CHAPTER 3 - THE RESPIRATORY SYSTEM

1 INTRODUCTION

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

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

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

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

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

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

1.1 Radiography

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

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

1.2 Pulmonary function testing

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

a Restrictive impairment

b Obstructive impairment

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

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

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

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

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

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

2 CHRONIC OBSTRUCTIVE AIRWAY DISEASE AND ASSESSMENT GUIDELINES

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

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

3 ASTHMA AND ASSESSMENT GUIDELINES

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

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

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

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

3.1 Assessment guidelines Class 1

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

[ ]

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

b treatment limited to **[**medication compatible to flight safety (inhaled corticosteroid or inhaled beta agonist or any combination of two, or inhaled cromoglycate, but no systemic steroids)**]**;

c absence of bronchospasm on clinical examination;

d absence of bronchospasm associated with mild respiratory infection;

e Acceptable personal and family history with regard to asthma (with regard to age of onset, frequency of severity of attacks, hospital admissions, loss of schooling and requirement for medication) and other atopic states;

f a comprehensive report of all of the above will be forwarded to the AMS.

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

3.2 Assessment guidelines Class 2

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

[ ]

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

b treatment limited to **[**medication compatible to flight safety (inhaled corticosteroid or inhaled beta agonist or any combination of two, or inhaled cromoglycate, but no systemic steroids)**]**;

c Absence of bronchospasm on clinical examination;

d bronchospasm associated with mild respiratory infections easily controlled;

e Acceptable personal and family history with regard to asthma (with regard to age of onset, frequency of severity of attacks, hospital admissions, loss of schooling and requirement for medication) and other atopic states;

f A comprehensive report of all of the above will be forwarded to the AMS.

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

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

4 ACTIVE INFLAMMATORY DISEASE

4.1 Assessment guidelines

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

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

4.2 Pulmonary tuberculosis

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

a A recognised course of medication has been completed.

b Chest radiography shows no significant lung damage.

c Normal pulmonary function testing is demonstrated.

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

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

5 SARCOIDOSIS AND ASSESSMENT GUIDELINES

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

5.1 Assessment guidelines for initial applicants

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

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

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

a A full clinical evaluation is normal. Tests must include a chest x-ray, resting and exercise ECG, 24-hour ambulatory ECG monitoring, and if needed myocardial scintigraphy or perfusion scanning.

b Normal pulmonary function tests are demonstrated.

c There is no evidence of other organ or parenchymal involvement.

d No medication is prescribed.

5.2 Assessment guidelines for revalidation/renewal of a medical certificate

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

a Disease is deemed to be inactive.

b Full clinical evaluation as detailed above in 5.1 a is normal.

c Normal pulmonary function tests are demonstrated.

d There is no evidence of other organ or parenchymal involvement.

e No medication is prescribed.

f **[**Fit assessment with multi-pilot (Class 1 ‘OML’) or saety pilot (Class 2 “OSL’) limitation**]**.

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

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

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

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

This assessment also applies to Class 2.

6 SPONTANEOUS OR IDIOPATHIC PNEUMOTHORAX

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

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

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

6.1 **[Assessment guidelines for initial applicants]**

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

[a One year has elapsed since full recovery after adequate treatment.**]**

[b**]** Full respiratory evaluation is normal.

[c No bullae are discovered on chest radiography, CT scans, or other medical imaging technique.**]**

[d The bullae have been treated by surgery and no smoking status has been confirmed.**]**

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

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

a Full re-expansion of the lung has taken place.

b A minimum of six weeks has elapsed since the occurrence.

c Full respiratory evaluation is normal.

d **[**No bullae are discovered on chest radiography, CT scan, or other medical imaging technique.**]**

e **[**Multi-pilot (Class 1 ‘OML’) of safety pilot (Class 2 ‘OSL’)**]** for one year from the original occurrence.

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

6.3 Bullae

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

6.4 Traumatic pneumothorax

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

7 THORACIC SURGERY AND ASSESSMENT GUIDELINES

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

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