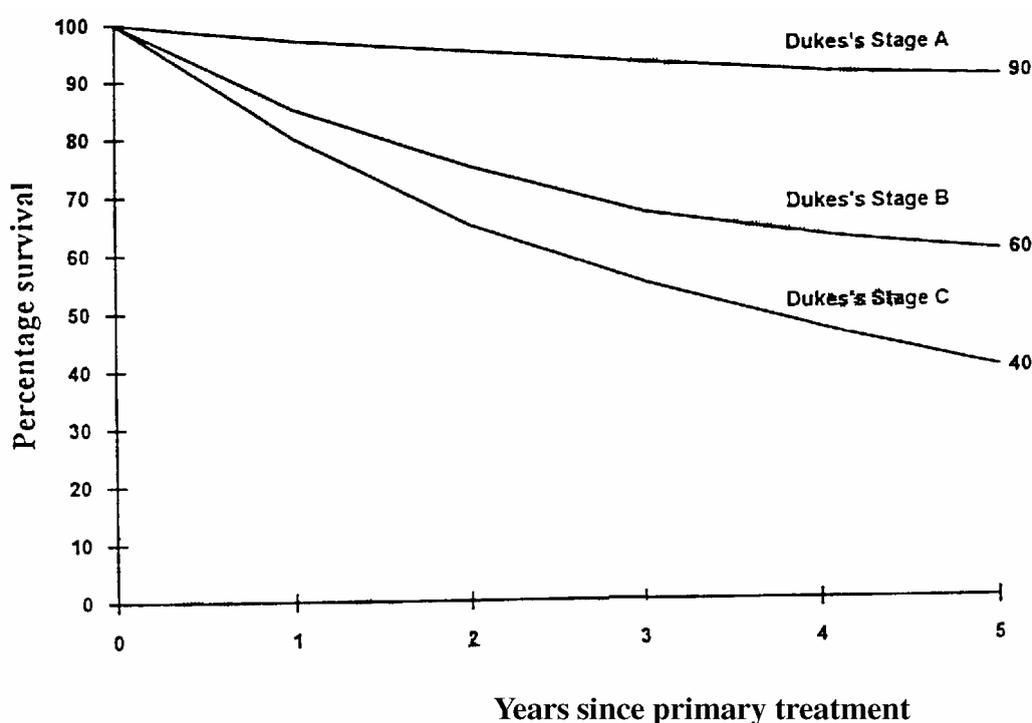


Figure 8

## 5 TUMOURS OF THE COLON AND RECTUM

Tumours of the colon and rectum account for approximately 15% of air crew and air traffic controllers applying for recertification following successful treatment for primary malignant disease. The classic method of pathological staging was devised by Cuthbert Dukes, pathologist at St Mark's Hospital, London, and is divided into stage A (T1,N0), stage B (T2/3/4,N0) and Dukes's stage C (T1/2/3/4,N1/2/3). The equivalent TNM classification is shown in parentheses. This has stood the test of time, and **Figure 9** shows the five year survival for patients after 'curative' resection of colonic and rectal tumours divided into Dukes's stages A, B and C. The mainstay of primary treatment is surgery, and it remains a salutary oncological fact that, despite the introduction of adjuvant radio and chemotherapy, the survival figures have not improved substantially. Indeed these figures have been obtained from major surgical series spanning the last 40 years (5,6).



**Figure 9: Five year survival after primary excision of colorectal tumours**

Carcinoma of the large bowel recurs almost exclusively in the liver or locally. Metastases in the brain as a first sign of recurrence are extremely rare. For certification assessment it has been assumed that 50% of first metastases will be in the liver (with a further 45% locally and 5% elsewhere), with a 5% risk of one of these metastases causing a sudden or subtle incapacitation.

As with tumour X, calculations of the incapacitation risk for each stage of the disease are represented graphically in **Figure 10**, allowing a certification assessment for pilots who present following treatment for stages A, B and C. The graph is used as before.

From **Figure 10** it can be seen that Dukes's stage A patients/pilots have such a good prognosis, and such a low risk of incapacitation from the commonest metastases (liver), that they can gain an unrestricted class 1 certificate on their return to flying. Professional air crew with Dukes's B lesions would need to be restricted to multi-pilot ('OML') flying for three years, and those with Dukes's C lesions, five years. Private pilots can have unrestricted certification at the end of their primary treatment, whatever the stage of their primary.

## 6 SEMINOMA AND TERATOMA OF THE TESTIS

Testicular tumours also comprise approximately 15% of the air crew and air traffic controllers seeking recertification following treatment for malignant disease. This is not surprising given the relatively young age and male sex in this group compared to the normal population. The treatment of testicular tumours has been changed radically in the last 20 years by the introduction of powerful chemotherapy, and the majority of patients can now be cured. Two other factors make the recertification of pilots with this disease slightly different from other tumours. The first is the use of tumour markers (alpha-fetoprotein and beta-human chorionic gonadotrophin), which can, in teratomas, accurately predict the presence of recurrent disease in asymptomatic patients. The second is the intense surveillance in the first few years, when recurrence is likely, to which these patients are subjected. This means that pilots, if they are being treated at a major oncology centre, will be under a regime that is geared to discover sub clinical recurrent disease: an ideal situation in air crew. This can be reflected in their certification assessment.

There are a number of staging systems for testicular tumours, but one using the extent of the initial disease is the most useful for aeromedical certification. This is shown in the table below.

| TESTICULAR TUMOUR |   |
|-------------------|---|
| Stage             | Extent of disease                         |
| I                 | Tumour confined to the testis             |
| II                | Primary + abdominal lymph nodes           |
| III               | Primary + supra diaphragmatic lymph nodes |
| IV                | Extra-lymphatic metastases (mainly lung)  |

The most common management of stage I disease in teratomas is a 'wait and see' policy after orchidectomy. Although 25% of these patients will relapse, this will be found during routine surveillance by a rise in the tumour markers, often before any anatomical disease can be located with even the most sophisticated of scanning equipment. In this situation unrestricted Class 1 certification can be maintained while the tumour markers are normal, and 75% of these pilot/patients will never need further treatment.

Stage I seminomas, because the tumour markers are not so accurate, may receive prophylactic treatment. This is usually in the form of radiotherapy, as the tumour is very radiosensitive. This produces a high cure rate (99%), and again unrestricted Class 1 certification is possible when the radiotherapy has finished. There is a move amongst oncologists to 'wait and see' in stage I seminomas, but here there will be a 15% relapse rate, and this will have to be monitored by serial CT or MRI scans. This type of policy may not be appropriate for air crew if they wish to maintain unrestricted certification.

Even with metastatic disease (stage II/III) the prognosis in testicular cancer is good compared to other tumours. If the bulk of the metastatic disease is small, cure rates of 90% can be achieved after chemotherapy for teratoma and radiotherapy for seminoma. More widespread (stage IV) disease has a relapse free rate of 60-70% at five years, but may require intensive chemotherapy to achieve this. If patients are disease-free three years after the end of treatment, it is highly likely that they will remain that way.

# Colorectal Cancer

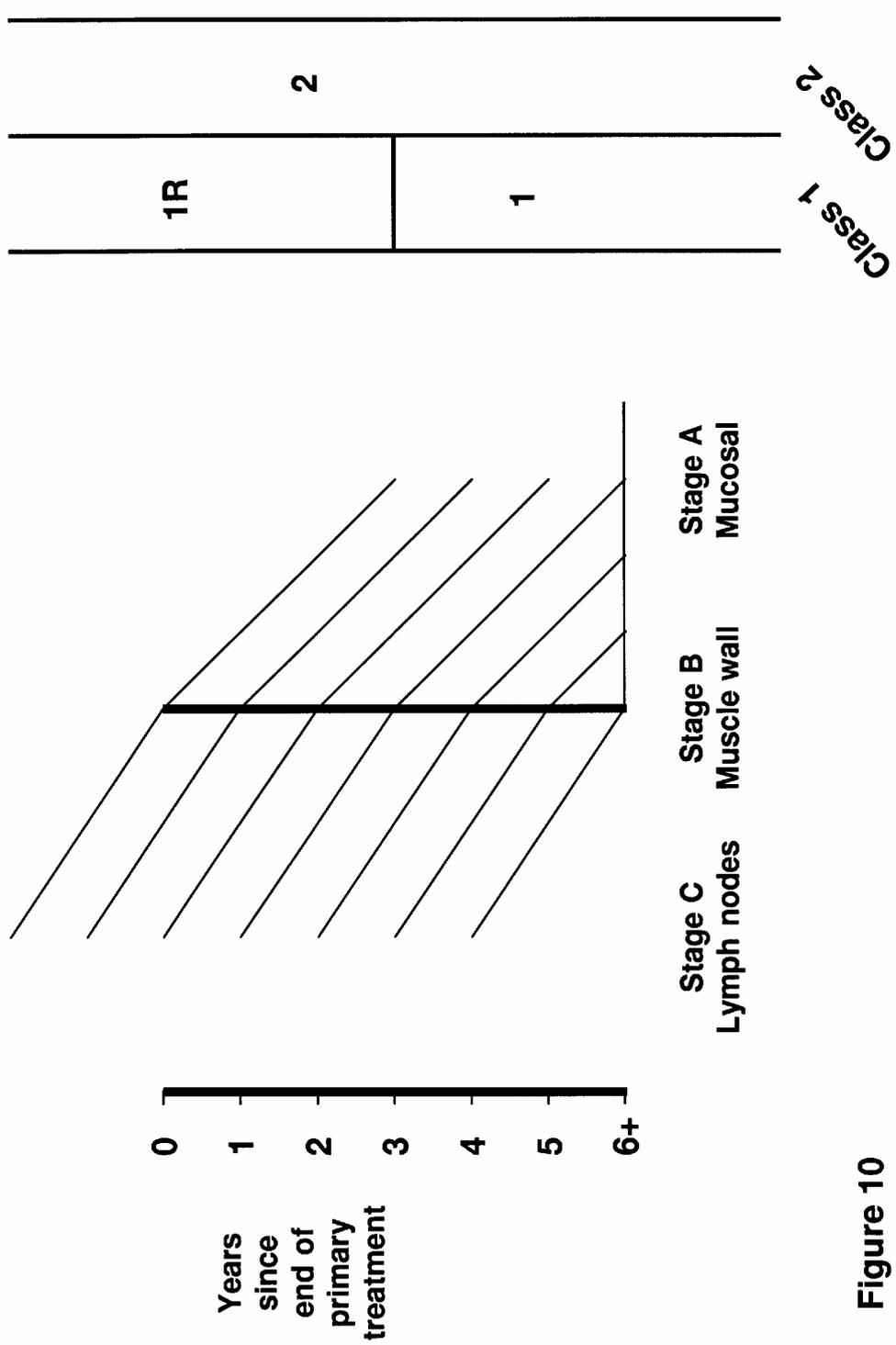


Figure 10

**Figure 11** shows the certification assessment following treatment for testicular tumours. Before recertification is possible, it will be necessary to make sure that there are no residual effects of treatment (bone marrow depression and anaemia). As noted above, certification can extend from initial unrestricted Class 1 in stage I cases, to no certificate in bad prognosis stage IV disease who is likely to need prolonged chemotherapy.

## 7 LYMPHOMA

Lymphoma, in its various forms, is perhaps the commonest malignancy in aircrew. It is broadly divided into Hodgkin's and Non-Hodgkin's disease, and because there are different ways of classifying these two types of lymphoma, and because there are considerable differences in prognosis, they are considered separately.

### 7.1 Hodgkin's lymphoma

With the advent of efficient staging and effective chemotherapy in the 1960's, the prognosis of Hodgkin's disease improved dramatically. The most widely used staging method was developed in Ann Arbor, and is outlined in the table below.

| HODGKIN'S LYMPHOMA |   |
|--------------------|---|
| Stage              | Extent of disease                             |
| I                  | One nodal area involved                       |
| II                 | Two nodal areas, same side of diaphragm       |
| III                | Two nodal areas, different sides of diaphragm |
| IV                 | Extra-nodal (visceral) disease                |

The relapse free rate ranges from 80% at five years in stage I to 65% in stage IV. The most likely site of metastatic disease is in the same or other nodal areas, and this, as was discussed with tumour X, carries a relatively small risk of incapacitation. However, there is a significant occurrence of bone marrow involvement, and this is the most likely source of subtle incapacitation risk. **Figure 12** shows the certification assessment in the usual way for Hodgkin's lymphoma, divided into stages I to IV and combining stages II and III which have a similar prognosis.

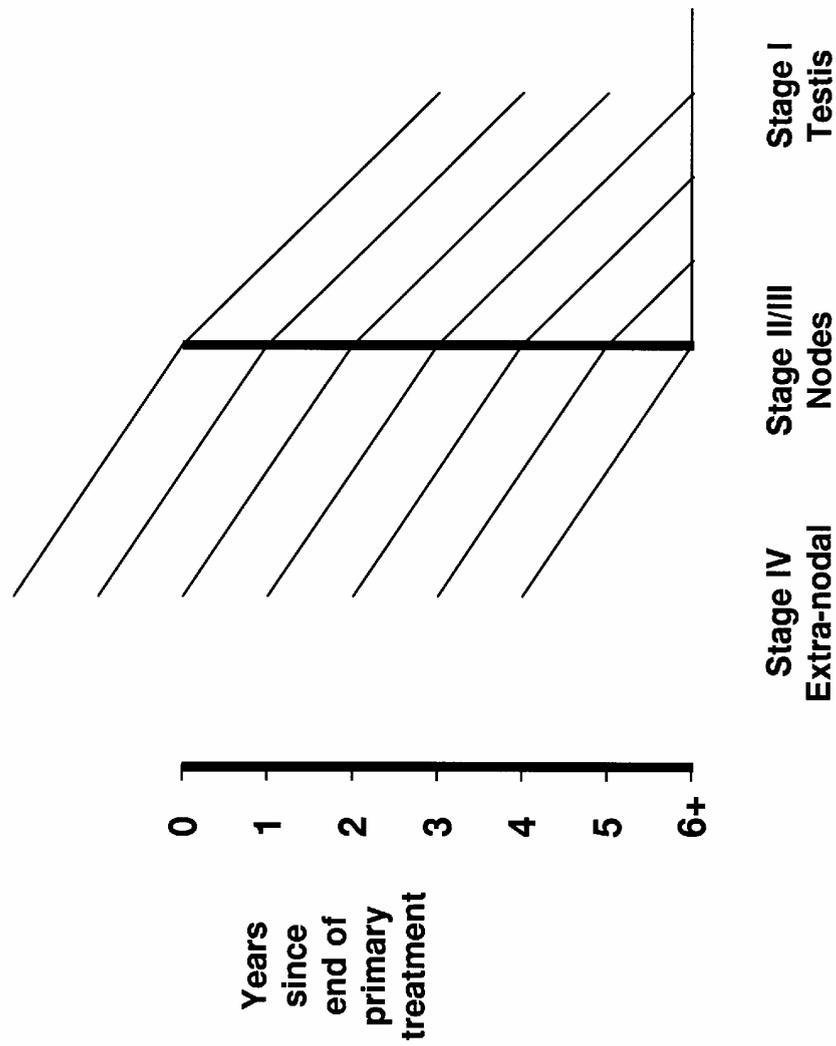
### 7.2 Non-Hodgkin's lymphoma

Although the Ann Arbor method of staging according to the site of nodal and extra-nodal involvement can be used in Non-Hodgkin's lymphoma, a better correlation with prognosis can be obtained by grading the tumour according to its cellularity. This is outlined in the table below.

| NON-HODGKIN'S LYMPHOMA |                              |
|------------------------|------------------------------|
| Grade                  | Histology                    |
| Low grade              | Small cell                   |
| Intermediate grade     | Large cell                   |
| High grade             | Undifferentiated blast cells |

Relapse free rates of 60% over five years can be expected with low grade tumours, falling to 40% in intermediate lesions, and 25% in the high grade group. Again the likely site of incapacitating secondary disease is the bone marrow, and this is reflected in the certification assessment in **Figure 13**. Because of the risk of late relapse, it is unlikely that a professional pilot would gain an unrestricted certificate in this disease.

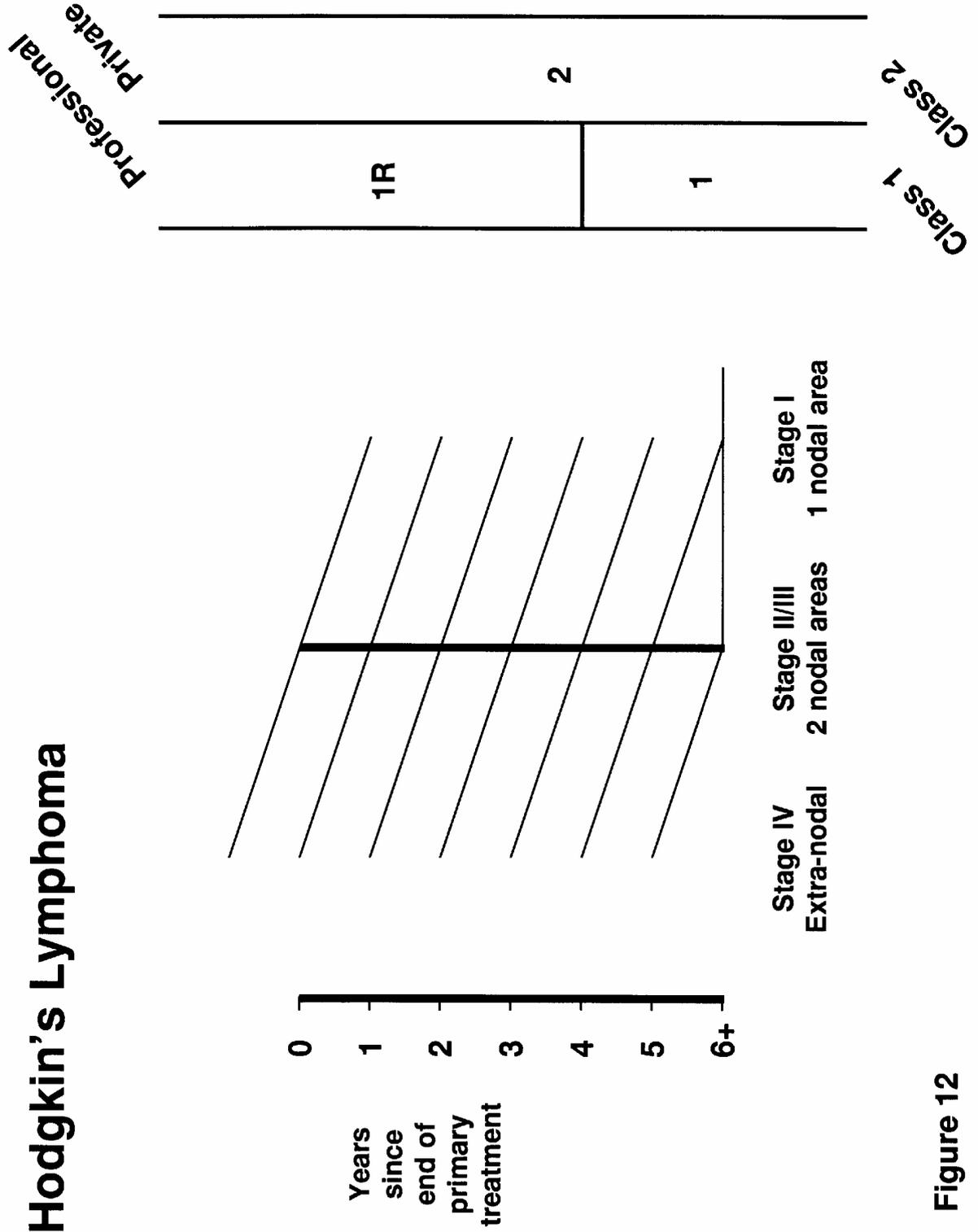
# Testicular tumours



|                         |      |         |         |
|-------------------------|------|---------|---------|
| Professional<br>Private | NIII | 1R      | 2       |
|                         | 2R   | 1       |         |
|                         |      | Class 1 | Class 2 |

Figure 11

# Hodgkin's Lymphoma



**Figure 12**

# Non-Hodgkin's Lymphoma

|                         |     |    |
|-------------------------|-----|----|
| Professional<br>Private | Nil | 2R |
|                         | 1R  | 2  |

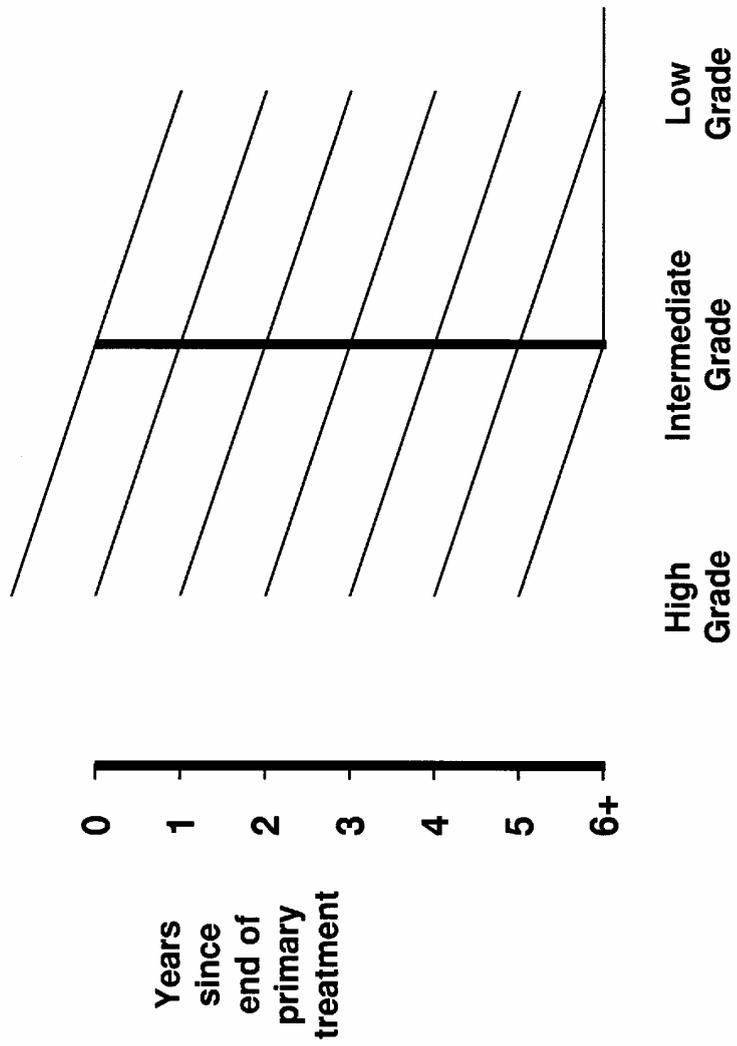


Figure 13

## [8] Tumours of the lung

Although lung tumours are common, accounting for a third of cancer deaths in men, they are rare in aircrew. It is a disease of older persons, and it is possible that pilots are developing it after retirement from flying. Pilots also face a lifetime of medical examinations which perhaps encourages them not to smoke.

Many staging and grading systems have been promoted for the classification of lung tumours, but the commonest method divides the tumours into two according to their histology (non-small cell and small cell tumours) and then applies the standard TNM classification (Tumour, Node, Metastasis) to each. Tumours of broadly similar size and nodal status can then be grouped into four stages, which allow more manageable prognostic groups to be formed. Stage 1 is a localised small tumour, stage 2 has local nodes involved, stage 3 tumours are larger and may have more distant nodal involvement, and stage 4 denotes metastatic disease.

Small cell tumours have almost invariably metastasised by the time of presentation, and it is unlikely that any pilot would be able to return to flying with this type of tumour. Non-small cell tumours include squamous lesions, adenocarcinomas and large cell tumours (undifferentiated). Those that can be resected (by definition stage 1 and 2) carry the best prognosis. The mean five year survival following surgical removal of stage 1 tumours is 50%, and stage 2 lesions 25%. In both stages, squamous lesions tend to do slightly better than adenocarcinomas or undifferentiated lesions. The usual treatment in patients with stage 3 tumours is radiotherapy, and the prognosis is correspondingly bad, the mean five year survival being only 6%.

Lung tumours can recur locally, in regional lymph nodes, and distantly. The common sites of distant spread are the liver (40%), the adrenals (30%), the brain (25%) and bones (20%). These figures are for metastases found at autopsy. It is more difficult to find figures for the nature of the first recurrence. Approximately a quarter of patients who have metastatic melanoma in the brain will present with a brain secondary as a first recurrence. Pragmatically, therefore, it is assumed that a quarter of patients with post-mortem brain metastases from lung carcinoma will present with a brain secondary as a first recurrence.

The certification assessment graph for carcinoma of the lung is shown in figure 14. It assumes annual recurrence rates corresponding to the survival figures above, a 6% risk of the first recurrence being in the brain (a quarter of the post-mortem rate), and a 100% risk that a brain recurrence will cause an incapacitation.

## Lung Cancer

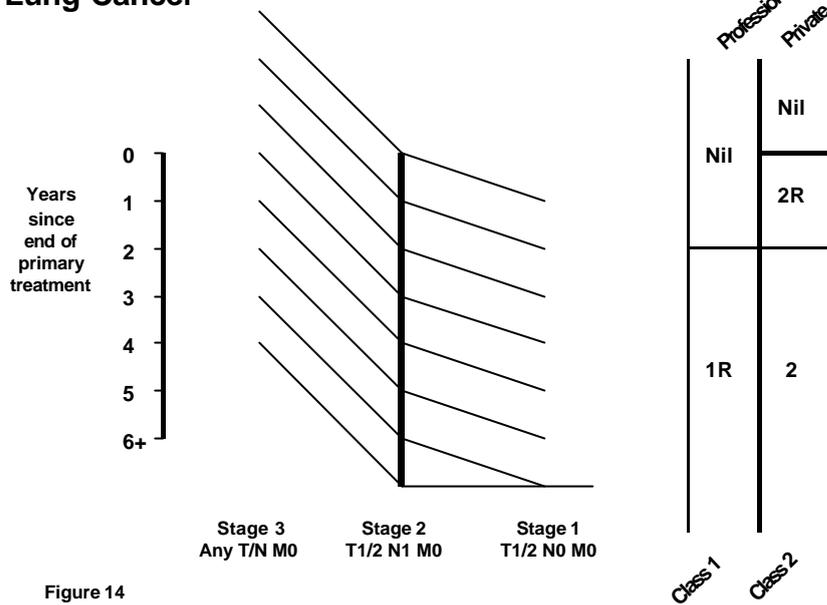


Figure 14

[

## 9 Tumours of the Kidney

Certification for pilots who have had a carcinoma of the kidney removed is shown in figure 15. The five year survival ranges from 70% in stage 1 (within the capsule) and stage 2 disease (within the perirenal fat), 35% in stage 3 (venous or regional node involvement) to 10% on stage 4 (extranodal spread). The most 'dangerous' metastasis is again in the brain, but the incidence of this as a first recurrence is probably only about 2%. This produces a relatively 'benign' certification graph, but, as in each tumour, all macroscopic disease must have been removed before certification can occur.

# Carcinoma of Kidney

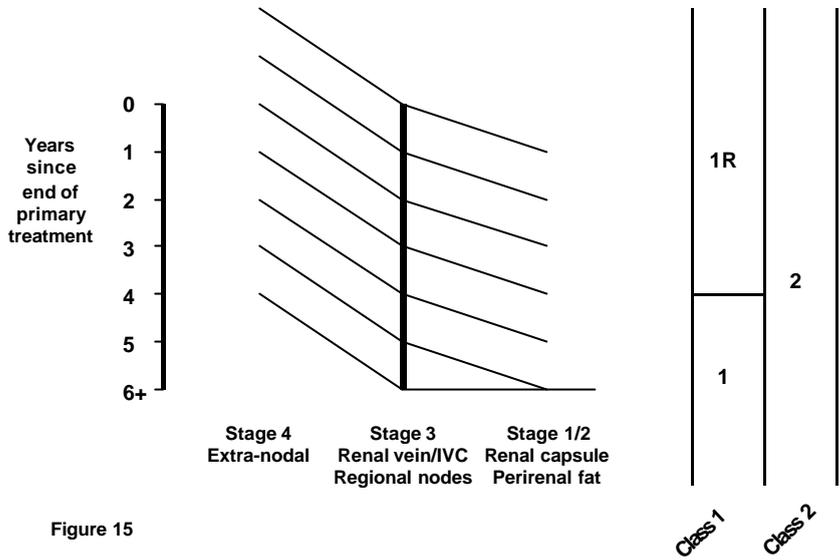


Figure 15

## 10. Tumours of the Breast

One of the welcome features of modern aviation is the increase in woman pilots and air traffic controllers. An unwelcome feature, however, will be an increase in the prevalence of breast cancer among the aviation population. Breast tumours are classically divided into four stages. Stage 1 lesions are confined to the breast. Stages 2 and 3 imply increasing numbers of involved local nodes and increasing size of the primary. Stage 4 lesions have spread to distant sites, the commonest of which is bone, and approximately a fifth of patients will develop cerebral metastases.

The certification graph for breast cancer is shown in figure 16. The calculations are based on five year survival rates of 90% (stage 1), 50% (combined stages 2 and 3) and 10% (stage 4). A 5% risk (a quarter of the post-mortem rate) of a brain metastasis being the first sign of recurrence is again the most likely cause of incapacitation, and is used to calculate the graph slopes. Breast cancer, perhaps more than any of the other tumours discussed in this chapter, can recur many years after the primary treatment. Any pilot wishing to maintain her medical certificate should be followed up long term in an oncology clinic.

### Carcinoma of the Breast

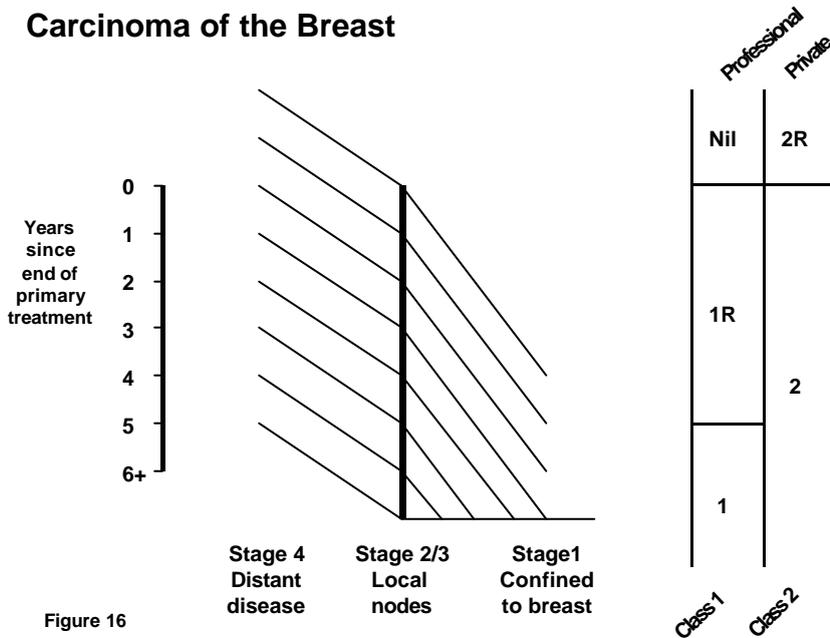


Figure 16

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## CHAPTER 18 - TROPICAL AND TRAVEL MEDICINE

### 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 - 25 %, may be caused by diseases, specific to the particular zone. Certain other types of infectious diseases are 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 chemo-prophylaxis 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 chemo-prophylaxis 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. | <b>Exposure prophylaxis</b>    | - General recommendations<br>- Protection against sun and climate<br>- Food and beverage hygiene<br>- Protection against insects |
| 2. | <b>Vaccination Prophylaxis</b> | - Active (and passive) vaccinations  |
| 3. | <b>Medical prophylaxis</b>     | - Malaria chemo-prophylaxis<br>- Prophylaxis against traveller's 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 immunization schedule**, a certain number of inoculations have to be performed, over a certain period of time. **Booster immunizations** 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 after Hartmann, P. MMW 20/2000)**

| 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.

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 after Steffen, R., von Sonnenburg, F. in W. Lang, T. Löscher, Tropenmedizin in Klinik und Praxis, 3. Auflage, 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),<br>d 1 (booster *) | Officially 6 m<br>Effective 3 – 6 m       |
| Cholera oral<br>(WC-BS)           | p.o.             | 60 - 86           | d 6 (first vaccination),<br>d 1 (booster *)  | Officially 6 m<br>Effective 3 – 6 m       |
| Cholera oral<br>(CVD-103 HgR)     | p.o.             | 13 - 100          | d 6 (first immunization),<br>d 1 (booster *) | Officially 6 m<br>Effective 3 – 6 m       |
| Diphtheria                        | i.m.             | ~ 80              | 4 w  | 5 (-10) yrs                               |
| ESME (Tick borne<br>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<br>Meningitis       | s.c.             | 70 -90            | d 7  | 1 – 3 yrs                                 |
| MMR (Measles,<br>Mumps, Rubella)  | i.m.             | 90 - 95           |  | lifelong                                  |
| Pest                              | 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)<br>d 1 (booster *) | Officially 10 yrs<br>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 after Zieger, Flug-u. Reisemed.5, 1/98)

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  
 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. note 1.  
 I.m. injection during oral anticoagulation therapy

Note 1. Under certain circumstances it may be possible where there is a real indication. The serologic control of a successful vaccination is recommended

#### 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 meningococcal 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 sardonicus, 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 tropical 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 <sup>1</sup> |                  |
|---------------------------------|-----------------------|------------------|--|------------------|
|                                 | Td or DT <sup>2</sup> | TIG <sup>3</sup> | Td or DT <sup>2</sup>                  | TIG <sup>3</sup> |
| Unknown                         | Yes                   | No               | Yes                                    | Yes              |
| 0 - 1                           | Yes                   | No               | Yes                                    | Yes              |
| 2                               | Yes                   | No               | Yes                                    | No <sup>4</sup>  |
| 3 or more                       | No <sup>5</sup>       | No               | No <sup>6</sup>                        | 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 oral-faecal 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 is usually carried out using an oral poliomyelitis vaccine (OPV, Sabin) or an inactivated poliomyelitis vaccine (IPV, Salk). 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. **The vaccination is generally recommended for all flight crew therefore**, immunizations that have been started with OPV can be completed with IPV.

#### Vaccination against Poliomyelitis

|                           |  |
|---------------------------|--|
| <b>Indication</b>         | <b>All persons with missing or incomplete basic immunization</b>   |
|                           | <b>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</b>   |
| <b>Vaccine</b>            | <b>Inactivated vaccine IPV<br/>Live vaccine OPV</b>  |
| <b>Vaccination Scheme</b> | <b>Depends on<br/>Which producer:                   - 2 x 1 ml with interval of 8 w better 6 m i.m.<br/><br/>  (IPV-Virelon®)<br/>  - 3 x 0,5 ml (0 - 4 to 8 w - 12 m) i.m.<br/>  (IPV-Mérieux®)<br/>  - 3 x 0,5 ml (0 – 4 to 8 w – 6 m) (OPV)<br/><b>(care must be taken with the interval of OPV with other live vaccines)</b></b> |
| <b>Effective Period</b>   | <b>IPV: 10 yrs (?), after that booster<br/>OPV: 10 yrs (lifelong), after that booster</b>  |
| <b>N.B.</b>               | <b>IPV: no intervals with other vaccinations required</b>  |
|                           | <b>In certain countries OPV is not used any more because of the risk of VAPP (only for containing epidemics)</b>   |
|                           | <b>Immunizations begun with OPV can be completed with IPV</b>  |

#### 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 immunization 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 / µl.). 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

|                           |  |
|---------------------------|--|
| <b>Indication</b>         | <b>Travel into infection zones</b><br><br><b>According to health regulations of certain countries for every visitor or after visits of endemic zones within the last 6 days</b>                                |
| <b>Vaccine</b>            | <b>Live Vaccine of attenuated virus of 17 D - strain</b>   |
| <b>Vaccination Scheme</b> | <i>1 x 0,5 ml sub.cut or im.</i>   |
| <b>Effectiveness</b>      | <b>Reliable, probably lifelong</b>   |
| <b>Validity</b>           | <b>As mandatory vaccination: from d<sub>10</sub> until 10yrs after vaccination</b>   |
| <b>N.B.</b>               | <b>Vaccination only by authorized vaccination centres</b><br><br><b>Intervals to be observed with other live vaccines</b><br><br><b>Care must be taken with the chicken protein allergy and HIV infection!</b> |

#### 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 faecal-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

|                            |  |
|----------------------------|--|
| <b>Indication:</b>         | <b>Wide indication, travels overseas and to the Mediterranean and Eastern Europe<br/>Patients born before 1950-1960 depending on titre of Anti-HAV</b> |
| <b>Vaccine:</b>            | <b>Inactivated vaccine (formalin activated virus)<br/>(HAVRIX®, VAQTA®, Epaxal®, HAVpur®)</b>  |
| <b>Vaccination Scheme:</b> | <b>0 - 6 (to 12) months, i.m.<br/>Immune protection starts after 2 – 4 w for 6 to 12 m</b>   |
| <b>Booster:</b>            | <b>After 10yrs</b>   |
| <b>N.B.:</b>               | <b>Testing of titre of Anti-HAV in patients born before 1950-1960</b>  |

#### 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 hepato- cellular 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

|                    |  |
|--------------------|--|
| <b>Indication:</b> | <b>long time stay, close contact to local population, adventure tours, bad hygiene</b> |
|--------------------|--|

|                            |  |          |                               |
|----------------------------|--|----------|-------------------------------|
| <b>Vaccine:</b>            | <b>Recombined vaccine (Engerix B®, Gen H-B-Vax®)</b>                           |          |                               |
| <b>Vaccination Scheme:</b> | <b>0 - 4 w - 6 (to 12) months, i.m.</b>  |          |                               |
|                            | <b>Rapid scheme d<sub>0</sub> - d<sub>7</sub> - d<sub>21</sub> - 12 m i.m.</b> |          |                               |
| <b>Booster:</b>            | <b>Depending on titre of Anti HBs</b>  |          |                               |
|                            | <b>&lt; 100 IE/ml</b>  | <b>®</b> | <b>another inoculation</b>    |
|                            | <b>&gt; 100 IE/ml</b>  | <b>®</b> | <b>booster after 10 years</b> |

#### 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 (d<sub>0</sub>, d<sub>7</sub>, d<sub>21</sub>, 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

|                            |  |
|----------------------------|--|
| <b>Indication:</b>         | <b>Travelling under simple conditions, with close contact with local population,<br/>Where there are lower standards of hygiene, stays &gt; 4 w, epidemics or catastrophes</b> |
| <b>Vaccines:</b>           | <b>- Oral live vaccine (Typhoral L®, Vivotif®)<br/>- Injectable inactivated vaccine Typherix®, TyphimVi®)</b>  |
| <b>Vaccination Scheme:</b> | <b>- Live vaccine: d<sub>1</sub>, d<sub>3</sub>, d<sub>5</sub> 1 capsule<br/>- Inactivated vaccine: a single inoculation i.m. or s.c. into deltoid muscle</b>                  |
| <b>N.B.:</b>               | <b>During vaccination with the oral live vaccine there should be no chemo-prophylaxis against Malaria or the administration of antibiotics</b>                                 |

#### 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.

Beside exposure prophylaxis, the vaccination is indicated for travel in rural basic areas and where there is close contact with the 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

|                           |   |
|---------------------------|---|
| <b>Indication</b>         | <b>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</b><br><b>Mandatory for pilgrimage to Mecca or flight crew transporting pilgrims upon entry to Saudi Arabia</b><br><b>Under certain circumstances probably required by certain countries upon entry from risk areas</b> |
| <b>Vaccine</b>            | <b>Inactivated vaccine, depending on producer</b><br><b>-Tetavalent vaccine with serotypes A, C, W 135, Y (Mencevax ACWY®)</b>  |
| <b>Vaccination Scheme</b> | <b>1 x 0,5 ml s.c.</b>  |
| <b>Effectiveness</b>      | <b>Reliable immune protection from 1 - 2 w after vaccination lasting 3yrs</b>   |
| <b>N.B.</b>               | <b>Mandatory vaccination valid from 10 d after until 3yrs after vaccination</b><br><b>No protection against serotype B (Europe, South America)</b>  |

#### 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

|                            |  |
|----------------------------|--|
| <b>Indication:</b>         | <b>Individual travels &gt;4 w in rural areas of endemic zones</b>  |
| <b>Vaccine:</b>            | <b>Inactivated vaccine with inactivated virus from mouse brain</b>   |
| <b>Vaccination Scheme:</b> | <b>1 ml s.c on days 0 - 7 - 28<br/>An alternative rapid scheme at days: 0 – 7 - 14<br/>A booster after 1 – 2 years</b> |
| <b>Effective period:</b>   | <b>4 years</b>   |
| <b>Side effects:</b>       | <b>local at site of inoculation (rare).</b>  |

#### 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.

The causative agents are different serovars of Vibrio Cholerae. The disease is characterized by diarrhoea with vomiting. 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, which are not licensed in several countries, are well tolerated and effective over a period of 6 to 12 months. Indications are for journeys under basic conditions with a high infection risk. This does not apply to flight crew. The best protection against cholera is appropriate food and beverage hygiene.

#### 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 forest 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.

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 FSME 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.

#### **Vaccination against Tick Born Encephalitis**

|                            |   |
|----------------------------|---|
| <b>Indication:</b>         | <b>Repeated, long-term or occupational stays in forest areas of endemic areas (Or living in rural areas of endemic zones)</b>   |
| <b>Vaccine:</b>            | <b>Inactivated vaccine with inactivated virus</b>   |
| <b>Vaccination Scheme:</b> | <b>3 x 0,5 ml i.m. , 0 - 1 to 3 m - 9 to 12 m<br/>Booster after 3 to 5 years<br/>Alternative rapid scheme d<sub>0</sub>, d<sub>7</sub>, d<sub>21</sub><br/>Booster after 1 year</b> |
| <b>Effectiveness:</b>      | <b>Sero-conversion in 99 %, protection rate 60 to 70 %</b>  |
| <b>N.B.:</b>               | <b>If applicable active or passive immunization (hyper-immuno-globulin) is possible up to 96 hr after tick bite (not suitable for children)</b>                                     |

#### **4.2.14 Vaccination Schemes for Flight Crews**

##### **Vaccination Schemes for Flight Crews: Recommended Vaccinations**

| <b>Missions in Europe and North America</b> |                          |
|---|--------------------------|
| Generally recommended vaccinations          | Tetanus                  |
|   | Diphtheria               |
|   | Poliomyelitis            |
|   | Hepatitis A <sup>1</sup> |

<sup>1</sup> if operating to Mediterranean destinations or Eastern Europe

| <b>Missions in Tropical and subtropical Zones</b>    |   |
|--|---|
| Generally recommended vaccinations                   | Tetanus   |
|  | Diphtheria  |
|  | Poliomyelitis   |
|  | Hepatitis A   |
| Additionally recommended vaccinations                | Yellow Fever <sup>3</sup>                                 |
| Recommended under certain circumstances <sup>2</sup> | Meningitis <sup>4</sup>                                   |
|  | Typhoid Fever   |
|  | Hepatitis B   |
| Malaria prophylaxis                                  | Exposure prophylaxis                                      |
|  | Chemoprophylaxis <sup>5</sup>                             |
|  | Making sure of early diagnosis and treatment <sup>6</sup> |

<sup>2</sup> 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

<sup>3</sup> Mandatory upon entry into certain countries, mandatory upon entry in to certain other countries after having visited endemic zones

<sup>4</sup> Mandatory upon entry into Saudi Arabia, especially if transporting pilgrims, the tetravalent vaccine has to be used and is recommended otherwise, too

<sup>5</sup> 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

<sup>6</sup> 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

| <b>Causative agent</b> | <b>Type of malaria</b> | <b>Incubation Period</b>                | <b>Type of Fever</b>    | <b>Prognosis</b>                |
|------------------------|------------------------|---|-------------------------|---------------------------------|
| <b>Pl. malariae</b>    | Malaria quartan        | 16 – 50 (longer possible)               | Fever attacks every 3 d | No spontaneous recovery         |
| <b>Pl. vivax</b>       | Malaria tertian        | 12 - 20 d (up to 10 months. possible)   | Fever attacks every 2 d | Spontaneous recovery possible   |
| <b>Pl. ovale</b>       | Malaria tertian        | 12 – 20 d (longer periods are possible) | Fever attacks every 2 d | Spontaneous recovery possible   |
| <b>Pl. falciparum</b>  | 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). This all 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. Local Area prevention 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 or 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 for the same reason.

### 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®)** has to be started only the day before entering the malaria risk area and **is recommended instead.**

#### a) Chloroquine (e.g. Resochin®) + Proguanil (e.g. Paludrine®)

The effectiveness of this combination of two anti-malarial medications is only about 60 % (West Africa) and should not be recommended any more 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. 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.

### Chloroquin + Proguanil (e.g. Resochin® + 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 (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) Atovaquone + Proguanil (Malarone®)**

**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 intracranial pressure. **Contraindications** are children < 8yrs, severe liver disorders.

**Doxycycline (several brand names)**

**Content:** - 100 mg Doxycycline  
**Intake:** - 1Tbl. / d, starting 1 to 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.

### 5.1.3 Standby Emergency Treatment

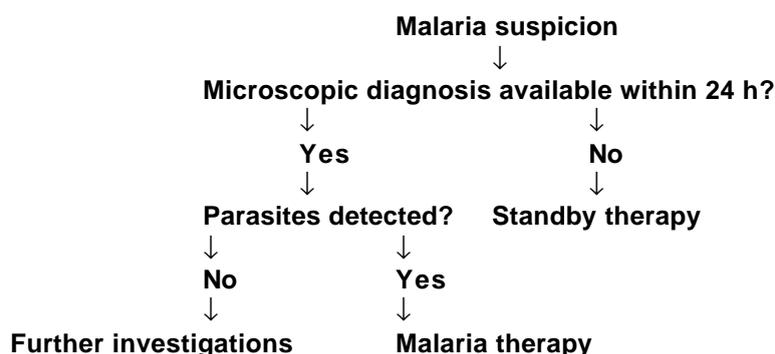
In Standby Emergency Treatment patients take an anti-malarial with them. This should be used if symptoms suspicious of malaria (e.g. fever > 38,5 °C, pain in the head and limbs, nausea and malaise) should occur, at least one week after having entered a risk area. Standby Emergency treatment can be recommended 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 drug as therapy, flight crew are not fit for flying duties for four weeks.**

#### Procedure if malaria is suspected

##### Requirements:

symptoms suspicious of malaria  
Stay in risk area for at least 7 d  
No doctor available for next 24 h



\*If applicable microscopic investigations have to be repeated every 6 h or in fever attacks

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.

**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 <i>P. vivax</i> areas only<br>Mefloquine<br>Quinine<br>Artemether/Lumefantrine <sup>a</sup><br>Atovaquone/Proguanil <sup>a</sup> |
| Chloroquine alone / with Proguanil | Mefloquine<br>Quinine   |
| Mefloquine                         | Quinine <sup>b</sup><br>Quinine + Doxycycline/Tetracycline for 7 d <sup>b</sup>   |
| Doxycycline                        | Mefloquine<br>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**

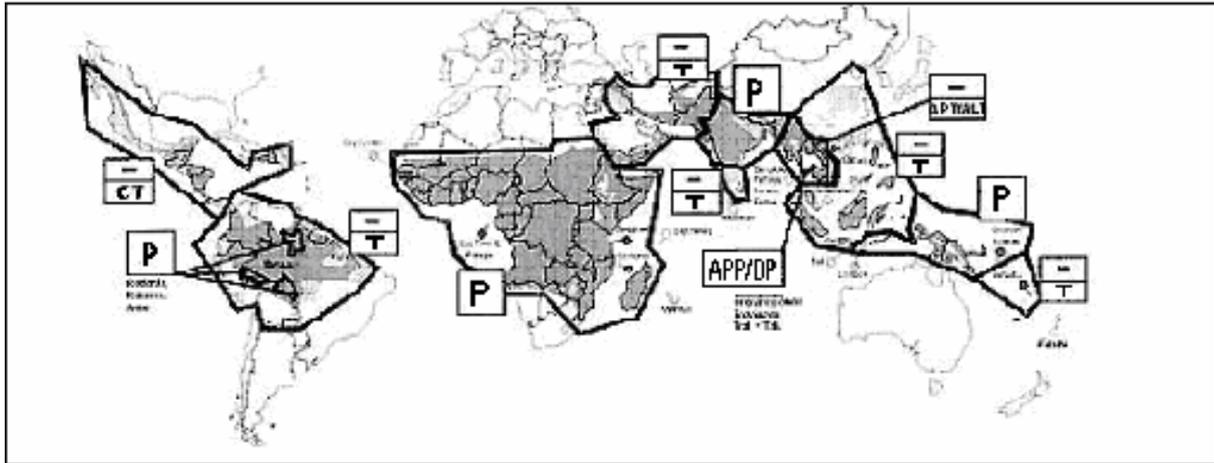
|                      | Mefloquin (Lariam®) (Tbl. à 250 mg)                              | Atovaquon/Proguanil (Malarone®) (Tbl. à 250 mg/100 mg) | Artemether/Lumefantrin (Riamet®) (Tbl. à 20 mg/120 mg) | Chloroquine (Resochin®) (Tbl. à 150 mg)      |
|----------------------|--|--|--|--|
| <b>d<sub>1</sub></b> | Initially 3 Tbl.<br>After 6 – 8 h 2 Tbl.<br>After 6 – 8 h 1 Tbl. | Initially 4 Tbl.                                       | Initially 4 Tbl.<br>After 8 h 4 Tbl.                   | Initially 4 Tbl.<br>After 6 h 2 Tbl.         |
| <b>d<sub>2</sub></b> | -  | 4 Tbl.   | 2 x 4 Tbl.   | 2 Tbl.                                       |
| <b>d<sub>3</sub></b> | -  | 4 Tbl.   | 2 x 4 Tbl.   | 2 Tbl.                                       |
| <b>Area</b>          | All malaria areas  | All malaria areas                                      | All malaria areas                                      | Only in areas without chloroquine resistance |

**Guidelines for Standby Emergency Treatment (International Travel and Health (2004), WHO, Geneva)**

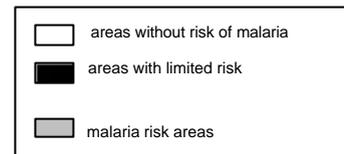
- Consult a physician immediately if fever occurs 1 week or more after entering an area with malaria risk.
- If it is impossible to consult a physician and/or establish a diagnosis within 24 hours of the onset of fever, start the stand-by emergency treatment and seek medical care as soon as possible 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 drug. 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 drug 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 2003, and SAR and DTG)



- 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)

| Geographic Region  | Prophylaxis          |
|--|----------------------|
| Tropical Africa, Eastern Indonesia, Papua-New Guinea, Salomon Islands, Amazonian-Provinces | P                    |
| Indian Subcontinent north of line, Goa-Madras  | P                    |
| Thailand (Provinces Trat and Tak)  | 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, June 2001)

1. **Information about malaria risk.**
2. **Pregnant women and children under 5 years should abstain from stays in risk areas.**
3. **Information about local area 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 *Plasmodium 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. This has to be repeated every 6 hours for 24 hours. 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. 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 Traveller's diarrhoea

Traveller's 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 faecal-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 traveller's 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 (H<sub>2</sub>-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 traveller's 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®, Rehdtrat, 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 traveller's diarrhoea

| Disease  | Therapeutic Options  |
|--|--|
| Diarrhoea without knowledge of the causative agent (calculated antibiosis) | Ciprofloxazin 2 x 500 mg/24 h for 3 – 5 days<br>Norfloxazin 2 x 400 mg/24 h for 3 – 5 days<br>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<br>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<br>Norfloxazin 2 x 400 mg/24 h for 3 – 5 days<br>Ofloxazin 2 x 200 mg/24 h for 3 – 5 days |
| Campylobacter  | Azithromycin 1 x 500 mg for 3 days<br>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 traveller's 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 one's 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 been 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 faecal-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 <i>E. dispar</i>  |
| - Positive serology ? PCR / Zymodeme to differentiate <i>E. dispar</i> / <i>E. histolytica</i>                           |
| - Symptomatic excretion of cysts ? serology and PCR / Zymodeme to differentiate <i>E. dispar</i> / <i>E. histolytica</i> |

**Amoebic liver abscess** is diagnosed by ultrasound (CT or NMR), supplemented by serology.

### 6.2.3 Therapy

#### Therapy of amoebiasis ( 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               |
|                       | Severe cases additionally Chloroquine | Initially 600 mg p.o.<br>Then 300 mg p.o. | 2 days<br>2 - 3 weeks |

In invasive amoebiasis, a luminal infection is present as well and should be treated with diloxanidfuroat (available in the U.K.). 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 should 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

|  |
|--|
| 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

|                         |
|-------------------------|
| Amoebiasis              |
| Giardiasis              |
| Shigellosis             |
| Enteric Salmonellosis   |
| Campylobacter Enteritis |

## Differential Diagnosis of Exanthema and other skin conditions

|                         |
|-------------------------|
| 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. Great care must be taken when handling any fish dead or alive. 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   |
|--------------------------------------|--|---------------------------------------|---|
| <b>African Tick Typhus</b>           |  |                                       | See Rickettsial Diseases  |
| <b>African Trypanosomiasis</b>       |  |                                       | See Trypanosomiasis   |
| <b>AIDS</b>                          |  |                                       | See HIV   |
| <b>American Trypanosomiasis</b>      |  |                                       | See Chagas Disease  |
| <b>Amoebiasis</b>                    | 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              |
| <b>Anaemia</b>                       | HK < 32 %  | unfit                                 |   |
| <b>Ancylostoma duodenale</b>         |  |                                       | See Helminthic Diseases   |
| <b>Angiostrongyliasis</b>            |  |                                       | See Helminthic Diseases   |
| <b>Anthrax</b>                       | All forms of disease                                   | 2 w after therapy and full recovery   | No spores or vegetative forms of B. anthracis in bacteriologic studies  |
| <b>Antibiotics</b>                   |  | Until cessation of therapy            |   |
| <b>Arboviral Encephalitis</b>        |  | 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 |
| <b>Arbovirus Fever</b>               | 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   |   |
| <b>Argentinian Hemorrhagic Fever</b> |  |                                       | See Haemorrhagic Fever  |
| <b>Ascariasis</b>                    |  |                                       | See Helminthic Diseases   |
| <b>Aspergillosis</b>                 |  |                                       | See Fungal Pulmonary Infections   |
| <b>Bacillus anthracis</b>            |  |                                       | See Anthrax   |
| <b>Bacterial Meningitis</b>          |  |                                       | See Meningitis  |

| Disease                           | Condition   | Period of Unfitness                 | Notes  |
|-----------------------------------|---|-------------------------------------|--|
| <b>Balantidium coli</b>           | Asymptomatic Infection  | No restriction                      |  |
|                                   | Symptomatic infection   | After therapy and full recovery     |  |
| <b>Bartonella henselae</b>        |   |                                     | See Cat Scratch Disease  |
| <b>Bartonella bacilliformis</b>   | Oroya Fever   |                                     | See Bartonellosis  |
|                                   | Verruga peruana   |                                     | See Bartonellosis  |
| <b>Bartonellosis</b>              | 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                      |  |
| <b>Beta Thalassaemia</b>          |   |                                     | See Thalassaemia   |
| <b>Blastocystis hominis</b>       | Asymptomatic Infection  | No restriction                      |  |
|                                   | Symptomatic infection   | Until therapy and full recovery     |  |
| <b>Blastomycosis</b>              |   |                                     | See Fungal Pulmonary Infections  |
| <b>Bolivian Hemorrhagic Fever</b> |   |                                     | See Hemorrhagic Fever  |
| <b>Borreliosis</b>                | <b>Lyme Disease</b> , skin, joint and peripheral enurologic manifestation | Until therapy and full recovery     | Individual assessment by serodiagnostic  |
|                                   | <b>Lyme Disease</b> , cardiac manifestation                               | Until therapy and full recovery     | Echocardiogram must demonstrate normal contraction and ejection and 24 h ECG must demonstrate absence of significant arrhythmias |
|                                   | <b>Lyme Disease</b> , 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                                   |
| <b>Burkholderia</b>               |   |                                     | See Melioidosis  |
| <b>Buruli Ulcer</b>               |   | No restriction                      | Normal function of limbs, sufficient local therapy and sufficient hygienic conditions  |
| <b>Campylobacter</b>              |   |                                     | See Travel Diarrhoea   |
| <b>Carrion Disease</b>            | Oroya Fever   |                                     | See Bartonellosis  |
|                                   | Verruga peruana   |                                     | See Bartonellosis  |
| <b>Cat scratch Disease</b>        |   |                                     | See Bartonellosis  |

| <b>Disease</b>                                 | <b>Condition</b>                              | <b>Period of Unfitness</b>          | <b>Notes</b>   |
|--|---|-------------------------------------|--|
| <b>Chagas Disease</b>                          | 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) |
| <b>Chicungunya (CHIK)</b>                      |   |                                     | See Arbovirus Fever  |
| <b>CHIK Virus</b>                              | Chicungunya (CHIK)                            |                                     | See Arbovirus Fever  |
| <b>Cholera</b>                                 |   | 2 w after therapy and full recovery |  |
| <b>Ciguatera</b>                               |   |                                     | See Seafood Toxins   |
| <b>Clonorchis sinensis</b>                     |   |                                     | See Helminthic Diseases  |
| <b>Clostridium perfringens</b>                 |   |                                     | See Travel Diarrhoea<br>See Gas Gangrene   |
| <b>Clostridium tetani</b>                      |   |                                     | See Tetanus  |
| <b>Coccidioides immitis</b>                    |   |                                     | See Fungal Pulmonary Infections  |
| <b>Coxiella burneti</b>                        |   |                                     | See Rickettsial Diseases   |
| <b>Creeping eruption</b>                       |   | No restriction                      |  |
| <b>Crimean Congo Haemorrhagic Fever</b>        |   |                                     | See Haemorrhagic Fever   |
| <b>Cryptococcus</b>                            |   | Unfit                               | Infection is sign for impaired immunity in HIV Infection   |
| <b>Cryptosporidium parvum</b>                  | Unspecific Diarrhoea                          |                                     | See Travel Diarrhoea   |
|  | In HIV Patients                               | Unfit                               | Infection is sign for impaired immunity in HIV Infection   |
| <b>Cutaneous Leishmaniasis</b>                 |   |                                     | In case of absence of functional sequelae (i.e. no restriction of joint movement by scar formation etc.)   |
| <b>Cyclosporida</b>                            |   |                                     | See Travel Diarrhoea   |
| <b>Cysticercosis</b>                           |   |                                     | See Helminthic Diseases  |
| <b>Cytomegalia (CMV-Infection)</b>             | Mostly asymptomatic in immuno-competent hosts | No restriction                      |  |
|  | In HIV Patients                               | Unfit                               | Infection is sign for impaired immunity in HIV Infection   |
| <b>Dengue Virus</b>                            | 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 |  |
| <b>Dracunculus medinensis</b>                  |   |                                     | See Helminthic Diseases  |
| <b>East American Equine Encephalitis (EEE)</b> |   |                                     | See Arboviral Encephalitis   |

| Disease  | Condition                               | Period of Unfitness                         | Notes   |
|--|---|---|---|
| <b>Ebola Virus.</b>  |   |   | See Hemorrhagic Fever   |
| <b>Ebstein Barr Virus (EBV)</b>                                |   |   | See Mononucleosis   |
| <b>Echinococcus</b>  |   |   | See Helminthic Diseases   |
| <b>EEE Virus</b>   | East American Equine Encephalitis (EEE) |   | See Arboviral Encephalitis  |
| <b>Ehrlichiosis</b>  |   |   | See Rickettsial Diseases  |
| <b>Encephalitis</b>  |   | 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 |
| <b>Endemic Syphilis</b>  | Early Lesions                           | 2 w after therapy and full recovery         |   |
|  | Late Lesions                            | Unfit                                       | Unless rendered fit by AMS  |
| <b>Entamoeba histolytica</b>                                   |   |   | See Amoebiasis  |
| <b>Enterobius vermicularis</b>                                 |   |   | See Helminthic Diseases   |
| <b>Epidemic Polyarthrits</b>                                   |   |   | See Arbovirus Fever   |
| <b>Epizoonosis</b>   |   | Unfit until infestation has been eradicated |   |
| <b>Escherichia coli</b>  |   |   | See Travel Diarrhoea  |
| <b>Falciparum Malaria</b>                                      |   |   | See Malaria   |
| <b>Fasciola</b>  |   |   | See Helminthic Diseases   |
| <b>Fasciolopsis buski</b>                                      |   |   | See Helminthic Diseases   |
| <b>Fièvre Boutonneuse</b>                                      |   |   | See Rickettsial Diseases  |
| <b>Filariasis</b>  |   |   | See Helminthic Diseases   |
| <b>Fleas</b>   |   |   | See Epizoonosis   |
| <b>Framboesia</b>  |   |   | See Yaws  |
| <b>Fungal Skin Infections</b>                                  |   | No restriction                              |   |
| <b>Fungal Pulmonary Infections, Systemic Fungal Infections</b> | 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)                             |
| <b>Gas Gangrene</b>  | Clostridial Myositis                    | 4 w after therapy and full recovery         |   |
| <b>Giardiasis</b>  | Asymptomatic Disease                    | No restriction                              |   |
|  | Symptomatic Disease                     | Until therapy and full recovery             |   |

| <b>Disease</b>                                      | <b>Condition</b>                   | <b>Period of Unfitness</b>          | <b>Notes</b>   |
|---|------------------------------------|-------------------------------------|--|
| <b>Glucose-6-phosphate dehydrogenase deficiency</b> |                                    | 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 <b>no missions to the tropics</b> |
| <b>Gonorrhoea</b>                                   |                                    | Until therapy and full recovery     |  |
| <b>Granuloma inguinale</b>                          |                                    | Until therapy and full recovery     |  |
| <b>Guanarito Virus</b>                              | Venezuelan Haemorrhagic Fever      |                                     | See Haemorrhagic Fever   |
| <b>Haemorrhagic Fever</b>                           |                                    | 4 w after therapy and full recovery | Successful recovery has to be proved by meticulous clinical and laboratory examination, 24h ECG and echocardiography   |
| <b>Hantavirus Haemorrhagic Fever</b>                |                                    |                                     | See Haemorrhagic Fever   |
| <b>Helminthic infections</b>                        | 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  |
| <b>Hemoglobin, abnormal, Hemoglobin Disorder</b>    | Homocytotic                        | Unfit                               |  |
|   | Heterocytotic                      | No restriction                      | HK < 32 %  |
| <b>Hepatitis</b>                                    | Hepatitis A                        | After therapy and full recovery     |  |
|   | Hepatitis B acute                  | After therapy and full recovery     |  |

| <b>Disease</b>                | <b>Condition</b>             | <b>Period of Unfitness</b>          | <b>Notes</b>   |
|-------------------------------|------------------------------|-------------------------------------|--|
|                               | 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   |
| <b>Histoplasma capsulatum</b> |                              |                                     | See Fungal Pulmonary Infections  |
| <b>HIV</b>                    |                              | Unfit                               | Unless assessed fit by AMS   |
| <b>Hookworm</b>               |                              |                                     | See Helminthic Diseases  |
| <b>Hydatid Disease</b>        |                              |                                     | See Helminthic Diseases  |
| <b>Hymenolepis nana</b>       |                              |                                     | See Helminthic Diseases  |
| <b>Immunization</b>           |                              |                                     | See Vaccination  |
| <b>Influenza</b>              |                              | Unfit until full recovery           |  |
| <b>Intestinal Flukes</b>      |                              |                                     | See Helminthic Diseases  |
| <b>Invasive Salmonellosis</b> |                              |                                     | See Typhoid Fever  |
| <b>Ippy Virus</b>             |                              |                                     | See Haemorrhagic Fever   |
| <b>Isospora belli</b>         |                              |                                     | See Travel Diarrhea  |
| <b>Japanese Encephalitis</b>  |                              | 4 w after therapy and full recovery |  |
| <b>Junin Virus</b>            | Argentine Haemorrhagic Fever |                                     | See Haemorrhagic Fever   |
| <b>Kala Azar</b>              | Visceral Leishmaniasis       | 4 w after therapy and full recovery |  |

| Disease                     | Condition                   | Period of Unfitness                       | Notes  |
|-----------------------------|-----------------------------|---|--|
| 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 pneumophilia     | 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  |
| 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                                       |  |

| Disease                                 | Condition   | Period of Unfitness                 | Notes   |
|---|---|-------------------------------------|---|
|   | 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/Lumefantrin | 4 w                                 |   |
| <b>Marburg Fever</b>                    |   |                                     | See Haemorrhagic Fever  |
| <b>Marburg Virus</b>                    |   |                                     | See Haemorrhagic Fever  |
| <b>Measles</b>                          |   | Until full recovery                 | Infectious until 2 d after onset of exanthema   |
| <b>Melioidosis</b>                      |   | Until full recovery                 |   |
| <b>Meningitis</b>                       |   | 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 |
| <b>Meningococci</b>                     |   |                                     | See Meningitis  |
| <b>Microsporidia</b>                    | Unspecific Diarrhea   |                                     | See Travel Diarrhoea  |
|   | In HIV Patients   | Unfit                               | Infection is sign for impaired immunity in HIV Infection  |
| <b>Mites</b>                            |   |                                     | See Epizoonosis   |
| <b>Mite Typhus</b>                      |   |                                     | See Rickettsial Diseases  |
| <b>Monkey Pox</b>                       |   | 4 w after therapy and full recovery | Extended ophthalmological examination must be normal  |
| <b>Mononucleosis</b>                    |   | 2 w after therapy and full recovery | Normal size of spleen (Ultrasound)  |
| <b>Mopeia Virus</b>                     |   |                                     | See Haemorrhagic Fever  |
| <b>Mucocutaneous Leishmaniasis</b>      |   | No restriction                      | In case of absence of functional sequelae   |
| <b>Mucosal Leishmaniasis</b>            |   |                                     | See Mucocutaneous Leishmaniasis   |
| <b>Murray Valley Encephalitis (MVE)</b> |   |                                     | See Arboviral Encephalitis  |
| <b>Murine Typhus</b>                    |   |                                     | See Rickettsial Diseases  |
| <b>MVE Virus</b>                        | Murray Valley Encephalitis (MVE)  |                                     | See Arboviral Encephalitis  |
| <b>Mycobacterium leprae</b>             |   |                                     | See Leprosy   |
| <b>Mycobacterium tuberculosis</b>       |   |                                     | See Tuberculosis  |
| <b>Mycobacterium bovis</b>              |   |                                     | See Tuberculosis  |
| <b>Mycobacterium ulcerans</b>           |   |                                     | See Buruli Ulcer  |
| <b>Myiasis</b>                          | Facial Manifestations   |                                     | Normal extended ophthalmological and ORL examination  |
| <b>Necator americanus</b>               |   |                                     | See Helminthic Diseases   |
| <b>Neisseria gonorrhoeae</b>            |   |                                     | See Gonorrhoea  |

| Disease                              | Condition                                 | Period of Unfitness                 | Notes                           |
|--------------------------------------|---|-------------------------------------|---------------------------------|
| <b>Neisseria meningitidis</b>        |   |                                     | See Meningitis                  |
| <b>Neurosyphilis</b>                 |   |                                     | See Syphilis                    |
| <b>Non-Veneral Treponematosi</b>     | Endemic Syphilis                          |                                     | See Endemic Syphilis            |
|                                      | Pinta                                     | 2 w after therapy and full recovery |                                 |
|                                      | Yaws                                      |                                     | See Yaws                        |
| <b>Norwalk Virus</b>                 |   |                                     | See Travel Diarrhoea            |
| <b>Ocular Toxocariasi</b>            |   | Unfit                               | Unless rendered fit by AMS      |
| <b>Old World Tick Typhus</b>         |   |                                     | See Rickettsial Diseases        |
| <b>Onchocerca volvulus</b>           |   |                                     | See Onchocerciasis              |
| <b>Onchocerciasis</b>                | Cutaneous and subcutaneous manifestations | Until full recovery                 |                                 |
|                                      | Ocular manifestation                      | Unfit                               | Unless assessed fit by AMS      |
| <b>ONN Virus</b>                     | O'Nyong Nyong (ONN)                       |                                     | See Arbovirus Fever             |
| <b>O'Nyong Nyong (ONN)</b>           |   |                                     | See Arbovirus Fever             |
| <b>Opisthorchiasis</b>               |   |                                     | See Helminthic Diseases         |
| <b>Opisthorchis</b>                  |   |                                     | See Helminthic Diseases         |
| <b>Opisthorchis felinus</b>          |   |                                     | See Helminthic Diseases         |
| <b>Opisthorchis guayaquilensis</b>   |   |                                     | See Helminthic Diseases         |
| <b>Opisthorchis sinensis</b>         |   |                                     | See Helminthic Diseases         |
| <b>Opisthorchis viverrini</b>        |   |                                     | See Helminthic Diseases         |
| <b>Oropouche Fever</b>               |   |                                     | See Arbovirus Fever             |
| <b>Oropouche (ORO) Virus</b>         | Oropouche Fever                           |                                     | See Arbovirus Fever             |
| <b>Oroya Fever</b>                   |   |                                     | See Bartonellosis               |
| <b>Pappataci Fever</b>               | Sandfly (SF) Fever, Phlebotomus Fever     |                                     | See Arbovirus Fever             |
| <b>Paracoccidioides brasiliensis</b> |   |                                     | See Fungal Pulmonary Infections |
| <b>Paracoccidioidomycosis</b>        |   |                                     | See Fungal Pulmonary Infections |
| <b>Paralytic Shellfish Poisoning</b> |   |                                     | See Seafood Toxins              |
| <b>Pediculosis pubis</b>             |   |                                     | See Epizoonosis                 |
| <b>Pediculosis capitis</b>           |   |                                     | See Epizoonosis                 |
| <b>Phthirus pubis</b>                |   |                                     | See Epizoonosis                 |
| <b>Pinta</b>                         |   |                                     | See Non-Veneral Treponematosi   |
| <b>Pinworm</b>                       |   |                                     | See Helminthic Diseases         |
| <b>Phlebotomus Fever</b>             | Sandfly (SF) Fever, Pappataci Fever       |                                     | See Arbovirus Fever             |
| <b>Plague</b>                        | Bubonic Plague                            | 2 w after therapy and full recovery |                                 |
|                                      | Pulmonary Plague                          | 4 w after therapy and full recovery |                                 |
| <b>Plasmodium falciparum</b>         |   |                                     | See Malaria                     |
| <b>Plasmodium malariae</b>           |   |                                     | See Malaria                     |
| <b>Plasmodium ovale</b>              |   |                                     | See Malaria                     |
| <b>Plasmodium vivax</b>              |   |                                     | See Malaria                     |

| Disease                            | Condition  | Period of Unfitness                 | Notes   |
|------------------------------------|--|-------------------------------------|---|
| <b>Pneumocystis carinii</b>        |  | Unfit                               | Opportunistic Infection in HIV Infection      |
| <b>Pneumonia</b>                   |  | 2 w after therapy and recovery      |   |
| <b>Pneumonic Plague</b>            |  |                                     | See Plague                                    |
| <b>Poliomyelitis</b>               |  | 4 w after therapy and full recovery |   |
| <b>Pork Tape Worm</b>              |  |                                     | See Helminthic Diseases                       |
| <b>Postvaccinal Encephalitis</b>   |  |                                     | See Encephalitis                              |
| <b>Pubic Lice</b>                  |  |                                     | See Epizoonosis                               |
| <b>Pyomyositis</b>                 |  |                                     | See Tropical Pyomyositis                      |
| <b>Q-Fever</b>                     |  |                                     | See Rickettsial Diseases                      |
| <b>Rabies</b>                      |  | Unfit                               |   |
| <b>Relapsing Fever</b>             |  |                                     | See Borreliosis                               |
| <b>Rhabdomyolysis</b>              |  | Unfit                               | Until renal function has been normalized      |
| <b>Rhodesian Sleeping Sickness</b> |  |                                     | See Trypanosomiasis                           |
| <b>Rickettsia</b>                  |  |                                     | See Rickettsial Diseases                      |
| <b>Rickettsial Diseases</b>        | Epidemic Typhus (Louse Borne Typhus)   | 4 w after therapy and full recovery |   |
|                                    | Endemic Typhus (Murine Typhus)   | 4 w after therapy and full recovery |   |
|                                    | <i>Tick Typhus (Spotted Fever)</i><br>American Tick Typhus<br>Old World Tick Typhus<br>Rickettsial Pox | 2 w after therapy and full recovery |   |
|                                    | Mite Typhus (Scrub Typhus)   | 4 w after therapy and full recovery |   |
| <b>Rickettsialpox</b>              |  |                                     | See Rickettsial Diseases                      |
| <b>Rift Valley Fever</b>           |  |                                     | See Haemorrhagic Fever                        |
| <b>Ross River Fever (RR)</b>       | Epidemic Polyarthritis   |                                     | See Arbovirus Fever                           |
| <b>Rota Virus</b>                  |  |                                     | See Travel Diarrhoea                          |
| <b>RR Virus</b>                    | Ross River Fever (RR),<br>Epidemic Polyarthritis   |                                     | See Arbovirus Fever                           |
| <b>Rubella</b>                     |  | Until full recovery                 | Infectious until 2 w after onset of exanthema |
| <b>Salmonella</b>                  |  |                                     | See Travel Diarrhoea                          |
| <b>Salmonella enteritidis</b>      |  |                                     | See Travel Diarrhoea                          |
| <b>Salmonella Enterocolitis</b>    |  |                                     | See Travel Diarrhoea                          |
| <b>Salmonella paratyphi</b>        |  |                                     | See Typhoid Fever                             |
| <b>Salmonella typhi</b>            |  |                                     | See Typhoid Fever                             |
| <b>Salmonella typhimurium</b>      |  |                                     | See Travel Diarrhoea                          |
| <b>Sarcoptes scabiei</b>           |  |                                     | See Epizoonosis                               |
| <b>Scabies</b>                     |  |                                     | See Epizoonosis                               |
| <b>Schistosoma</b>                 |  |                                     | See Schistosomiasis                           |
| <b>Schistosoma haematobium</b>     |  |                                     | See Schistosomiasis                           |

| Disease                             | Condition                    | Period of Unfitness                 | Notes   |
|-------------------------------------|------------------------------|-------------------------------------|---|
| <b>Schistosoma intercalatum</b>     |                              |                                     | See Schistosomiasis   |
| <b>Schistosoma japonicum</b>        |                              |                                     | See Schistosomiasis   |
| <b>Schistosoma mansoni</b>          |                              |                                     | See Schistosomiasis   |
| <b>Schistosoma mekongi</b>          |                              |                                     | See Schistosomiasis   |
| <b>Schistosomiasis</b>              | CNS Schistosomiasis          | Unfit                               | Unless rendered fit by AMS  |
|                                     | Hepatoportal Schistosomiasis | Unfit                               | Unless rendered fit by AMS  |
|                                     | Intestinal Schistosomiasis   | After therapy and full recovery     | In case of absence of complications like rectal prolapsed or intersusception        |
|                                     | 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   |
| <b>Scrub Typhus</b>                 |                              |                                     | See Rickettsial Diseases  |
| <b>Seafood Toxins</b>               |                              | 2 w after therapy and full recovery | Absence of neurologic sequelae  |
| <b>Shigella</b>                     |                              |                                     | See Travel Diarrhoea  |
| <b>Shingles</b>                     |                              |                                     | See Varizella Zoster Virus  |
| <b>SLE Virus</b>                    | St. Louis Encephalitis (SLE) |                                     | See Arboviral Encephalitis  |
| <b>Sleeping Sickness</b>            |                              |                                     | See Trypanosomiasis   |
| <b>Snake Bite</b>                   |                              | Unfit                               | Unless any neurological, cardiac and haematological complication has been ruled out |
| <b>Splenomegaly</b>                 |                              | Unfit                               | Unless only slightly enlarged with no danger of rupture                             |
| <b>Spotted Fever</b>                |                              |                                     | See Rickettsial Diseases  |
| <b>St. Louis Encephalitis (SLE)</b> |                              |                                     | See Arboviral Encephalitis  |
| <b>Strongyloides stercoralis</b>    |                              |                                     | See Helminthic diseases   |
| <b>Syphilis</b>                     |                              | Unfit                               | Unless rendered fit by AMS in stage I or II   |
| <b>Systemic Fungal Infections</b>   |                              |                                     | See Fungal Pulmonary Infections   |
| <b>Taenia saginata</b>              |                              |                                     | See Helminthic diseases   |
| <b>Taenia solium</b>                |                              |                                     | See Helminthic diseases   |
| <b>Tana Pox</b>                     |                              | 2 w after therapy and full recovery |   |
| <b>Tapeworms</b>                    |                              |                                     | See Helminthic diseases   |
| <b>Tetrodotoxin Poisoning</b>       |                              |                                     | See Seafood Toxins  |
| <b>Thalassaemia</b>                 | Beta-Thalassaemia maior      | Unfit                               |   |
|                                     | Beta-Thalassaemia minor      | No restriction                      | HKT > 32 %  |

| Disease  | Condition   | Period of Unfitness                                      | Notes  |
|--|---|--|--|
|  | Alfa-Thalassaemia maior                           | Unfit  |  |
|  | Alfa-Thalassaemia minor                           | No restriction   | HKT > 32 %   |
| <b>Threadworm</b>                              |   |  | See Helminthic diseases  |
| <b>Tick Borne relapsing Fever</b>              |   |  | See Relapsing Fever  |
| <b>Tick Typhus</b>                             |   |  | Seen Rickettsial Diseases  |
| <b>Toxocara cani</b>                           |   |  | See Heminthic Diseases   |
| <b>Toxocara cati</b>                           |   |  | See Heminthic Diseases   |
| <b>Toxocariasis</b>                            |   |  | See Heminthic Diseases   |
| <b>Toxoplasma gondii</b>                       |   |  | See Toxoplasmosis  |
| <b>Toxoplasmosis</b>                           | 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   |
| <b>Travel Diarrhea</b>                         |   | Until full recovery                                      |  |
| <b>Traveller´s Diarrhea</b>                    |   |  | See Travel Diarrhoea   |
| <b>Trench Fever</b>                            |   |  | See Rickettsial Diseases   |
| <b>Treponema pallidum</b>                      | Syphilis  |  | See Syphilis   |
| <b>Treponema pallidum subspecies endemicum</b> | Endemic Syphilis                                  |  | See Endemic Syphilis   |
| <b>Treponema pallidum subspecies pertenue</b>  | Yaws  |  | See Yaws   |
| <b>Treponema pallidum subspecies carateum</b>  | Pinta   |  | See Non-Venereal Treponematosis  |
| <b>Trichuris trichiura</b>                     |   |  | See Helminthic Diseases  |
| <b>Trichuris trichuria</b>                     |   |  | See Helminthic Diseases  |
| <b>Tropical Pyomyositis</b>                    |   | 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.) |
| <b>Tropical Splenomegaly Syndrome</b>          |   |  | See Splenomegaly   |
| <b>Tropical Sprue</b>                          |   | After successful therapy, substitution and full recovery |  |
| <b>Tropical Ulcer</b>                          |   | No restriction   | If local therapy can be performed and hygienic conditions are sufficient                                 |
| <b>Trypanosoma brucei</b>                      |   |  | See Trypanosomiasis  |
| <b>Trypanosoma brucei gambiense</b>            |   |  | See Trypanosomiasis  |
| <b>Trypanosoma brucei rhodesiense</b>          |   |  | See Trypanosomiasis  |
| <b>Trypanosoma cruzi</b>                       |   |  | See Chagas Disease   |

| Disease                                  | Condition                               | Period of Unfitness                 | Notes   |
|--|---|-------------------------------------|---|
| 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 |
| <b>Tunga penetrans</b>                   |   |                                     | See tungiasis   |
| <b>Tungiasis</b>                         |   | No restriction                      |   |
| Typhoid Fever                            |   | 4 w after therapy and full recovery |   |
| <b>Typhus Fevers</b>                     |   |                                     | 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  |
| 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  |

| <b>Disease</b>              | <b>Condition</b>                  | <b>Period of Unfitness</b>          | <b>Notes</b>  |
|-----------------------------|-----------------------------------|-------------------------------------|---|
| <b>West Nile (WN) Fever</b> | 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 |
| <b>West Nile (WN)Virus</b>  |                                   |                                     | See West Nile (WN) Fever  |
| <b>Whipworm</b>             |                                   |                                     | See Helminthic Diseases   |
| <b>Wuchereria bancrofti</b> | Lymphatic Filariasis              |                                     | See Helminthic Diseases   |
| <b>Yaws</b>                 | Early Lesions                     | 2 w after therapy and full recovery |   |
|                             | Late Lesions                      | Unfit                               | Unless rendered fit by AMS  |
| <b>Yellow Fever</b>         |                                   | 4 w after therapy and full recovery |   |
| <b>Yersinia</b>             |                                   |                                     | See Travel Diarrhoea  |
| <b>Zoster</b>               |                                   |                                     | See Varicella Zoster Virus  |

## CHAPTER 19- MEDICATION AND FLYING

### 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.

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 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).

The decision as to whether a pilot is fit to fly under medication has always to be taken in conjunction with knowledge of his clinical situation and the dose and form of prescribed drug.

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 a treatment may be cause for disqualification;
- b flight conditions may modify the reactions of the body to a treatment (jet lag, dehydration, moderate hypoxia); and
- c most important, medication may cause adverse side effects impairing flying safety. It should be noted that the effects of medicine 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 treatments in order to entice them to refrain from taking unreported treatments 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 the greatest supervision.

It is possible that new therapeutic agents will become available that offer significant advantages in treatment. If such agents are considered by the LSST(M) to be appropriate for use by aircrew, with due consideration 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 drug while not on flying duty for an appropriate period of time (temporary disqualification) with proven efficacy and without any side effects, interfering with flying duties.

## **2 DIGESTIVE PATHOLOGY**

### **2.1 Anti-ulcer medicines (anti acids)**

Gastric secretion inhibitors such as H<sub>2</sub> antagonists (e.g. ranitidine, cimetidine) or inhibitors of the proton pump (e.g. omeprazole) may now be acceptable after diagnosis of the pathological condition. After the initial period of treatment which may require temporary disqualification, the risk of a recurrency during the first year, in spite of the scarring observed during endoscopic examination, may justify a treatment with these medicines, which is compatible with flying status.

### **2.2 Treatment of inflammatory bowel disease**

- a Local anti-inflammatory drugs such as mesalazine, a well-tolerated drug, may be compatible with flying status.
- b Rectal corticoids may be acceptable.
- c Salazosulfapyridine should be avoided because of its frequent adverse effects.

### **2.3 Anti spasmodics**

- a Antimuscarinics – 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 diarrhea and possible cholecystitis.

### **2.7 Other bowel disorders**

In patients suffering from the gastrointestinal colics, the prescription of trimebutine, mebeverine and antacids is compatible with flying status provided that the possibility of an organic disease has been ruled out.

### **2.8 Kinetosis**

Motion sickness drugs are incompatible with flying status since they 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 hypokaliemia, and possible metabolic and hydration disorders. Potassium supplements may be required. A combination of thiazide diuretic and spironolactones may also be compatible with flying status.

**c Angiotensin Converting enzyme inhibitors**

These medications (e.g. captopril, enalapril, lisinipril) 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 also compatible with flying status, they may induce peripheral edemas or headaches, but they are generally well tolerated. Preference shall be given to drugs with the most flexible use (e.g. diltiazem, verapamil, nicardipine or nitrendipine). 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, prazonin, 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)            | not compatible |
| b) | Class II  | Beta blockers (e.g. bisoprolol)                      | compatible     |
| c) | Class III | Potassium channel blockers (e.g. Amiodaron, Sotalol) | not compatible |
| d) | Class IV  | Calcium channel blockers (e.g. Verapamil)            | compatible     |
| e) |           | Digitalis derivatives                                | compatible     |

**3.3 Anticoagulants**

Anticoagulants (warfarin, heparin) are strictly incompatible with flying status. But low dose of antiplatelet drugs (aspirin, dipyridamole) may be acceptable.

### **3.4 Antianginal medications**

Nitrates or other antianginal substances (molsidomine and other substances) are incompatible with flying status when used for prevention or treatment of ischemic symptoms.

## **4 a RESPIRATORY SYSTEM**

### **4.1 Treatment of asthma**

Use of oral steroids or theophylline derivatives is incompatible with flying status. Leukotriens may be acceptable.

Respiratory aerosols at small 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 dipropionate); and
- d a regular use of a chromoglicic acid (e.g. cromolyn sodium 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 antihistaminics are not authorised for flying personnel and incompatible with flying status. Non-sedating oral (e.g. fexofenadine) and topical antihistaminics 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**

Replacement therapy (e.g. levothyroxin sodium) is compatible but requires laboratory monitoring until euthyreoid status is achieved.

### **5.2 Hyperthyroidism**

Treatment of hyperthyreoidism with synthetic antithyroid drugs (e.g. carbimazole or bensylthiouracile), is incompatible with flying status. After treatment - whether radioiodine, surgery

or after antithyroidal medication - pilots may only resume flying duties after euthyroidism is achieved.

### 5.3 **Treatment of gynaecological diseases**

Treatments of hormonal gynaecological diseases are compatible with continued flying status

- a normal or mini doses of oestro-progestative drugs;
- b progestatives, either natural progesterone or synthetic derivatives.

## 6 **METABOLIC DISEASES**

### 6.1 **Diabetes**

Insulin dependent diabetes is a contra-indication to flying. Only insulin independent diabetes and diabetes not requiring insulin administration and non complicated remains compatible with flying status. Hypoglycaemic sulfonamids and insulin treatment are disqualifying for all types of flying activities. Biguanides associated with appropriate monitoring and diet remain the only possible treatment.

### 6.2 **Dyslipidaemia**

Dyslipidaemia in flying personnel should be treated in conjunction with an appropriate diet and weight reduction if appropriate. A treatment with drugs that lower concentrations of plasma lipoproteins should be prescribed if this diet is not fully effective, and only in this case.

- a HMG-CoA reductase inhibitors with preference for hydrophilic molecules such as pravastatine 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 (greater than 3 times the normal concentration).
- c Cholestyramine, after a previous evaluation of gastrointestinal tolerance (frequent constipation).

### 6.3 **Hyperuricemia**

Acute gout is incompatible flying status.

Hypouricemic substances (e.g. allopurinol) may be acceptable. Flying personnel should be disqualified during the initial period of therapy.

## 7 **NEUROLOGY**

### 7.1 **Treatment of epilepsy and Parkinson's disease**

Drugs prescribed for the treatment of epilepsy and Parkinson's disease are incompatible with flying status.

A withdrawal period of approximately two months must be allowed if the anti-comital treatment is discontinued prior to a new electroencephalographic evaluation.

### 7.2 **Migraine treatment**

No anti-migraine treatment is allowable.

Only derivatives of ergot used in single-drug therapy after a previous test period and vascular evaluation may be compatible with flying status.

### 7.3 **Drugs for the autonomic system**

These drugs are far less commonly prescribed than in earlier times. This is true for parasympathomimetic drugs, sympathicomimetic drugs such as adrenaline or parasympatholytic drugs such as atropine derivatives. When prescribed for systemic use or local applications (collyrium) all these drugs must be considered as incompatible with flying status.

### 7.4 **Nicotine products**

Nicotine products used for smoking cessation may be allowed.

## **8 PSYCHIATRY**

All drugs used for psychiatric treatment may affect alertness and upper brain functions: therefore they are incompatible with flying status. These drugs include barbiturates, neuroleptic antidepressant, normothymic, anxiolytic and hypnotic drugs.

The problem is to preserve the quality of sleep during stop-overs in long-haul flights, and for this purpose the ingestion of very short half-life hypnotics (e.g. zolpidem, zopiclone) appears as an elegant remedy. However, as medical monitoring is not guaranteed and sufficient time lapse between intake and subsequent flight duties cannot be guaranteed, use of any 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 and lower temperature in bedroom, relaxation techniques) should be recommended.

The use of narcotics is strictly forbidden. In the anglo-saxon meaning of the word, the term 'narcotics' covers heroin, morphine, cocaine, cannabis, but also amphetamines and other stimulants.

## **9 ANALGESIC AND ANTI-INFLAMMATORY DRUGS**

### 9.1 **Analgesics**

Analgesics containing morphine or not (nefopam) which act upon the central nervous system are strictly incompatible with flying status.

The most commonly prescribed peripheral analgesics remain compatible with flying status depending on the reason why they have been prescribed, and if they are administered at moderate doses. These are paracetamol, aspirin, and derivatives of propionic acid.

A frequently encountered problem is that of the combination of these substances with sympathicomimetic drugs and antihistamines for nasal decongestion purposes. Such a prescription is *a priori* disqualifying.

### 9.2 **Anti-inflammatories**

#### a *Non steroid anti-inflammatories*

These substances prescribed for a short treatment at moderate doses may be compatible with flying status if there is no contra-indication (gastro-duodenal ulcer, hypersensitivity), and if the condition which justifies their prescription is itself compatible with flying status.

#### b *Steroid anti-inflammatories*

These substances are incompatible with flying status.

## **10 TREATMENT OF INFECTIONS**

### **10.1 Antibiotics**

Considering the reasons why antibiotics are prescribed they are usually not compatible with flying status.

Anti-tuberculosis treatments are incompatible with flying status.

### **10.2 Antiviral treatment**

AZT (azidothymidine) or DDI (Videx) are incompatible with flying status.

Interferon treatment is also incompatible with flying status.

### **10.3 Vaccinations**

Flying personnel are liable to currently mandatory vaccinations recommended by domestic and international sanitary regulations. Furthermore anti-A and -B hepatitis, anti-typhoid and anti-meningitis vaccination must be highly recommended.

There is no contra-indication against vaccination for flying personnel except in cases of immunodeficiency, and vaccination must be strongly recommended. It induces no flying restriction. However, pilots should not fly within 24 hours after receiving a vaccination.

For more information on vaccinations please refer to the Subchapter 4 Vaccinations in Chapter 18- Tropical Medicine.

### **10.4 Chemoprophylaxis (anti-malarials)**

Anti-malarial drugs used for the treatment of malaria are incompatible with flying status.

Basis of malaria prophylaxis is exposure prophylaxis, consisting of prevention against mosquito bites (repellents, nets, insecticides).

Additional Chemoprophylaxis: Long-term antimalarial chemoprophylaxis, warranted due to frequent visits to endemic areas, used to be a problem for aviators. The only approved drug for airmen used to be Chloroquine and Proguanil. As the efficacy of that combination is only about 50- 60 % for the time being, a more effective regime should be chosen. Mefloquine and Atovaquone/Proguanil have an efficacy of about 90 %. Nevertheless, Mefloquine is not compatible with flying duties. Atovaquone/Proguanil (Malarone®) is malaria prophylactic 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.

For more information about malaria please refer to the Subchapter 5 Malaria in Chapter 18 - Tropical Medicine.

## **11 DERMATOLOGY**

### **11.1 Keratolytic treatments**

Such treatments frequently used by flying personnel suffering from psoriasis are incompatible with flying status.

Systemic treatment with these agents (etretinate) may cause serious drying of the skin and mucosa and particularly of the conjunctival tissues, intensified by flying conditions and resulting in significant dark vision disorders.

#### 11.2 **Dermatological topical treatments**

These are acceptable except for chronic applications of class I and II topical dermocorticoids.

#### 11.3 **Acne**

Antiseptics, keratolytics, topical retinoids and topical antibiotics are acceptable.

Systemic antibiotics or a cyproterone acetate ethinyloestradiol combination is also acceptable.

Isotretinoin is not acceptable because of side-effects.

#### 11.4 **Exczema**

A topical emolient, soap substitutes, keratolytics, coal tar, paste (with zinc or ichthamol) and tar shampoos are acceptable. Treatments for weeping exczema are generally contra-indicated because underlying disorder. Systemic gamolenic acid is acceptable.

#### 11.5 **Pruritus**

Systemic treatment of pruritus with oral anti-histamine drugs is unacceptable.

### 12 **EAR-NOSE-THROAT**

Local ENT treatments may be compatible with flying status if the affection which requires this treatment is also compatible with flying status. Their use shall be limited in time in order to avoid iatrogenic complications, particularly for nasal decongesting agents.

#### 12.1 **ENT drugs**

Nasal decongestants with no effect on alertness (e.g. clobutinol or oxeladine) are compatible.

Mucolytic agents (e.g. carbocysteine) are well tolerated and are compatible with flying status .

#### 12.2 **Antiallergic drugs**

Sedating oral antihistaminics are not authorised for flying personnel and incompatible with flying status. Non-sedating oral (e.g. fexofenadine) and topical antihistaminics may be acceptable.

### 13 **OPHTHALMOLOGY**

Local anti-infection and non cortisonic anti-allergic collyria are compatible with flying status. Anti-glaucoma collyria containing beta-blockers are also compatible with flying status, but anti-glaucoma collyria modifying the diameter of the pupils, and mydriatic, myotic, and cytoplegic collyria are incompatible with flying status.

Pilots who wear contact lenses while flying should never use any preparation while wearing the lenses.

**Table: MEDICATION AND FLYING**

|  | Generic International Name |                                      | Remarks   |
|--|----------------------------|--------------------------------------|---|
|  | compatible                 | incompatible                         |   |
| <b>1 Digestive Pathology</b>             |                            |                                      |   |
| Anti-ulcer medicines                     | <b>RANITIDINE</b>          |                                      |   |
|  | <b>CIMETIDINE</b>          |                                      |   |
|  | <b>OMEPRAZOL</b>           |                                      |   |
| Treatment of inflammatory colitis        | <b>MESALAZINE</b>          | SALAZOSULFAPYRIDINE                  | Minimal medication such as sulphasalazine or local medication like steroid or sulphasalazine enema or suppository may be acceptable |
| Anti-spasmodics                          |                            | DICYCLOMINE                          |   |
|  |                            | MEPENZOLATE                          |   |
|  |                            | PIPENZOLATE                          |   |
|  |                            | POLDINE                              |   |
|  |                            | PROPATHELINE                         |   |
|  |                            | <b>ALVERINE</b><br><b>MEBEVERINE</b> |   |
| Anti-diarrhoeals                         | <b>LOPERAMIDE</b>          | CODEINE PHOSPHATE                    |   |
|  |                            | COPHENOTROPE                         |   |
|  |                            | LOPERAMIDE                           |   |
| Anti-haemorrhoids                        |                            |                                      | Local medication like steroid or sulphasalazine enema or suppository may be acceptable  |
| Treatment of Gallstone                   | <b>TRIMEBUTINE</b>         |                                      |   |
|  | <b>MEBEVERINE</b>          |                                      |   |
| Kinetosis, motion sickness               |                            |                                      | not acceptable  |
| <b>2 Cardiovascular System</b>           |                            |                                      |   |
| <b>2.1 Anti-hypertensive drugs</b>       |                            |                                      |   |
| Beta blockers                            | <b>ATENOLOL</b>            |                                      |   |
|  | <b>METOPROLOL</b>          |                                      |   |
|  | <b>BISOPROLOL</b>          |                                      |   |
| Angiotensin converting enzyme inhibitors | <b>CAPTOPRIL</b>           |                                      |   |

|                                     |                       |            |  |
|-------------------------------------|-----------------------|------------|--|
|                                     | <b>ENALAPRIL</b>      |            |  |
|                                     | <b>LISINOPRIL</b>     |            |  |
| Angiotensin II Receptor Antagonists | <b>CANDESARTAN</b>    |            |  |
|                                     | <b>EPROSARTAN</b>     |            |  |
|                                     | <b>IRBESARTAN</b>     |            |  |
|                                     | <b>LOSARTAN</b>       |            |  |
|                                     | <b>TELMISARTAN</b>    |            |  |
|                                     | <b>VALSARTAN</b>      |            |  |
| Diuretics                           | <b>THIAZIDICS</b>     |            |  |
|                                     | <b>SPIRONOLACTONE</b> |            |  |
|                                     |                       | FUROSEMIDE |  |
| Calcium channel blockers            | <b>DILTIAZEM</b>      |            |  |
|                                     | <b>VERAPAMIL</b>      |            |  |
|                                     | <b>NICARDIPINE</b>    |            |  |
|                                     | <b>NITRENDIPINE</b>   |            |  |

|   | <i>Generic International Name</i>               |   | <i>Remarks</i>   |
|---|---|---|--|
|   | <i>compatible</i>                               | <i>incompatible</i>   |  |
| Central anti-hypertensive drugs         |   | CLONIDINE   |  |
|   |   | ALPHAMETHYL- DOPA   |  |
| Vasodilating anti-hypertensive drugs    |   | DIHYDRALAZINE   |  |
|   |   | PRAZOZINE   |  |
|   |   | URADIPIL  |  |
| <b>2.2 Anti-arrhythmic drugs</b>        |   |   |  |
| Vaughan Williams Class I                |   | CHINIDIN,<br>DISOPYRAMID, AJMALIN,<br>LIDOCAIN,<br>PHENYTOIN, PROPAFON,<br>FLECAINID, MEXITILLINE |  |
| Vaughan Williams Class II, BETABLOCKERS | <b>ATENOLOL,<br/>METOPROLOL,<br/>BISOPROLOL</b> |   |  |
| Vaughan Williams Class III              | <b>SOTALOL</b>                                  | AMIODARON   |  |
| Vaughan Williams Class IV               | <b>VERAPAMIL</b>                                |   |  |
| Other anti arrhythmic drugs             | <b>DIGITALICS</b>                               |   |  |
| <b>2.3 Anticoagulants</b>               |   |   |  |
|   |   | 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   |  |
|   | <b>ASPIRIN</b>                                  |   |  |
|   | <b>DIPYRIDAMOL</b>                              |   |  |
| <b>2.3 Antianginal medication</b>       |   |   |  |
|   |   | NITRATES  |  |
|   |   | MOLSIDOMINE   |  |

| <b>3 Respiratory system</b>  |                      |             |                   |
|------------------------------|----------------------|-------------|-------------------|
| Treatment of asthma          |                      |             |                   |
| Theophylline derivatives     |                      | THEOPHYLLIN |                   |
| Respiratory aerosols         | SALBUTAMOL           |             |                   |
|                              | OXYTROPIDIUM BROMIDE |             |                   |
|                              | BECLMETHASONE        |             |                   |
|                              | CROMOGLYCIN SODIUM   |             |                   |
| Decongestive drugs           | CLOBUTINOL           |             |                   |
|                              | OXELADINE            |             |                   |
| Mucolytic agents             | BROMHEXIDINE         |             |                   |
|                              | ACETYLCYSTEINE       |             |                   |
|                              | CARBOCYSTEINE        |             |                   |
| Sedating antihistaminics     |                      |             | not acceptable    |
| Non-sedating antihistaminics |                      |             | may be acceptable |

|  | <i>Generic International Name</i> |                     | <i>Remarks</i> |
|--|-----------------------------------|---------------------|----------------|
|  | <i>compatible</i>                 | <i>incompatible</i> |                |
| <b>4 Endocrinology</b>                         |                                   |                     |                |
| Hypothyroidism                                 | LEVOTHYROXINE SODIUM              |                     |                |
| Hyperthyroidism,<br>Anti-thyroid drugs         |                                   | CARBIMAZOLE         |                |
|  |                                   | BENZYL THIOURACILE  |                |
| Hormonal treatments of gynecological diseases  |                                   |                     |                |
| Progestative                                   | MEDROXYPROGESTERONE               |                     |                |
|  | LYNESTRENOL                       |                     |                |
|  | LEVONORGESTREL                    |                     |                |
|  | NORETHISTERONE                    |                     |                |
|  | NORGESTRIEONE                     |                     |                |
| <b>5 Metabolic diseases</b>                    |                                   |                     |                |
| Dyslipidemia                                   | PRAVASTATINE                      |                     |                |
|  |                                   | SIMVASTATINE        |                |
|  | CHOLESTYRAMINE                    |                     |                |
|  | FENOFIBRATE                       |                     |                |
|  | GEMFIBROZIL                       |                     |                |
| Hyperuricemia                                  | ALLOPURINOL                       |                     |                |
|  |                                   | COLCHICINE          |                |
| <b>6 Neurology</b>                             |                                   |                     |                |
| <b>7 Psychiatry</b>                            |                                   |                     |                |
| Sleep disorders                                |                                   | ZOLDIPEM            |                |
|  |                                   | ZOPICONE            |                |
|  |                                   | MELATONINE          |                |
| <b>8 Analgesic and anti-inflammatory drugs</b> |                                   |                     |                |
| Central analgesics and narcotics morphinics    |                                   | MORPHINE            |                |
|  |                                   | CODEINE             |                |
|  |                                   | CODETHYLIN          |                |

|                               |                                  |          |                  |
|-------------------------------|----------------------------------|----------|------------------|
|                               |                                  | HEROÏNE  |                  |
|                               |                                  | COCAÏNE  |                  |
|                               |                                  | CANNABIS |                  |
| Peripheric analgesic          | <b>PARACETAMOL</b>               |          |                  |
|                               | <b>ACETYL SALICYLIC ACID</b>     |          |                  |
|                               | <b>DERIVED OF PROPIONIC ACID</b> |          |                  |
| Steroid anti-Inflammatories   |                                  |          | all incompatible |
| Non steroid anti-inflammatory | <b>DICLOFENAC</b>                |          |                  |
|                               |                                  |          |                  |

|                                   | <i>Generic International Name</i> |                     | <i>Remarks</i>  |
|-----------------------------------|-----------------------------------|---------------------|---|
|                                   | <i>compatible</i>                 | <i>incompatible</i> |   |
| <b>9 Treatment of infections</b>  |                                   |                     |   |
| Antibiotics                       |                                   |                     |   |
| Macrolides                        |                                   | JOSAMYCINE          |   |
| Beta- lactamines                  |                                   | PENICILLINE         |   |
| Phenicoles                        |                                   | CHLORAMPHENICOL     |   |
| Antiviral treatment               |                                   | AZIDOTHIAMINE       |   |
|                                   |                                   | DDI                 |   |
|                                   |                                   | INTERFERON          |   |
| Vaccinations                      |                                   |                     | all compatible, minimum period of 24 h before next flight |
| Chemoprophylaxes                  |                                   |                     |   |
| Antimalarials                     | <b>CHLOROQUINE</b>                |                     |   |
|                                   | <b>PROGUANIL</b>                  |                     |   |
|                                   |                                   | MEFLOQUINE          |   |
|                                   | <b>ATOVAQUONE / PROGUANIL</b>     |                     |   |
| <b>10 Dermatology</b>             |                                   |                     |   |
| Keratolytic treatments            |                                   | ETRETINATE          |   |
|                                   |                                   |                     |   |
| Dermatological topical treatments |                                   | ISOTRETINOID        |   |
|                                   | <b>CYPROTERONE ACETATE</b>        |                     |   |
|                                   | <b>GAMOL ENIC ACID</b>            |                     |   |