Part 3 - Clinical Aviation Medicine

3.2 Respiratory System

ICAO Annex 1: 6.3.2, 6.4.2, 6.5.2
Civil Aviation Act: s27B
CAR Part 67: 67.103 b, & e, 67.105 b, & e, 67.107 b, & e
GD: Timing of Routine Examinations, Examination Procedures
ICAO medical Manual Chapter 2

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3.2.1 Asthma

3.2.1.1 Considerations:

The 1992 International Consensus Report on Diagnosis and Treatment of Asthma proposed the following definition for Asthma:

“Asthma is a chronic inflammatory disorder, in which many cells and cellular elements play a role, in particular mast cells, macrophages, neutrophils, and epithelial cells. In susceptible individuals, this inflammation causes recurrent episodes of wheezing, breathlessness, chest tightness and coughing, particularly at night or in the early morning. These episodes are usually associated with widespread but variable airflow obstruction that is often reversible either spontaneously or with treatment. The inflammation also causes an associated increase in the existing bronchial hyperresponsiveness to a variety of stimuli”.

Persistent changes in lung function may occur over time as a result of sub-basement membrane fibrosis.

Asthma represents a special problem for certification because it is a very common condition that has the potential to result in impairment or incapacitation.

Important factors in aeromedical decision making are:

- Adequacy of respiratory function
- Severity of asthma
- Stability of asthma
- Medication requirements

A history of asthma requires careful consideration, so does a history of symptoms or clinical signs, including impaired lung function, suggesting the possibility of asthma.

Symptoms & Signs suggestive of asthma

- Cough, worse at night, recurrent wheeze, recurrent difficulty in breathing;
- Peak expiratory flow (PEF) variation of 20 % or more from PEF measured in the morning (prior to any bronchodilator) to PEF taking in the afternoon or evening (can be after bronchodilator);
- FEV1 variation of > 200 ml;
- FEV1 variation or 12%; or more;
- Hyperexpansion of the thorax;
- Expiratory wheezing during normal breathing, noting that sounds during forced exhalation may originate in the glottis;
- Nasal symptoms or polyps;
- Allergic skin manifestations in the presence of the above symptoms.

Investigations

The GD “Examination Procedures” prescribes the standard for spirometry completion. A single PEFR reading or even a single spirometry reading “within normal limits” is not
sufficient to determine whether there is stability. PEFR diaries and serial spirometry may give some indication of asthma stability and an indirect measure of airways inflammation, but there are better tests available.

A spirometry before and after short acting bronchodilator should be performed at each examination on any one with a history of asthma, and anyone who has symptoms or clinical signs suggestive of asthma. The post bronchodilator spirometry should be performed even if the base line spirometry reading is entirely normal. This is because a normal spirometry does not exclude significant reversibility. The normal values may also be optimistic.

The Global Lung Function initiative (GLI), aims at establishing a mathematic formula (software) to predict normal values of spirometry for all ages and ethnic group. This is process in evolution. Ultimately it is expected that the GLI tool will become the universal tool for assessing spirometry results. See [http://www.lungfunction.org/](http://www.lungfunction.org/). Until then the current NHANES 3 tables are acceptable, see:

http://www.cdc.gov/niosh/topics/spirometry/nhanes.html

People with a history of childhood asthma have a 40 % probability of recurrence in adulthood. Detailed inquiry and spirometry should also be performed in such applicants from time to time.

**Interpretation of spirometry**

Spirometry must be interpreted as prescribed in the GD Examination Procedures and with consideration of the following information:

- Loop spirometry (showing inspiratory and expiratory flow volume loops) gives more information than measurement of FEV1 and FVC alone;
- According to the American Thoracic Society a variability of 12 % or 200 ml in FEV1 is significant. An FEV1/FVC ratio of less than 70 % indicates obstruction;
- A reduced FVC with maintenance of the FEV1/FVC ratio suggests a restrictive pattern.

**Bronchial challenge using Methacholine (or Histamine):**

Methacholine used to provoke bronchoconstriction is a repeatable method of assessing bronchiolar hyperresponsiveness (BHR). The table below demonstrates the interpretation of a Methacholine challenge.

Categorisation is based upon the concentration of Methacholine that results in a 20% reduction in FEV1. PC20 (mg/ml) - Bronchial Hyperresponsiveness (BHR)

<table>
<thead>
<tr>
<th>PC20 (mg/ml)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 16</td>
<td>Normal bronchial responsiveness</td>
</tr>
<tr>
<td>4.0 – 16</td>
<td>Borderline BHR</td>
</tr>
<tr>
<td>1.0 – 4.0</td>
<td>Mild BHR - positive test</td>
</tr>
<tr>
<td>&lt; 1.0</td>
<td>Moderate to severe BHR</td>
</tr>
</tbody>
</table>
Before applying this interpretation, the following must be true: (1) baseline airway obstruction is absent; (2) spirometry quality is good; (3) there is substantial post-challenge FEV1 recovery. (Reference: American Thoracic Society Guidelines, categorisation of Methacholine Challenge Test Results).

**Exhaled Nitric Oxide** estimation is another indicator of inflammation. It has been shown to permit significantly better control of asthma with reduced doses of corticosteroid inhalers. It does not predict well for exacerbations.

Directing treatment at normalising the pulmonary eosinophilia has been shown to reduce exacerbations. Technically, however, it remains a labour intensive process and is not practical.

**Classification of Asthma Severity**

Severity is determined by the worst clinical features **before** treatment. This determination will give the ME an idea of how severe the condition may become if left untreated or compliance is in question.

<table>
<thead>
<tr>
<th>Ref: American Thoracic Society</th>
<th>Symptoms</th>
<th>Night time symptoms</th>
<th>Lung function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Symptoms ≤ 2 times a week</td>
<td>≤ 2 times a month</td>
<td>FEV1 of PEF &gt;80 % predicted</td>
</tr>
<tr>
<td><strong>Mild Intermittent</strong></td>
<td>Asymptomatic and normal PEF between exacerbations</td>
<td></td>
<td>PEF variability &lt; 20 %</td>
</tr>
<tr>
<td></td>
<td>Exacerbations brief (a few hours to a few days), variable intensity</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mild Persistent</strong></td>
<td>Symptoms &gt; twice weekly but less than once a day</td>
<td>&gt; 2 times a month</td>
<td>FEV1 of PEF &gt;80 % predicted</td>
</tr>
<tr>
<td></td>
<td>Exacerbation may affect activity</td>
<td></td>
<td>PEF variability 20 – 30 %</td>
</tr>
<tr>
<td><strong>Moderate Persistent</strong></td>
<td>Daily symptoms</td>
<td>&gt; 1 time a week</td>
<td>FEV1 of PEF &gt; 60% &lt; 80 %</td>
</tr>
<tr>
<td></td>
<td>Daily use of inhaled short- acting beta agonist</td>
<td></td>
<td>PEF variability &gt; 30 % predicted</td>
</tr>
<tr>
<td></td>
<td>Exacerbation affect activity</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exacerbation &gt; twice weekly</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exacerbation may last days</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Severe Persistent</strong></td>
<td>Continual symptoms</td>
<td>Frequent</td>
<td>FEV1 of PEF &lt; 60% of predicted</td>
</tr>
</tbody>
</table>
Indications of Control / Stability

<table>
<thead>
<tr>
<th></th>
<th>Excellent control</th>
<th>Good Control</th>
<th>Moderate control</th>
<th>Poor control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prophylactic medication</td>
<td>None</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Night symptoms</td>
<td>No</td>
<td>No</td>
<td>More than 2 episodes per month</td>
<td>Occasional</td>
</tr>
<tr>
<td>Symptoms on exercise</td>
<td>No</td>
<td></td>
<td>Occasional</td>
<td></td>
</tr>
<tr>
<td>Symptoms affecting work</td>
<td>No</td>
<td></td>
<td>Occasional</td>
<td></td>
</tr>
<tr>
<td>Use of bronchodilator</td>
<td>No</td>
<td>No</td>
<td>Occasional</td>
<td>Frequent</td>
</tr>
<tr>
<td>Variation in FEV1 after Ventolin</td>
<td>No or less than 10%</td>
<td>No or less than 10%</td>
<td>10-15%</td>
<td>&gt;15%</td>
</tr>
<tr>
<td>Bronchial hyperresponsiveness to Methacholine</td>
<td>Negative</td>
<td>greater than 2umol/l</td>
<td>less than 2umol/l</td>
<td>less than 0.1 umol/l</td>
</tr>
<tr>
<td>Nitric oxide (while taking inhaled steroid treatment)</td>
<td>Less than 35 ppb</td>
<td>Less than 35 ppb</td>
<td>35-50 ppb if symptomatic.</td>
<td>Greater than 50 ppb if symptomatic</td>
</tr>
</tbody>
</table>

3.2.1.2 Information to be provided

The ME should obtain sufficient information to assess the severity of the asthma and its stability.

Moderate and Severe asthma require a high level or evidence that stability has been achieved to ensure a sufficiently low likelihood of impairment or incapacitation.

History of childhood asthma:

- Respiratory questionnaire on first application;
- GP notes on first application if uncertain about the history;
- Spirometry pre and post bronchodilator on the first application;
- Spirometry at subsequent application if there is doubt about recurrence of asthma;
- Inquiry at each subsequent examination about symptoms suggesting recurrence of asthma – if any positive answers, refer to ‘current asthma’ below.

History of asthma in adulthood, or current asthma:

- Respiratory questionnaire at each examination;
- PEF series on first application, and consider at subsequent examinations;
• Spirometry pre and post bronchodilator at each examination, unless there is well established stability. In this case slightly less frequent spirometry testing is permissible;

• Copy of GP notes for the past 24 months at the first Class 1 application;

• Copy of GP notes for the past 24 months at the first Class 2, or 3 application if the asthma is suspected to be mild persistent or worse;

• Copy of GP notes for the past 12 months at subsequent Class 1, 2 and 3 if there is any doubt regarding the recent asthma history and its treatment or if the asthma is known or suspected to be mild persistent or worse;

• A respiratory physician report at the first Class 1 application if the asthma is suspected to be “mild persistent”, or worse. Subsequent reports may be required on a case by case basis;

• A respiratory physician report on the first Class 2 or 3 application if the asthma appears to be moderately severe or worse. Subsequent reports may be required on a case by case basis;

• Other reports as the ME may find reasonably necessary.

3.2.1.3 Disposition

In case of doubt the ME should contact the CAA Aviation Medicine unit. The following guidance assumes correct assessment of the severity and stability of asthma. The ME should take a conservative approach to certification if unsure about the applicant’s asthma severity and err in favour of public safety by following the flexibility process.

Reminder: Severity is determined by the worst clinical features before treatment i.e. the worst asthma episode an applicant may have experienced.

• Past childhood asthma - Class 1, 2 or 3 adult applicants with a history of childhood asthma but none since childhood: May be assessed as having a condition that is not or aeromedical significance, i.e. as meeting the Part 67 medical standards, if no asthma is demonstrated during examination;

• Mild intermittent asthma - Class 1, 2, or 3 – Excellent or Good control achieved: The applicant may be assessed as having a condition that is not or aeromedical significance provided the certificate is endorsed with the requirement to have a short acting bronchodilator readily available at all time when flying and not to fly while experiencing symptoms of asthma;

• Mild persistent asthma - Class 1: The applicant may be assessed as having a condition that is not or aeromedical significance provided that the applicant is successfully treated with inhaled steroids, compliant with treatment, and stability (excellent or good control) has been reliably demonstrated following a respiratory physician report. The certificate should be endorsed with the requirement to have a short acting bronchodilator readily available at all time when flying and not to fly while having symptoms of asthma. The applicant should be informed to ground self and report CAA in case of discontinuation of prophylactic medication.
• **Mild persistent asthma - Class 2 & 3**: The applicant may be assessed as having a condition that is not or aeromedical significance provided that the applicant is successfully treated with inhaled steroids, compliant, and stability has been reliably demonstrated (excellent, good or moderate control). In doubt a respiratory physician report should be requested. The certificate should be endorsed with the requirement to have a short acting bronchodilator readily available at all time and not to fly or operate as an ATC while experiencing any symptoms of asthma. The applicant should be informed to ground self and report CAA in case of discontinuation of prophylactic medication.

• **Moderate asthma - Class 1**: The applicant should be assessed as having a condition that is of aeromedical significance and should be considered via the flexibility process.

• **Moderate asthma - Class 2 & 3**: The applicant may be assessed as having a condition that is not or aeromedical significance provided that the applicant is successfully treated with inhaled steroids, compliant, and stability has been reliably demonstrated (excellent, good control or moderate control) following a respiratory physician report. The certificate should be endorsed with the requirement to have a short acting bronchodilator readily available at all time when flying and not to fly or operate while experiencing any symptoms of asthma. The applicant should be informed to ground self and report CAA in case of discontinuation of prophylactic medication.

• **Severe asthma – All classes**: The applicant should be assessed as having a condition that is of aeromedical significance and should be considered via the flexibility process.
3.2.2 COPD

3.2.2.1 Considerations

The Global Initiative of Chronic Obstructive Lung Disease (GOLD) – a project initiated by the US National Heart, Lung, and Blood Institute (NHLBI) and the World Health Organisation defines COPD as follows:

“Chronic obstructive pulmonary disease (COPD), a common preventable and treatable disease, is characterized by airflow limitation that is usually progressive and associated with an enhanced chronic inflammatory response in the airways and the lung to noxious particles or gases. Exacerbations and comorbidities contribute to the overall severity in individual patients”.

COPD may be caused by chronic bronchitis, chronic asthma, emphysema, and alpha-1 antitrypsin deficiency. The most important risk factor for COPD is smoking. Around 80% of people affected by COPD have a history of smoking. In the absence of genetic/environmental predispositions, smoking less than 10-15 pack-years is unlikely to result in COPD while smoking more than 40 pack years has a positive likelihood ratio of 12 [Confidence interval 2.7-50]. Thus inquiring about smoking habits is important.

Symptoms of COPD include chronic cough, sputum production and dyspnoea. Exertional dyspnoea is an early symptom.

Pulmonary functions tests are the cornerstone in the diagnosis of COPD. The most important values measured during spirometry are the forced expiratory volume in one second (FEV1) and the forced vital capacity (FVC). The post bronchodilator ratio FEV1/FVC determines the severity of irreversible airflow limitation. A ratio of less than 0.7 is considered abnormal however the normal value decreases with age. The force expiratory volume in six seconds (FEV6) obtained by stopping expiratory effort a 6 seconds is an acceptable surrogate for FVC. Spirometry reference values are available from: http://www.cdc.gov/niosh/topics/spirometry/nhanes.

Please refer also to the asthma subchapter for spirometry normal values.

Staging of COPD

The Revised GOLD Classification looks at three things: Symptoms (Dyspnoea), FEV1 and history of Exacerbations.

Dyspnoea

Grade 0: “I only get breathless with strenuous exercise”.
Grade 1: “I get short of breath when hurrying on level ground or walking up a slight hill”.
Grade 2: “On level ground, I walk slower than people of the same age because of breathlessness, or have to stop for breath when walking at my own pace”.
Grade 3: “I stop for breath after walking about 100 meters or after a few minutes on level ground”; 
Grade 4: “I am too breathless to leave the house or I am breathless when dressing”.

FEV1

<table>
<thead>
<tr>
<th>GOLD</th>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mild</td>
<td>FEV1 &gt; 80% (but FEV1/FVC less than 0.7)</td>
</tr>
<tr>
<td>2</td>
<td>Moderate</td>
<td>50% &lt; FEV1 &lt; 80%</td>
</tr>
<tr>
<td>3</td>
<td>Severe</td>
<td>30% &lt; FEV1 &lt; 50%</td>
</tr>
<tr>
<td>4</td>
<td>Very severe</td>
<td>FEV1 &lt; 30%</td>
</tr>
</tbody>
</table>

Exacerbations

- Low risk: 1 or less exacerbations per year
- High risk: 2 or more exacerbations per year.

### 3.2.2.2 Information to be provided

- Routine spirometry at the first application in accordance with the GD “timing of routine examination”;
- Routine spirometry at age 46 and 56 if the applicant has ever smoked tobacco, in accordance with the GD “timing of routine examination”;
- Spirometry at any application when an applicant presents with a history, signs or symptoms suggestive of lung disease;
- The spirometry is to include post bronchodilator recordings if the FEV1 is less than 80% of predicted, in accordance with the GD “timing of routine examination”;
- The spirometry is to include post bronchodilator recordings if the FEV1/FVC is less than 0.7 (70%);
- Pulse Oxymetry Oxygen Saturation result;
- GP notes for the past 24 months if the applicant reports attending for respiratory problems or the ME is uncertain about the history given;
- A respiratory physician report if the FEV1/FVC is less than 65% or if the applicant has attended for respiratory problems or has signs, symptoms or spirometry results suggestive of more than mild COPD.

### 3.2.2.3 Disposition

- A Class 1 applicant with mild COPD should be considered as having a condition that is of aeromedical significance unless: The FEV1 is 0.65 (65%) or more, the dyspnoea Grade 1 or less, there is no history of exacerbation and the pulse oxymetry is normal;
- A Class 2 or 3 applicant with COPD should be considered as having a condition that is of aeromedical significance unless: The FEV1 is 60% or more, the Dyspnoea is Grade 2 or less, there is no more than one exacerbations per year, and the pulse oxymetry is normal.
3.2.3 Traumatic Pneumothorax

3.2.3.1 Considerations:

Traumatic pneumothorax is generally the result of a penetrating trauma to the chest resulting in perforation of the chest wall, the parietal and possibly visceral pleura. It may also be caused by a blunt injury resulting in a fractured rib then penetrating the visceral pleura. Pulmonary barotrauma due to an excessive differential pressure between ambient and the respiratory tree may also be responsible for a pneumothorax. The latter can occur while diving, at the time of ascending without exhaling fast enough (asthma may be a cause for this), or during sudden decompression at high altitude or in the decompression chamber. Surgery is another possible cause.

Flying duty can normally be resumed 6 weeks after the traumatic pneumothorax, provided full recovery from the trauma and the pneumothorax have occurred. However the ME should be confident that there is no underlying pathology that may have precipitated the event, i.e. asthma in a diver, bullous emphysema in an older pilot etc.

A chest X-ray confirming resolution of the intrapleural air and a spirometry is the minimum requirement. A respiratory physician opinion may at time be necessary. When in doubt the applicant should seek advice from CAA.

3.2.3.2 Information to be provided:

- A detailed history of the trauma leading to the pneumothorax;
- Copy of all relevant medical notes and reports if the event has occurred in the past 12 months, if the history is not clear, or if the ME suspect any underlying condition (i.e. Asthma, COPD);
- Copy of all chest radiology reports if the event has occurred in the past 12 months;
- At least one post event chest X-ray report;
- A respiratory physician report if the ME suspects that any underlying condition has contributed to the event, or if there has been recurrence of pneumothorax.

3.2.3.3 Disposition:

A Class 1, 2 or 3 applicant may be considered as having a condition that is not of aeromedical significance if:

- A clear history of trauma has been established and full recovery has occurred;
- The latest Chest X-ray report confirms resolution of the traumatic pneumothorax;
- At least 6 weeks have lapsed since radiological resolution of the traumatic pneumothorax;
- The ME has considered and excluded any underlying pathology.
3.2.4 Spontaneous Pneumothorax

3.2.4.1 Considerations

A pneumothorax is said to be spontaneous if it occurs in the absence of trauma or underlying pathology. For instance an apparently spontaneous pneumothorax in someone with emphysema is not considered to be spontaneous for the purpose of this chapter.

The incidence of admissions for spontaneous pneumothorax in the UK has been reported to be 16.7 / 100,000 / year in males and 5.8 / 100,000 / year in females. The condition typically occurs in tall thin men between 20 and 30 years of age. 75 % are smokers.

A pneumothorax present on take-off or occurring during climb may result in a tension pneumothorax owing to the decreasing ambient pressure. This can lead to incapacitation and possibly death. At best, a pneumothorax would be distracting and could induce a degree of hypoxia.

Recurrence rate

Recurrence is common, 20 – 60 % at 5 years. Risk factors for recurrences are:

- Gender: Women have a higher risk of recurrence, 71 % against 46 % for Men in one study;
- Smoking habits: Interestingly, according to one study, there is a higher recurrence rate in non-smokers. In smokers, smoking cessation decreases the likelihood of recurrence and is therefore important. It takes two years of cessation for the improvement to become significant.
- Bullae or blebs: The prognostic significance of pulmonary bullae of blebs remains controversial. However concern remains that the presence of bullae of blebs constitutes a risk factor.

In addition contralateral recurrences occur in 15 – 30 % of cases. Therefore patients who have undergone unilateral surgical intervention remain at increased risk of developing a pneumothorax on the contralateral side, for some years. The likelihood of a recurrence decreases exponentially over time. Half the recurrences happen in the first year, a quarter in the second year, one eighth in the third year etc.

Current surgical techniques generally involve Video Assisted Thoracic Surgery (VATS) with apical resection (whether bullae are visible or not) or stapling of bullae, and (but not always done) pleurodesis by abrasion, using a sand paper type of material. This may be augmented by chemical pleurodesis or/and peeling of strips of pleura. The procedure may be unilateral or bilateral. Pleurectomy is now rarely performed as it is mostly unnecessary and has a significant morbidity. Relapse is possible even after surgery.

It must be understood that different combinations of techniques have different rates of relapse. MEs should therefore not assume that an applicant who underwent surgery is necessarily eligible for a Medical Certificate at a certain point in time.

The following table, compiled by CAA after meta-analysis of some 18 studies, gives an indication of the estimated recurrence rate depending on the procedure(s) performed if any.
### Bilateral VATS + subtotal pleurodesis

<table>
<thead>
<tr>
<th>Recurrence rate: no data. however it is safe to assume 3 % or less</th>
</tr>
</thead>
</table>

### Unilateral VATS + subtotal pleurodesis

| Recurrence rate ~ 3 % |
| Contralateral ~ 5 - 15 % |

### Unilateral VATS, no pleurodesis

| Recurrence rate ~ 10 - 16 % |
| Contralateral ~ 5 - 15 % |

### Conservative

| Recurrence rate ~ 20 - 60 % |
| Contralateral ~ 5 - 15 % |

Most recurrences following surgery occur in the first 12 – 18 months post intervention.

It is possible that an applicant who underwent bilateral Pleurectomy, or VATS with pleurodesis, could obtain a Medical Certificate 6 month post-surgery, perhaps restricted to multicrew operations for 6 – 12 months. In contrast someone who underwent unilateral bullectomy only may have to wait 18 to 24 months, while an applicant treated conservatively may have to wait up to a few years before becoming eligible for a Medical Certificate.

#### 3.2.4.2 Information to be provided

The following information should be provided:

- Copies of any discharge summary and all specialist reports pertaining to the episode(s) of spontaneous pneumothorax;
- Copy of all radiology reports;
- Copy of operating reports, showing details of the procedure(s) performed;
- A recent spirometry;
- A respiratory physician report and high resolution chest CT may be requested in some cases;
- The smoking status, before the episode(s) of spontaneous pneumothorax and after, including time elapsed since smoking cessation.

#### 3.2.4.3 Disposition

No surgery undertaken

- A Class 1 applicant with a history of a single episode of spontaneous pneumothorax occurring less than 5 years prior should be considered as having a condition that is of aeromedical significance;
A Class 2 applicant with a history of a single episode of spontaneous pneumothorax occurring less than 3 years prior should be considered as having a condition that is of aeromedical significance;

A Class 3 applicant with a history of a single episode of spontaneous pneumothorax occurring less than 6 weeks prior should be considered as having a condition that is of aeromedical significance;

A Class 1, 2 or 3 applicant with a history of more than one episode of spontaneous pneumothorax should be considered as having a condition that is of aeromedical significance.

**Surgery undertaken**

A Class 1 or 2 applicant with a history of spontaneous pneumothorax treated by **bilateral VATS and pleurodesis** may be considered as having a condition that is not of aeromedical significance following a period of observation of 12 months for unrestricted Class 1, 6 months for Class 1 restricted to “other than single pilot air operations carrying passengers” and for Class 2;

A Class 1 or 2 applicant with a history of spontaneous pneumothorax treated by lesser surgery may be considered to have condition that is not of aeromedical significance following a longer period of observation;

The period of observation depends on the surgery performed; whether the surgery was bilateral and the Class of licence applied for;

The ME should inquire with CAA to seek advice about the period of observation applicable on a case by case basis;

In case of doubt the ME should consider the applicant as having a condition that is of aeromedical significance;

A Class 3, applicant with a history of spontaneous pneumothorax treated by surgery may be considered as having a condition that is not of aeromedical once recovery from surgery is complete, but nor earlier than six weeks post-surgery.
3.2.5 Non-spontaneous Pneumothorax

3.2.5.1 Considerations
The term non-spontaneous pneumothorax refers to a pneumothorax that is caused or contributed to by an underlying condition other than trauma, for instance asthma or bullous emphysema.

3.2.5.2 Information to be provided

- Copies of any discharge summary and all specialist reports relating to the episode(s) of spontaneous pneumothorax;
- Copy of all radiology reports;
- Copy of any operation report, showing details of the procedure(s) performed;
- Copy of the GP notes for the past two years, or longer if relevant;
- A recent spirometry;
- A respiratory physician report;
- The smoking status;
- A high resolution chest CT may be requested.

3.2.5.3 Disposition

- A Class 1, 2 or 3 applicant with a history of non-traumatic, non-spontaneous pneumothorax should be assessed as having a condition that is of aeromedical significance.
3.2.6 Obstructive Sleep Apnoea

3.2.6.1 Considerations (reference ICAO medical manual):

Refer also to bpac:


Obstructive sleep apnoea (OSA) is a condition in which, during sleep, the upper airway is obstructed due to loss of tone in the pharyngeal musculature. The obstruction may be complete, leading to cessation of airflow (apnoea) or partial, leading to a markedly reduced inspiratory flow (hypopnoea).

OSA can be defined as the presence of five or more obstructive events (either apnoeas or hypopnoeas) per hour of sleep i.e. Apnoea-Hypopnoea Index (AHI) of 5 or more.

The obstructive sleep apnoea syndrome is defined as the presence of OSA with daytime sleepiness. During apnoeas and hypopnoeas the difficulty in inspiration causes arousals from sleep. Poor quality of sleep is then the cause of daytime sleepiness. OSA is both common and under-diagnosed.

Excessive daytime sleepiness, difficulty in concentration, an unusually high rate of road traffic accidents and impairment of skilled motor tasks are consistently associated with moderate and severe OSA. Applicants often only recognize the extent of their performance decrement once it is successfully remedied with treatment. The diagnosis is made with evaluation in a sleep clinic.

OSA is also associated with an increased risk of coronary artery disease, hypertension, stroke and diabetes although there is some debate as to whether the association is causal or secondary to associated obesity, which is often present. Because of this association, it is appropriate to also conduct a cardiovascular risk assessment.

Risk factors for OSA include increasing age, obesity, hypothyroidism and a family history of OSA. Type 2 diabetes is found in association with OSA, probably secondary to the frequently present obesity. Most patients seen in a sleep clinic are significantly overweight, although not all. In addition, the majority with significant OSA snore to a level that is commented on by their bed partners, who typically report being alarmed by the apnoeic episodes. Specific questions addressed to the partner may be helpful if the medical examiner suspects that OSA may be an issue. Of note a few individuals with severe OSA move so little air before they obstruct that they do not snore as much as those with a less severe condition. However, they may have a history of severe snoring which has subsequently lessened. Severe snoring is a sensitive marker for OSA. Daytime sleepiness as a symptom is also reasonably sensitive, but may not be declared to a ME unless specific questions are asked.

There is also a group who despite having significant OSA state that they are not at all sleepy during the day and have very low Epworth scores, i.e. 0 – 3 (normal maximum score is about 9).

There is a separate but related condition that is not uncommon in which a patient has a history of severe snoring but on sleep studies there is no evidence of OSA, and yet he is
sleepy during the day and responds well to continuous positive airway pressure (CPAP). This condition is known as the “upper airway resistance syndrome.”

CPAP is very effective in those who tolerate it. Most symptomatic patients who are accurately assessed and have a proper fitting of their interface (mask and headset), tolerate CPAP well. However, a few do not and a mandibular advancement device (MAD) may be considered. In the past MAD was considered unlikely to work in anything other than mild OSA, however, some CPAP-intolerant patients respond well to a MAD.

The Epworth sleepiness scale is a measure of daytime sleepiness that numerically scores the response to eight questions concerning an individual’s likelihood of sleeping during different activities e.g. watching television, sitting and talking to someone. First published in 1991 and named after the Sleep Disorders Unit, Epworth Hospital, Melbourne, Australia (Copyright of Murray W. Johns, Australian physician, 1937).

ICAO recommends that the diagnosis of OSA should be considered in crew members who are overweight, have Type 2 diabetes, have a history of snoring or complain of excess daytime sleepiness. Any pilot who has fallen asleep on the flight deck, outside a planned rest period, may need investigation.

Applicants who have hypertension and those with certain facial features, such as retrognatism, busy pharynx etc, should also be considered for this diagnosis. People with a BMI of 35 or more have a ~ 70-75 % likelihood of suffering from OSA and those with a BMI of 40 or above, a ~ 80% likelihood of having OSA.

The Mallampati score, initially used in anaesthesia to predict difficulties with intubation also predicts OSA. A Grade III or IV suggests the presence of OSA (AHI >5) but does not predict for severe OSA (AHI >30). However a high Mallampati score should incite the ME to inquire further about OSA.

Class 0: Ability to see the entire tonsils, any part of the epiglottis upon mouth opening and tongue protrusion;
Class I: Soft palate, entire tonsils, uvula, pillars visible;
Class II: Soft palate, upper part of tonsil fossa, uvula visible;
Class III: Soft palate, base of uvula visible;
Class IV: Soft palate not visible.

Obstructive sleep apnoea is not the only cause of daytime hypersomnolence. Periodic leg movement disorder, narcolepsy, idiopathic hypersomnolence, sleep phase reversal, poor sleep hygiene and sleep disturbance due to depression or pain should be considered in patients who have hypersomnolence but normal respiratory sleep studies. Sleepy individuals, even in the absence of OSA risk factors, require evaluation.

**Process for identifying obstructive sleep apnoea**

The ME should inquire about snoring at a level that disturbs someone sleeping in the same room, tendency to fall asleep or doze at inappropriate times and traffic accidents.

The ME should consider the BMI, neck circumference, blood pressure, glucose metabolism status and facial and throat morphologic features of the applicant.
An Epworth Sleepiness questionnaire should be completed in case of any suspicion of OSA. It is however worth noting that, in the context of employment medical examinations and the regulatory environment, the Epworth Sleepiness questionnaire has a poor negative predictive value. A score of 10 or above has however a high predictive value for OSA.

*bpac advises:* (adapted from Skjodt, 2008)

<table>
<thead>
<tr>
<th>Measure Neck circumference + Addition as below = <strong>Adjusted neck circumference</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck circumference in cm + Add:</td>
</tr>
<tr>
<td>3 cm for snoring history:</td>
</tr>
<tr>
<td>3 cm for history of witnessed apnoea</td>
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<tr>
<td>4 cm for a history of hypertension</td>
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<tr>
<td>Result:</td>
</tr>
<tr>
<td>&lt; 43 cm low probability (17%)</td>
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<tr>
<td>43 – 47.9 intermediate probability</td>
</tr>
<tr>
<td>48 cm and above high probability (&gt; 80 %)</td>
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**Types of sleep studies:**

*Level 1 study:* This is a Polysomnography conducted in a laboratory with a technician present and under the supervision of a respiratory physician involved in sleep medicine. It is the gold standard.

*Level 2 study:* This is an unattended sleep study, recording the same parameters. The patient is pre-wired in the lab or a technician may attend the patient at home to conduct the study there. This has the advantage of a more natural environment, but the study is not witnessed.

*Level 3 study:* Records airflow, respiratory effort, SatO2 and heart rate. It is inadequate for certification purpose.

*Level 4 study:* Typically only records SatO2 and heart rate. It is inadequate for certification purpose.

**3.2.6.2 Information to be provided**

- An Epworth Sleepiness questionnaire should be completed if the response to any sleep or fatigue related question asked by the ME is positive or if the ME has reasons to believe that OSA may be present – a low score does not exclude OSA however;

- An Epworth sleepiness questionnaire should be completed if the applicant has morphologic features suggestive of OSA, such as an adjusted neck circumference of 43 cm or above, a Body Mass Index greater than 35 or a Grade III or IV Mallampati score;
• A respiratory physician report, to include a Level 1 or 2 sleep study, on the first occasion that OSA is thought to be likely by the ME;
• In the case of diagnosis of OSA, a follow up respiratory physician report indicating successful treatment by CPAP or MAD and compliance; and
• A CPAP usage data log in case of treatment by CPAP.

Once satisfactory CPAP is established, demonstrated by reduced daytime sleepiness and absence of snoring on treatment, return to flying should normally be allowed. Unless major weight loss occurs, CPAP treatment is likely to be needed lifelong. Follow-up at a sleep clinic may be required to ensure the adequacy of treatment and compliance.

3.2.6.3 Disposition

An applicant with demonstrated Obstructive Sleep Apnoea should be considered as having a condition of aeromedical significance unless:

• The applicant is treated by CPAP or MAD; and
• The applicant is compliant with the treatment as demonstrated by a machine log if using CPAP;
• The treatment is successful as indicated by a respiratory physician report; and
• The applicant does not suffer from aeromedically significant complications from OSA; and
• The applicant does not suffer from excessive fatigue or sleepiness; and
• The applicant is informed that cessation or noncompliance with the prescribed treatment will constitute a change in medical condition under section 27C, requiring the applicant to ground self and report to the director.

An applicant treated by other means or not fulfilling the above criteria should be considered having a condition that is of aeromedical significance and be assessed via the flexibility process.

In doubt the Medical Examiner should consult with CAA.
3.2.7 Sarcoidosis

3.2.7.1 Considerations

Sarcoidosis is a systemic disease of unknown origin. It causes widespread non-caseating granulomas that may affect not only the lung but also the myocardium, eyes, skin, liver, spleen, lymph nodes, bones, joints, nervous system, endocrine system and digestive tract. The peak incidence is in patients between the ages of 20-40 years and up to 50% of patients are asymptomatic. The overall mortality rate varies between 5 and 10%.

The symptoms usually consist of cough that may be paroxysmal in the acute phase and may cause incapacitation. The non-respiratory symptoms may consist of anorexia, malaise, lassitude, joint pains and the almost pathognomonic occurrence of erythema nodosum (nodular skin lesions).

The presence of Lofgrens Syndrome with erythema nodosum, bilateral hilar lymphadenopathy, and a low-grade fever, imply a favourable prognosis.

Lung function is often normal despite some chest X-ray changes. Of those presenting with interstitial pulmonary disease alone, only one quarter show complete resolution. The remainder may progress to pulmonary fibrosis with impaired lung function, and then, cor pulmonale.

**Acute sarcoidosis:**

Acute sarcoidosis normally resolves within 2 months to 2 years. There are risks of sudden disabling symptoms in acute sarcoidosis.

The risk of chronicity is reduced if the acute illness is of short duration (less than a year), the onset occurs at a young age, there is presence of erythema nodosum, (a good prognostic factor), there is minimum lung involvement i.e. any interstitial shadowing should be mild and short lived, there is no cardiac involvement and no steroids are required.

Hyperalcaemia or hypercalciuria may occur as non caseating granulomas secrete 1,25 vitamin D. This occurs in about 10-13% of patients. The presence of elevated vitamin D levels are associated with protracted treatment in sarcoidosis.

**Cardiac Sarcoidosis**

One of the main concerns with sarcoidosis is the possibility of cardiac sarcoidosis. Thallium myocardial scans suggest granulomatous involvement of the heart in 30% of cases of sarcoid.

There is clinical evidence that tachy-arrhythmias, heart blocks, cardiomyopathy, congestive cardiac failure and sudden death may occur. The instances of sudden death in patients known clinically to have myocardial involvement are almost 50%, with 65% of these being due to arrhythmia. Unfortunately the risk of sudden death and cardiac dysfunction persists for up to 15 years, possibly longer, after the onset of symptoms, even once the sarcoidosis symptoms have resolved.
Chronic sarcoidosis

Chronic disease causes a wider and more severe complex of symptoms than the acute disease, and tends to occur in patients in middle age or older. The condition may evolve to progressive pulmonary fibrosis. Advanced disease will cause breathlessness, cough, reduced lung function and exercise intolerance. Any suggestion that the disease is becoming chronic and progressive usually implies that the condition is incompatible with flying status.

3.2.7.2 Information to be provided

- A detailed history of the illness together with a copy of all specialists reports;
- A copy of all investigations reports;
- A copy of any Transbronchial Biopsy (TBBX) or Endobronchial Biopsy of Mediastinal Lymph Nodes (EBUS) results;
- A recent Chest X-ray (PA and Lateral);
- Pulmonary Function Tests (Spirometry)
- Gas Transfer if the spirometry result is not normal;
- An ECG;
- A special eye report;
- Calcium, serum angiotensin-converting enzyme (ACE) and liver function tests, unless the disease is considered to have resolved by the treating specialist;
- A CT of the chest and detailed cardiac investigations may be required as part of an AMC process;
- Other tests and report may be required as part of an AMC process.

3.2.7.3 Disposition

An applicant who first present with a history of Sarcoidosis should be considered as having a condition that is of aeromedical significance unless:

- The application is for a Class 2 or 3 medical certificate;
- The sarcoidosis was acute and of less than two year duration; and
- The sarcoidosis was mild and did not require steroids or immunosuppressant treatment; and
- The acute episode occurred more than 15 years ago; and
- A recent respiratory physician report indicates absence of chronicity or any abnormal findings.
3.2.8 Tuberculosis

3.2.8.1 Considerations

Tuberculosis (TB) remains an important communicable disease in New Zealand. There are 350 – 400 new reported cases per year for an incidence of 6.6 per 100’000. In recent years the incidence rate has been higher than those in Australia, the United States, and Canada, and slightly lower than the rate in the United Kingdom.

Student pilots from regions where tuberculosis is endemic are commonly training at New Zealand flying schools. Thus MEs should remain alert to this condition when examining applicants. The GD “Timing of Routine examinations” stipulates when a routine chest X-ray should be undertaken.

The civil aviation rules Part 67 stipulate that an applicant must not have, to an extent that is aeromedical significance: "an infection, unless adequate treatment or resolution or both is demonstrable”.

ICAO specifies that Applicants with active pulmonary tuberculosis shall be assessed as unfit; and Applicants with quiescent or healed lesions which are known to be tuberculous, or are presumably tuberculous in origin, may be assessed as fit.

3.2.8.2 Information to be provided

- A chest X-ray on the first occasion that an applicant presents with a history of treated tuberculosis;
- Copy of any treating physicians reports relating to the history of tuberculosis;
- In case of doubt regarding resolution of the infection, a recent respiratory physician report;
- In the case of tuberculosis undergoing treatment, a recent respiratory physician report; and
- Copy of all reports relating to the infection.

3.2.8.3 Disposition

- An applicant with a history of past tuberculosis that has been successfully treated and suffering no sequelae may be assessed as having a condition that is not of aeromedical significance;
- An applicant with active disease or currently undergoing treatment should be assessed as having a condition that is of aeromedical significance.