

Medical Examiners’ – Medical Manual

Part 3 - Clinical Aviation Medicine

3.1 Cardiovascular System

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3.1.1 General Considerations

· ICAO Annex 1:	6.3.4, 6.4.4, 6.5.4
· Civil Aviation Act:	s27B
· CAR Part 67:	67.103 k & l, 67.105 k & l, 67.107 k & l
· GD:	Timing of Routine Examinations & Examination Procedures
· ICAO medical Manual:	Chapter 1

This chapter gives guidance for the assessment of applicants' cardiovascular system.

The aim of the examination is to ensure that the applicant does not suffer from any cardiovascular condition likely to cause aeromedically significant impairment of the cardiovascular function or an unacceptable risk of incapacitation.

The cardiovascular examination may also identify applicants who are more likely to develop cardiovascular disease in the future, and allows giving preventative advice. This may reduce future aeromedical risk and assist those applicants in retaining their medical certificate for longer, thus keeping experienced pilots and controllers in the work force.

These applicants should be given advice or preferably be referred to their GP to seek such advice. While not part of the Director's regulatory function, this approach is consistent with sound risk management, medical ethics and most recent ICAO recommendations.

The assessment should consider that an unrestricted medical certificate permits the exercise of all the privileges that are granted under the licence held. These may include aerobatics, high altitude operations with reduced O₂ partial pressure, long period of immobility etc. When appropriate, relevant operational restrictions may be imposed.

This chapter of the manual lists a number of frequently encountered cardiovascular conditions relevant to flight safety. The list is not exhaustive. The CAA Aviation Medical Team should be consulted as necessary.

3.1.2 12-lead ECG interpretation

3.1.2.1 Considerations

The 12-lead electrocardiogram (12-lead ECG) is an integral element of CAA applicant medical assessment. A 12-lead ECG is required at the time of the initial application for a class 1, 2, or 3 CAA medical certificate, and periodically thereafter. The periodicity requirements for routine 12-lead ECGs, and details about their conduct and results interpretation, are described in the relevant General Directions.

This medical manual section describes a number of 12-lead ECG variants that may be considered as being normal for the purpose of interpreting a machine-generated 12-lead ECG report (See Examination Procedures GD 3.3.2).

3.1.2.2 Information to be provided

For the purpose of CAA medical assessment, the consideration of a 12-lead ECG requires

The full ECG tracing, which:

- Is signed and dated by the medical examiner; and
- If a single-channel recorder is used, is cut, mounted, and labelled; or
- If a multi-channel recorder is used, is presented in an A4 format.

A report:

- If applicable, the machine-generated report; or
- If applicable, the report of the Medical Examiner confirming that the tracing is a 'normal variant', as described below, and therefore normal for the purpose of CAA medical assessment; or
- If applicable, the report of the cardiologist or specialist medical physician who interpreted the results of the 12-lead ECG.

3.1.2.3 Disposition

A machine-generated 12-lead ECG report may be interpreted as being normal, for the purposes of paragraph 3.3.2 of the Examination Procedures GD, if:

- The ECG machine reports the tracing as being normal or a normal variant, without qualification[i]; or
- A cardiologist or specialist medical physician has reported the ECG as being normal or a normal variant; or

The ECG machine reports only one of the following:

- Sinus arrhythmia;
- Early repolarization;
- Short QT;
- First degree AV (atrio-ventricular) block with P-R interval of no more than 0.21 seconds (210 ms) that shortens to 0.20 seconds or less with simple exercise in the Medical Examiner's office; the Medical Examiner should submit both pre exercise and post exercise ECGs that document the shortening of the P-R interval;
- Sinus bradycardia below 45 bpm under the age of 50, and below 50 bpm at age 50 or more; provided the heart rate increases with simple exercise in the Medical Examiner's office; the Medical Examiner should submit both pre exercise and post exercise heart rate, preferably by way of an ECG;
- Sinus tachycardia of less than 110 bpm;
- RSR pattern in leads V1 and / or V2 with QRS interval less than 0.12 sec;
- Isolated conduction delays (such as Intra-atrial Conduction Delay, Intra-ventricular conduction delay, Incomplete / partial right bundle branch block) provided this is not a new appearance;
- Left ventricular hypertrophy by voltage criteria only in a slim applicant, in the absence of hypertension;
- Low voltage in limb leads (but consider obesity and hypothyroidism);
- Left axis deviation, less than or equal of -30 degrees;
- No more than one premature ventricular beat on a 12-lead ECG;
- No more than one premature atrial beats on a 12-lead ECG in an asymptomatic applicant.

The ECG should be interpreted as representing a medical condition of aeromedical significance, unless:

- The machine reports the ECG as normal; or
- A cardiologist or specialist medical physician reports the ECG as normal or a normal variant.

^[1] "Qualification" refers to wording that serves to suggest other than an absolutely normal ECG. Words such as 'possibly' (e.g. "possibly normal"), 'essentially' (e.g. "Essentially normal"), are examples of such words that are sometimes used in this context.

3.1.3 Hypertension

3.1.3.1 Considerations

Hypertension represents a long term risk factor for cardiovascular, cerebrovascular and peripheral vascular disease. Isolated mild to moderate hypertension seldom represents an immediate risk of incapacitation but has to be considered when conducting the cardiovascular risk assessment in accordance with the General Direction “Examination Procedures”.

Blood pressure that is difficult to control or requiring multiple antihypertensive agents should alert the ME of the possibility of medical causes that require excluding.

Treatment of hypertension should be compatible with flying activities. ACE inhibitors, Beta-blockers, Calcium antagonist and mild Diuretics are generally compatible. A period of grounding should be observed when initiating treatment, lasting from a few days to one month depending on the agent. Dose increments should be more cautious than for the general population to ensure absence of side effects, including electrolytes imbalance, hypotension and decreased G tolerance.

Clonidine and Methyldopa and other centrally acting agents are not acceptable. Loop diuretics are generally not acceptable. Sympatholytics such as Guanethidine are not acceptable except that low dose Alpha-blockers may be used with caution. Selective Alpha-blockers such as Tamsulozin are preferred when used for benign prostate hyperplasia.

Alpha-blockers should be avoided by pilots doing aerobatics. They generally require a longer, up to one month, ground trial. BP determination lying and standing to observe for postural drop should be recorded on several occasions prior to authorising a return to flying.

Particular care must be taken in assessing applicants working in a hot environment, with possible resulting dehydration, or exposure to high G loads (i.e. agricultural pilots, aerobatic pilots).

Measurement of Blood Pressure:

The blood pressure is measured in the sitting position. The arm must be supported and held at the level of the Atria. If the BP is outside the range 90-140 systolic, lying and standing BP readings should also be taken.

If initial two readings are below 140 systolic and 90 diastolic no further action is required.

If levels are 140/90 or higher two further readings at several minutes' intervals should be taken together with pulse rate.

The same applies to people on antihypertensive medication. Standing and lying readings should also be taken for those on medication to assess for postural drop ([see Blood Pressure Examination Report form 24267-114](#)).

If three blood pressure readings exceed 140/90, hypertension is likely and further readings over several days should be taken. This can be done by the applicant's own GP or their nursing staff. Persistently elevated blood pressure should not be dismissed as due to “white coat”. If hypertension is suspected a fundus examination should be done.

Pre-existing records from the GP, community readings or ambulatory monitoring can assist in confirming if an individual suffers from unacceptable hypertension. They should be obtained whenever in doubt.

If still in doubt a 24 h blood pressure recording should be considered and the applicant be referred to their treating physician if hypertension is confirmed.

The mean Blood Pressure can be estimated with the following formula: $[\text{Diast} + (\text{Syst} - \text{Diast}) / 3]$. The normal mean blood pressure range is 70 – 110 mmHg;

A fast pulse rate may mean that the applicant is particularly anxious; a slow pulse may reveal good cardiovascular conditioning or undeclared use of beta blockers.

Medication and Hypertension:

Beta-blockers:	Hydrophilic drugs are preferred (i.e. Atenolol, Metoprolol). Only a few days' grounding is necessary. Observe for any bronchospasm and fatigue.
ACE inhibitors:	Long acting ACE inhibitors are preferred; 1 to 3 weeks period off flying duty are recommended; Observe for postural hypotension and electrolytes imbalance. Do several lying and standing BP measurements.
Angiotensin Receptor Blocker (ARB):	Permitted, see ACE inhibitors, excellent first line.
Calcium channel antagonists:	Long acting permitted, i.e. Amlodipine. Nifedipine not permitted, unless it is a controlled release preparation, taken once daily. A one week period off flying duty is recommended.
Thiazide diuretics & Spironolactone:	Low dose diuretics only. Avoid in people with a history of gout. Watch for hyponatremia, hypokalaemia / hyperkalaemia. Only a few days off flying duty are necessary unless introduced as second line.
α-Blockers	Observe for postural hypotension. Do several lying and standing BP measurements. Avoid in aerobatic pilots. 3 to 4 weeks period off duty are recommended. Slow increase in dosage (For prostatism, selective alpha blockers should be used i.e. Tamsulozin rather than Prazocin).
Loop diuretics:	Generally not permitted – of aeromedical significance.
Centrally acting medication:	Not permitted.

3.1.3.2 Information to be provided

- A Blood Pressure Examination Report ([form 24067-214](#))
- ECG in accordance with the General Directions, or as clinically indicated;
- Fasting glucose or HbA1c and blood lipids in accordance with the GD “Timing of examination” and at other times as indicated;
- Creatinine, e-GFR and electrolytes on the first occasion that hypertension is diagnosed, then as indicated;
- Echocardiogram, if clinically indicated, i.e. suspected ventricular hypertrophy;
- Investigations to exclude secondary hypertension as clinically indicated, or
- Investigations as clinically indicated in the presence of co-existing cardiac, vascular renal disease or other significant pathology.

3.1.3.3 Disposition

Applicants with untreated hypertension should be referred back to their GP for review and treatment as appropriate.

Controlled or mild hypertension is generally allowable at all levels of medical certification.

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

- The systolic blood pressure is <160 mmHg;
- The diastolic blood pressure is < 90 mmHg;
- The 5-years cardiovascular risk assessment is below 10%; or
- If the 5-years cardiovascular risk is 10% or above, ischaemia has been excluded in accordance with any relevant General Direction;
- The ECG is normal;
- There is no evidence of ventricular hypertrophy;
- There is no evidence of end-organ damage or peripheral vascular disease;
- The medication is acceptable and there are no adverse drug side effects that are of aeromedical significance;
- There is no known or suspected unresolved cause of hypertension such as: alcoholism, reno-vascular disease, endocrine disorder, obstructive sleep apnoea, etc.

The certificate duration may be reduced and / or surveillance imposed if the ME considers it appropriate.

3.1.4 Cardiovascular Risk Assessment

3.1.4.1 Considerations

Cardiovascular events may lead to medical incapacitation. Thus an estimation of the probability of an applicant suffering a cardiovascular (CV) event is an essential part of the assessment. Such estimation is based on community prevalence of ischaemia.

The General Direction "[Timetable for Routine Examinations](#)" prescribes when a formal cardiovascular risk assessment is required to be performed.

The General Direction "[Examinations Procedures](#)" prescribes how a formal cardiovascular risk assessment should be performed.

The General Direction "Examination Procedures" requires that a 5-year CV risk estimate of 10% or above requires exclusion of cardiac ischaemia.

The information sheet "[Cardiovascular risk](#)" provides explanations for applicants. MEs may find the information useful.

Note: An applicant with a history of peripheral vascular disease, cerebrovascular accident or cardiovascular disease automatically falls in a high 5-year cardiovascular risk category, i.e. well above 10%.

Stress ECG (or ETT):

In general a symptom limited, unequivocally negative, stress ECG reaching a good level of exercise (end of stage 3, i.e. 9 minutes or above of the Bruce protocol, 85% of maximum predicted, 10 METS) is acceptable evidence of absence of ischaemia.

When a stress ECG cannot be accomplished by exercise, a pharmacological stress test may be acceptable. The reason for undertaking such test must be explained and considered.

When required, the CAA acknowledged validity of such test is:

- One year in the case of Class 1 and 3 applicants;
- Two years in the case of Class 2 applicants.

The Part 5 of this manual provides CAA [protocols](#) for the various tests and their reporting.

The relevant protocol should be printed and given to the applicant to pass on to the practitioner conducting the test. This is to ensure a high quality stress is performed, that is useful for aviation public safety purposes.

Calcium Scoring:

CT Coronary Artery Calcium Scoring (CT Calcium Scoring) is a relatively inexpensive test. Published research confirms the powerful prognostic value of a zero Agatston score.

For the purpose of the cardiovascular risk assessment, a Calcium Score of zero will allow to reassess the cardiovascular risk as being lower than suggested by the method prescribed in the GD "Examination procedures". A Calcium score of zero can be relied upon for several years.

3.1 Cardiovascular System I Revision I August 2018

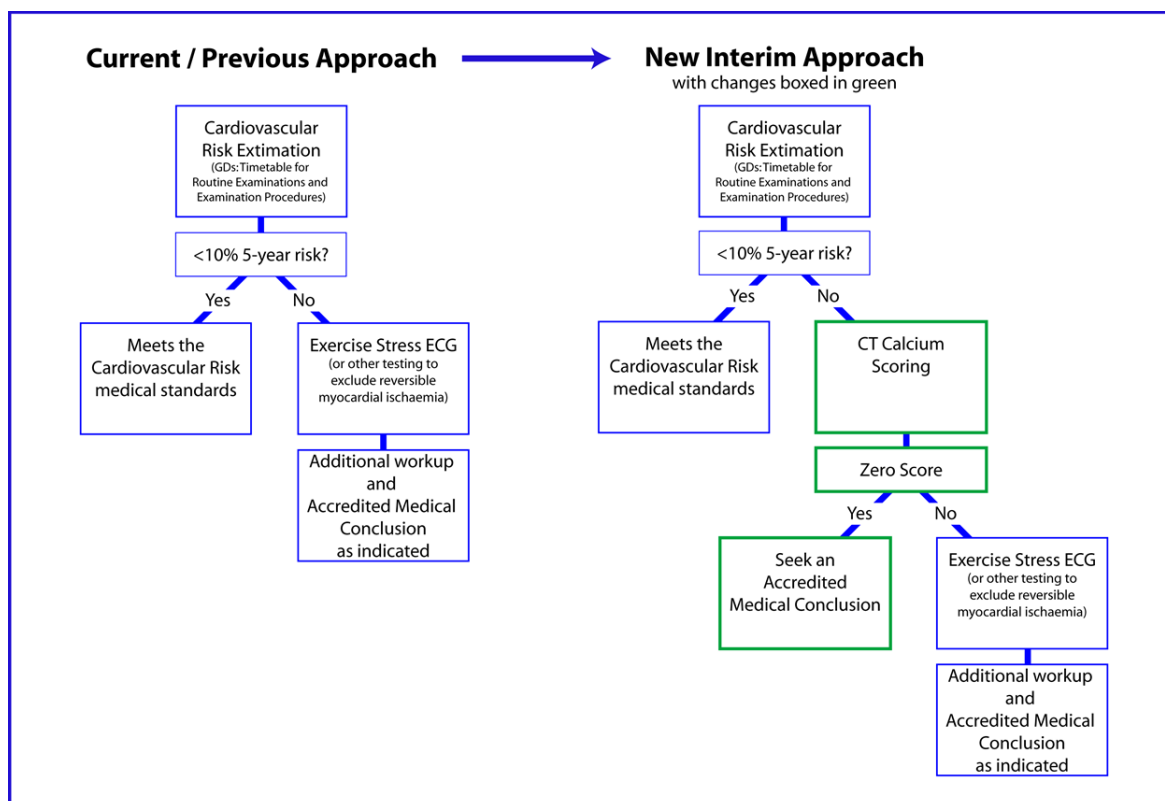
Currently, until changes are made to several documents, this policy can only be implemented via the statutory process provided by sections 27B(2) and (3) of the Civil Aviation Act flexibility (Accredited Medical Conclusion).

At this point of time CAA will accept an Agatston score of zero as remaining valid for a period of five years.

So, currently:

1. If an applicant returns an elevated 5-year Cardiovascular Risk Estimation (10% or greater) then a CT Calcium Score may be undertaken instead of an Exercise Stress ECG;
2. If the CT Calcium Score is zero the application may be progressed via the statutory flexibility process, by applying for the identification of AMC experts;
3. If the CT Calcium Score is non-zero then the usual workup, to exclude reversible myocardial ischaemia, is required.

This process is also shown here in diagram form.



Other cardiac tests:

In some cases a stress ECG is not sufficient to exclude ischaemia because of an insufficient level of exercise, a non-unequivocally negative or a positive tracing.

A stress echocardiogram or myocardial perfusion scan can be undertaken to more reliably exclude ischaemia. Other reasons to undertake such investigations may be the applicant's cardiovascular history or a previous equivocal stress ECG. In doubt MEs should contact the CAA.

The role of other investigative modalities has not been clearly established in the context of aeromedical certification. MEs should consult with CAA whenever an applicant presents to

them having undergone any other such investigations, including coronary angiography or CT coronary angiography.

3.1.4.2 Information to be provided.

See comments about CT Calcium Scoring that may affect the following list.

- ECG, blood lipids and blood glucose or HbA1c, in accordance with the GD “Timing for Routine Examinations”;
- Cardiovascular risk assessment in accordance with the GDs “Timing of Routine Assessments” and “Examination Procedures”;
- In the case of a Class 1 or 3 applicant: Annual stress ECG (or test of higher sensitivity / specificity as appropriate) when ischaemia needs excluding under the GD “Examination Procedure” - Full ECG tracings and report to be provided to CAA;
- In the case of a Class 2 applicant: Two yearly stress ECG (or test of higher sensitivity / specificity as appropriate) when ischaemia needs excluding under the GD “Examination Procedure” - Full tracing and report to be provided to CAA;
- Tests and reports as may have been advised by CAA in the case of an applicant with a history of cardiovascular disease. Such applicants often require annual specialist review and exercise testing of some kind.

3.1.4.3 Disposition

- An applicant with an estimated 5-year CV risk below 10 % may be assessed as not having a condition that is of aeromedical significance;
- An applicant with an estimated 5-year CV risk of 10 % or above, who has provided an unequivocally negative stress ECG, may be assessed as having a condition that is not of aeromedical significance. The test must be to a good level of exercise i.e. at least end of stage 3 of the Bruce protocol, 85% of maximum predicted heart rate or 10 METS, and be free of symptoms and signs of ischaemia;
- An applicant who has undergone Calcium Scoring, with a zero score, may be considered, under the flexibility process (i.e. AMC), as having a cardiovascular risk of less than 10% at five years;
- An applicant with a history of cardiac ischaemia, cerebrovascular or peripheral vascular disease should be assessed as having a condition that is of aeromedical significance and should be considered under the flexibility process.

3.1.5 Coronary Heart Disease

3.1.5.1 Considerations

In this subsection we will refer to ischaemic heart disease (IHD) when ischaemia is present and coronary artery disease (CAD) when there is known CAD but ischaemia is absent or has resolved.

Ischaemia may be diagnosed following an acute coronary syndrome, the development of angina or arrhythmia, an abnormal ECG or through routine screening for elevated CV risk.

An applicant with a history of cardiac ischaemia should be considered as having ongoing elevated cardiovascular risk, even if full revascularisation has taken place.

Demonstration of absence of ischaemia, adequate cardiac function (LVEF 50% or above), and adequate control of risk factors have to be demonstrated, initially and recurrently. In particular:

- Smoking cessation if the applicant is a smoker; and
- Use of antithrombotic agents: Aspirin lifelong and another agent (i.e.: Clopidogrel, Ticagrelor) for twelve months post event; and
- Use of a Statin for plaque stabilisation; and
- Satisfactory blood lipids profile; and
- Use of a beta-blocker or other cardio-protective medication if advised by the treating cardiologist.

Operational restrictions are generally imposed on medical certificates Class 1 and occasionally on medical certificates Class 2 and 3, in order to mitigate third party risk.

3.1.5.2 Information to be provided

On the first occasion that an applicant presents with a history of acute coronary syndrome or coronary artery disease with or without revascularisation.

- All discharge summaries;
- All specialists reports;
- Any angiography report and images, including an electronic copy;
- Any echocardiogram report and images, including an electronic copy if available;
- All stress ECGs, including complete tracings and reports;
- Any other investigation reports, for instance myocardial perfusion scan or stress echocardiography, with all tracings/ images/ videos;
- Any Holter monitoring tracing and report,
- Blood lipids, glucose or HbA1c and renal function.

On subsequent occasions that an applicant presents with a history of coronary syndrome or a history of coronary artery disease, at least annually.

- Recent cardiologist report;
- Copy of any interim investigation report;
- Demonstration of absence of ischaemia by stress ECG or stress echocardiography or as advised by CAA;
- Blood lipids, glucose or HbA1c, and renal function.

Note: Applicants applying six monthly, should provide the above information annually, all things being equal, or as required otherwise by CAA or the ME.

3.1.5.3 Disposition

- An applicant with a history acute coronary syndrome or any history or symptoms suggestive of cardiac ischaemia should be considered as having a condition that is of aeromedical significance.

Under the flexibility process, many applicants with a history of ischaemic cardiac disease are able to be certificated. CAA generally requires the following medical evidence:

- 6 months have lapsed since the acute coronary event and any re-vascularisation procedure;
- Satisfactory cardiac vascularisation;
- Satisfactory cardiac function: LVEF 50 % or above;
- Absence of ischaemia, demonstrated at 6 months post event and then annually. The acceptable tests to demonstrate absence of ischaemia may vary on a case by case basis;
- Control of risk factors: Non-smoking, favourable blood lipid profile;
- Compliance with optimum medication.

Under the flexibility process, an applicant who has undergone coronary artery stenting to be considered for certification earlier than 6 months post re-vascularisation, provided that:

- There has been no myocardial infarction;
- Three months have lapsed since stenting;
- The cardiac function is normal;
- There is single vessel disease, not affecting the main coronary artery or the proximal LAD;
- Absence of ischaemia is demonstrated at three months post stenting;
- There is control of risk factors: Non-smoking, favourable blood lipid profile;
- There is compliance with optimum medication.

3.1.6 Mitral valve disease

3.1.6.1 Considerations

Auscultation remains the main screening test for valvular heart disease. Systolic murmurs in the young and slim are very common and are generally benign and of no consequence. The cause of a murmur should however be ascertained, particularly when dealing with an applicant planning to do a career in aviation or in older pilots first presenting with a heart murmur. An innocent murmur is systolic, soft and musical, and heard at the upper left sternal border. There is no historical or clinical suggestion of any heart disease.

Rheumatic heart disease is fortunately uncommon in a population of applicants for a medical certificate. One needs to remember however that NZ has a relatively high incidence of rheumatic fever.

Lesions that produce volume overload are better tolerated than those producing pressure overloads.

Rheumatic mitral stenosis and / or regurgitation can lead to atrial fibrillation (AF) and cerebral embolism, particularly if associated with atrial dilatation. Fast AF poses a risk of syncope, particularly if associated with mitral stenosis. There is an elevated risk of endocarditis.

The mitral annulus may be calcified, usually in the elderly, or dilated. Leaflets may be affected by rheumatic fever, endocarditis, myxomatous degeneration or redundant tissue, causing prolapse. There may be rupture of the chordae tendinae or papillary muscle rupture or dysfunction from endocarditis or ischaemia.

Mitral valve prolapse is relatively common, being found in 5-8% of the general population. Mild mitral prolapse and regurgitation not associated with ventricular or atrial dilatation is acceptable. More than mild mitral regurgitation, ventricular dilation [$>6\text{cm}$ diastolic or $>4.1\text{cm}$ systolic dimension] and atrial dilatation of 4.5 cm or more are of concern to flight safety.

The ECG may show signs of left atrial (LA) enlargement, left ventricular hypertrophy (LVH) or AF. Cardiac echocardiography is the most useful and often the only test needed. It allows evaluation of chambers size and function, identification of any anatomical abnormalities, estimate the severity of any regurgitation and establish a base line for follow-up.

3.1.6.2 Information to be provided

- An echocardiogram report on the first occasion that an applicant presents with a history of rheumatic fever or that a murmur is heard, other than a faint typical flow murmur in a young applicant;
- Other tests such as stress ECG, as recommended by the investigating cardiologist or advised by CAA.
- Subsequent recurrent reports and investigations as advised by the investigating cardiologist or CAA.

3.1.6.3 Disposition

Mitral regurgitation (MR)

An applicant with no more than mild mitral prolapse and / or regurgitation may be assessed as having a condition that is not of aeromedical significance provided:

- The applicant is asymptomatic; and
- There is no history of any tachyarrhythmia or AF;
- There is no history of cardiac ischaemia; and
- The ventricular dimensions and ejection fraction are normal; and
- The left atrium is less than 4.5 cm in diameter; and
- The mitral valve is not myxomatous;
- Any regurgitation is classified as mild by the investigating cardiologist;
- Any regurgitation is not due to ruptured chordae or LV wall dysfunction;
- The applicant undergoes a cardiologist review and echocardiogram every two years or more frequently if so advised by the treating cardiologist or CAA;
- Trivial to mild MR in the absence of any valve or LV abnormality does not need any further follow up.

An applicant, who does not meet the conditions outlined here, should be considered as having a condition that is of aeromedical significance.

Mitral Stenosis (MS)

An applicant with mitral stenosis should be considered as having a condition that is of aeromedical significance, unless:

- The applicant is in sinus rhythm; and
- The ECG is normal; and
- The valve area is over 2 cm²; and
- The pressure gradient across the valve is < 5 mmHg; and
- The mitral stenosis is considered to be mild by the investigating cardiologist.

3.1.7 Aortic valve disease

3.1.7.1 Considerations

Auscultation remains the main screening test for valvular heart disease. Systolic murmurs in the young and slim are very common and are generally benign and of non-consequence. The cause of a murmur should however be ascertained, particularly when dealing with an applicant planning to do a career in aviation or in older pilots first presenting with a heart murmur. An innocent murmur is systolic, usually soft and musical, and heard at the upper left sternal border. There is no historical clinical suggestion of any heart disease.

Bicuspid aortic valve affects around 1% of the population. It increases the risk of endocarditis, and may lead to aortic stenosis, regurgitation and aortic dilatation. Haemodynamic changes occur slowly and problems generally only occur in the fifth decade or later. Bicuspid aortic valve requires surveillance but is seldom a cause to decline medical certification. A flow velocity across the valve of 2 m/sec or less and an ascending aortic dimension of less than 3.8 cm should generally not affect eligibility.

Aortic regurgitation, if acute, may be caused by endocarditis, dissecting aneurysm and trauma. Chronic aortic regurgitation may be caused by bicuspid aortic valve, rheumatic heart disease, myxomatous degeneration, aneurysm of the ascending aorta, annulo-aortic ectasia, Marfan syndrome and similar. Other possible causes are Syphilis and ankylosing spondylitis.

Aortic regurgitation is generally well tolerated for prolonged period until left ventricular failure, pulmonary oedema, palpitations or angina develop. Clinical signs are wide systo-diastolic blood pressure gradients, bounding pulses (water hammer pulse) and bifid pulse.

The ECG may show signs of LA enlargement or LVH. The chest X-ray may show a dilated aortic root or a large heart. Echocardiography is the most useful and often the only test needed. It allows to evaluate chambers size and function, identify any anatomical abnormalities, estimate the severity of any regurgitation and establish a base line for follow-up.

Even moderate aortic regurgitation may be acceptable as long as there is good exercise tolerance and no evidence of diastolic dilatation.

Aortic stenosis may result in the inability to maintain cardiac output and blood pressure if faced with increased output demand or vasodilation. This may result in the inability to provide adequate cardiac perfusion to a hypertrophied myocardium.

The stenosis may be congenital, secondary to a bicuspid aortic valve, degenerative, or secondary to rheumatic heart disease. It is generally marked by a long asymptomatic phase during which the pressure gradient across the valve increases at a quoted rate of around 7 mmHg / year and the valve area decreases by around 0.15 cm² / year. These figures are however highly variable.

When a patient becomes symptomatic the clinical progression may be rapid with a high mortality incidence, the five year survival being less than 50%. There is a high risk of syncope or sudden death. Symptoms are poor exercise tolerance, light headedness, syncope and angina.

Aortic stenosis ECG changes consist of signs of left ventricular hypertrophy and left atrial enlargement seen in around 80 % of patients.

Aortic Stenosis Severity Criteria [European Society of Cardiology guidelines]:

	Mean gradient mmHg	Aortic Jet Velocity	Aortic valve area cm ²
Mild	< 20	2.6 – 2.9 m/s	> 1.5
Moderate	20 – 40	3.0 – 4.0 m/s	1.0 – 1.5
Severe	> 40	>4.0 m/s	< 1.0

3.1.7.2 Information to be provided

- Cardiologist report on the first occasion that an applicant presents with a history of aortic stenosis, or a murmur, other than a faint typical flow murmur in a young Class 2 applicant;
- Echocardiogram;
- Other tests such as stress ECG, as recommended by the investigating cardiologist or CAA;
- Subsequent recurrent reports and investigations as advised by the investigating cardiologist or CAA.

3.1.7.3 Disposition

An applicant with aortic stenosis or bicuspid aortic valve should be considered as having a condition that is of aeromedical significance unless:

- The applicant is asymptomatic;
- Exercise tolerance is normal;
- There is no arrhythmia detected;
- There is no ventricular enlargement or hypertrophy; and
- The ascending aorta diameter is less than 3.8 cm; and
- The velocity across the valve is less than 3 m/sec or the mean pressure gradient is less than 25 mmHg; and
- The valve area is 1.5 cm² or more; and
- The applicant undergoes a cardiologist review and echocardiogram every two years or more frequently if so advised by the treating cardiologist or CAA.

In doubt the MEs should contact CAA for advice.

3.1.8 Tricuspid and Pulmonary valve disease

3.1.8.1 Considerations

Tricuspid stenosis is most commonly associated with rheumatic fever but may be caused by other conditions. In the case of rheumatic fever it is invariably associated with involvement of the left sided valves. Tricuspid stenosis results in right atrial hypertension and elevated systemic venous pressure with associated pulsations in the neck veins and peripheral oedema. It may be protective of the pulmonary vascular bed if there is co-existing mitral stenosis. The diastolic heart murmur, best heard along the left low sternal border, increases with inspiration. The ECG may show tall, tented shape, P waves.

Tricuspid Regurgitation is most commonly secondary to right ventricular dilatation and hypertrophy. The jugular veins will display large waves. The murmur is holosystolic and best heard over the left sternal edge, during inspiration. AF is often present with little else showing on the ECG. Tricuspid regurgitation results in hepatic congestion and peripheral oedema.

Pulmonary valve stenosis is most commonly the result of congenital heart disease. See subchapter 3.1.26.

Pulmonary valve regurgitation is commonly caused by pulmonary hypertension, itself secondary to mitral stenosis, pulmonary thrombus or chronic lung disease. The murmur is diastolic and high pitched and best heard along the left sternal border.

3.1.8.2 Information to be provided

- Information relating to any associated cardiac condition as outlined in this chapter;
- Cardiologist report on the first occasion that an applicant presents with a murmur, other than a faint typical flow murmur in a young applicant, or with a history of pulmonary or tricuspid valve disease;
- Echocardiogram;
- Other tests such as stress ECG, as recommended by the investigating cardiologist or CAA;
- Subsequent recurrent reports and investigations as advised by the investigating cardiologist or CAA.

3.1.8.3 Disposition

- An applicant with a history of Tricuspid or Pulmonary valve disease should generally be considered as having a condition that is of aeromedical significance.

3.1.9 Valve replacement or repair

3.1.9.1 Considerations

Valve replacement usually means that severe valve disease has existed, often accompanied by atrial dilatation, ventricular hypertrophy or dilatation, possible aortic dilatation and other cardiac functional impairment, including arrhythmia.

Mechanical valves result in an elevated thrombo-embolic stroke risk necessitating the use of anticoagulation with Warfarin. The target INR for aortic valve replacement is 2.0 – 3.0. The target INR for mitral valve replacement is 2.5-3.5, but these targets may be individualised depending on the patient and the type of prosthesis (See use of Warfarin at the end of this chapter).

Novel Oral Anticoagulants (NOACs) such as Dabigatran, Rivaroxaban and similar are not currently considered appropriate prophylaxis in the case of mechanical valve replacement. This may change in the future.

Bio-prosthetic valves are safer in regard to the thrombo-embolic risk and generally do not require anticoagulation by Warfarin, Aspirin treatment being sufficient. They may not provide for ideal valve sizing and can result in less than optimal valvular function. They also have a more limited lifespan.

A heart that has undergone any form of surgery should be regarded as being compromised.

Valvular surgery is not cognitively benign. Cerebral impairment is a known complication following open heart surgery. Mood disorders, loss of confidence and anxiety are common post-operative features.

3.1.9.2 Information to be provided

- Copy of all pre and post-operative cardiologist consultations reports;
- Copy of the operating report;
- Copy of all investigations complete reports, to include images and full tracing of any stress ECG or Holter monitoring;
- Copy of GP notes for the past 12 months.

3.1.9.3 Disposition

- An applicant with a history of valvular replacement or repair should be considered as having a condition that is of aeromedical significance.

3.1.10 Atrial Fibrillation (AF) and Atrial Flutter

3.1.10.1 Considerations

Atrial fibrillation is the commonest rhythm disorder, affecting 1% of the general population and 10 % of people over age 80. AF is commonly seen at a younger age in Maori and Pacific Island population, according to the NZ Ministry of Health. Its incidence is increasing.

It may be associated with structural heart disease, ischaemia, hyperthyroidism, high alcohol intake or an acute respiratory tract infection. The list is not exhaustive.

The term ‘Lone Atrial Fibrillation’ was coined in 1954. It is no longer relevant as our understanding of the condition has increased and there is no consistent definition of lone AF. A review published in the Journal of the American college of Cardiology in 2014 reads: “This working group proposes that the category of lone (idiopathic) AF no longer has either mechanistic or clinical utility, causes confusion in the literature because of tremendous variability in its definitions, and should therefore be avoided”.

A cause for AF must be sought but often cannot be identified.

Pulmonary vein isolation (PVI) has become an accepted treatment option in patients with paroxysmal atrial fibrillation (AF). Single procedure success rates of around 60% have been achieved. About 30% of patients undergo a repeat ablation procedure because of AF recurrence. Thus a period of observation of three months is generally required following this procedure together with follow up Holter monitoring.

AF may be acceptable for certification provided that:

- Any underlying condition causing AF is acceptable;
- Any episode of AF remains asymptomatic or any symptoms are not likely to interfere with flight safety;
- The AF risk of recurrence is low or adequately minimised;
- The AF, when occurring, is at a heart rate unlikely to cause haemodynamic compromise, (i.e. maximum rate 90 bpm at rest, 200 bpm on exercise);
- The AF, if chronic, is asymptomatic and at a heart rate unlikely to cause haemodynamic compromise, even under effort, i.e. (90 bpm at rest, 200 bpm on exercise);
- Medication is acceptable and well tolerated;
- The thromboembolic risk is acceptably low;
- The bleeding risk is acceptably low if anticoagulants are used. (See use of Novel Oral Anticoagulants (NOACs) and Warfarin at the end of this chapter).

3.1.10.2 Information to be provided

On the first occasion that an applicant presents with a history of AF:

- Copy of any discharge summary;
- Copy of all specialists' reports;
- Copy of all investigations reports, to include all laboratory results, full tracing of all ECGs, stress ECGs and Holter recordings, and all cardiac imaging;
- If Warfarin is used, a copy of all INR results for at least the past 6 months;
- If Flecainide is used, a recent trough level determination result.

On subsequent occasions:

- Copy of any interim cardiologist and investigations reports;
- A recent cardiologist report as recommended by the treating cardiologist or CAA.

3.1.10.3 Disposition

- An applicant with a history of Atrial Fibrillation should be considered as having a condition that is of aeromedical significance;
- An applicant with a history of Atrial Flutter should be considered as having a condition that is of aeromedical significance;
- An applicant with a history of Atrial Fibrillation and Pulmonary Veins isolation should be considered as having a condition that is of aeromedical significance.

3.1.11 Atrial and ventricular premature beats

3.1.11.1 Consideration

Atrial and premature ventricular, or ectopic beats, are common findings on routine ECG. Frequently benign, their presence may however suggest the possibility of aeromedically significant arrhythmia or underlying cardiomyopathy.

The finding of no more than one atrial premature beat or one ventricular premature beat on a routine ECG is acceptable without further investigations.

Atrial ectopic beats are common and mostly harmless unless very frequent, or sustained. Holter monitoring is helpful in detecting the presence of sino-atrial disease and any tachycardia of aeromedical significance.

Ventricular premature beats are also usually harmless if infrequent, unifocal and the heart is anatomically normal. Couplets, multifocal ectopics and bouts of tachycardia not exceeding 120 bpm may still be acceptable following detailed specialist assessment.

3.1.11.2 Information to be provided

On the first occasion that symptomatic or frequent ectopy is diagnosed, a 24h Holter monitor;

- A cardiologist report if the Holter is abnormal, or reveals more than 2 % of ectopic beats over the 24h period, or if the applicant is symptomatic;

On subsequent occasions:

- A cardiologist report if there is an increase in the frequency of premature beats, the applicant has become symptomatic, or such review has been advised.

3.1.11.3 Disposition

- An applicant with a history of relevant symptoms (distraction, dizziness, fainting), couplets or runs, multifocal premature beats, abnormal heart anatomy, or abnormal 24h Holter, should be considered as having a condition that is of aeromedical significance;
- An applicant with more than one premature beat on the ECG but no more than 2% premature beats on a 24h Holter, may be assessed as having a condition that is not of aeromedical significance, if there is no suspicion of underlying heart disease;
- An applicant previously investigated for premature beats that were considered not aeromedically significant, may be considered as having a condition that is not of aeromedical significance if there has been no suspected change in condition;
- An applicant with no more than one premature beat on the ECG may be considered as having a condition that is not of aeromedical significance.

3.1.12 Sinus node arrest and sinoatrial block

3.1.12.1 Consideration

Sinus pauses may at time be seen in athletes with high vagal tones. Sinus node dysfunction can lead to pauses or tachyarrhythmia. The condition usually progresses slowly with no complications for sustained periods, but will eventually become problematic, requiring a pacemaker.

Asymptomatic applicants found to have sinoatrial dysfunction at routine ECG can often be certificated following investigations, with ongoing surveillance.

3.1.12.2 Information to be provided

On the first occasion that an applicant present with an abnormal ECG suggesting sinoatrial disease:

- A cardiologist report;
- 24h Holter monitor;
- Other tests as suggested by the cardiologist or CAA. This may include Electro-Physiology study.

On subsequent occasions that an applicant present with an abnormal ECG suggesting sinoatrial disease:

- Investigations results as recommended following earlier cardiologist review, or by CAA.

3.1.12.3 Disposition

- An applicant with evidence of, or suspected sinoatrial disease should be considered as having a condition that is of aeromedical significance.

A certificate is likely to be issued if the applicant is asymptomatic, there are no pauses longer than 2.5 sec, no complex or sustained rhythm disturbance, and no other unacceptable characteristic have been identified.

3.1.13 Ventricular pre-excitation

3.1.13.1 Considerations

This spectrum of ventricular pre-excitation syndromes includes Wolff-Parkinson-White pattern, Lown-Ganong-Levine and other similar conditions related to an accessory pathway.

They also include atrioventricular and atrioventricular nodal re-entrant tachycardia, (AVRT and AVNRT respectively). These can lead to rapid tachycardia and cardiovascular compromise, and even syncope. This is more likely to occur if AF develops.

WPW may be compatible with flying with demonstration of a long by-pass tract refractory period.

3.1.13.2 Information to be provided

On the first occasion that an abnormal ECG, suggestive of pre-excitation, is identified or that a history of tachy-arrhythmia or cardiovascular compromise exists:

- A cardiologist report;
- A 24h Holter monitor;
- Electrophysiology study will often be required;
- Other tests as may be suggested by the cardiologist or CAA during an AMC process.

On subsequent occasions:

- ECG;
- 24-Holter or other tests as may have been suggested by a cardiologist or CAA.

3.1.13.3 Disposition

- An applicant with a history of ventricular pre-excitation should be considered as having a condition that is of aeromedical significance;
- An applicant with a history of ventricular pre-excitation treated by radioablation should be considered as having a condition that is of aeromedical significance;
- An applicant with a history of accessory pathway successfully treated by radio-ablation may be considered as having a condition that is not of aeromedical significance if a previous AMC has deemed the condition to be no longer of aeromedical significance, in the absence of new ECG changes or symptoms.

3.1.14 Atrio-Ventricular block (AV block)

3.1.14.1 Considerations

First degree heart blocks are common and often the result of high vagal tone. In this situation, increasing the heart rate to a higher level, i.e. 100 bpm or more, by doing some exercise, and repeating the ECG, should see a normalisation of the PR interval. A conduction defect must be suspected if the PR interval does not normalise, or if the PR interval increases over time.

The PR interval can occasionally be found to be very prolonged. If normalising with exercise, this is likely to be due to a very high vagal tone in a healthy individual.

The combination of AV block and a bundle branch block however suggests the existence of a conduction tissue disorder.

Mobitz I (Wenkebach) AV block may be seen in normal individuals during sleep. However, the presence of second degree block requires investigation as those can occasionally progress to complete block.

Mobitz II AV block and complete heart blocks are generally not acceptable.

3.1.14.2 Information to be provided

On the first occasion that the PR interval is abnormal (i.e. ≥ 210 ms); or if the PR interval has increased since last investigated.

- ECG following exercise to raise the heart rate;
- A cardiologist report in the case that a Mobitz I (Wenkebach) AV block has been identified), this should generally include a Holter monitoring.

3.1.14.3 Disposition

- An applicant presenting with a first degree AV block that normalises [< 200 ms] during exercise may be considered as having a condition that is not of aeromedical significance.
- An applicant presenting with second degree AV block, Mobitz I type, should be considered as having a condition that is of aeromedical significance, unless a previous AMC has considered the condition to be of no ongoing aeromedical significance;
- An applicant with a second degree AV block, Mobitz II, or third degree AV block, should be considered as having a condition that is of aeromedical significance.

3.1.15 Left Bundle Branch Block (LBBB)

3.1.15.1 Consideration

Left Bundle Branch Block results from ischaemic heart disease in over a quarter of cases. This is particular true for applicants presenting over the age of 45 with a new LBBB. The risk of sudden death in this group is about 10 times that of a control group. A LBBB may manifest as an intermittent rate related phenomenon or be constant.

The discovery of a LBBB requires investigations. Stress ECG alone is unable to exclude ischaemia. Stress echocardiography or myocardial perfusion scan are necessary for that purpose. A stress echocardiography can be difficult to interpret as the LBBB will affect septal motion.

3.1.15.2 Information to be provided

On the first occasion that an applicant presents with LBBB:

- A cardiologist report and investigations reports to include at least the result of a stress echocardiogram, alternatively a CT Coronary Angiography or stress myocardial perfusion scan (MPI). The applicant should not be exercising their privileges while investigations are carried out.
- Other tests as may be required during the flexibility process.

On subsequent occasions:

- Reports and tests results as recommended by a cardiologist and / or advised by the CAA.

3.1.15.3 Disposition

An applicant with LBBB must be considered as having a condition that is of aeromedical significance; unless:

- A previous AMC has concluded that the condition may be considered as not being of aeromedical significance.

3.1.16 Right Bundle Branch Block(RBBB)

3.1.16.1 Consideration

Incomplete RBBB is common, being seen in 2-3 % of routine ECGs. It has no negative prognostic features. It is considered to be a normal variant of no aeromedical significance.

Complete RBBB is seen much less frequently. It has a good prognosis provided that ischaemia has been excluded and there is no associated cardiac abnormality or atrioventricular block.

3.1.16.2 Information to be provided

On the first occasion that an applicant presents with a RBBB a cardiologist report to include:

- The result of an echocardiogram;
- A stress ECG if the applicant is aged 45 years old or above, or if required under the General Directions, or as clinically indicated.

On subsequent occasions:

- Routine investigations as prescribed by the General Directions, provided no change to the ECG has occurred;
- A cardiologist report if a change to the ECG has occurred.

3.1.16.3 Disposition

On the first occasion that an applicant presents with an RBBB, that applicant may be considered as having a condition that is not of aeromedical significance if:

- No myocardium anatomy abnormality has been identified;
- There is no AV block;
- Ischaemia has been excluded by stress testing if the applicant is 45 years old or above, or if required under the General Directions, or as clinically indicated.

On subsequent occasions that an applicant presents with an RBBB, that applicant may be considered as having a condition that is not of aeromedical significance if:

- The ECG has not changed;
- The applicant's cardiovascular risk estimate is assessed as being acceptable under the GD.

3.1.17 Left anterior and Left posterior Hemi-Block

3.1.17.1 Consideration

These ECG abnormalities can be found in 1-2 % of healthy individuals.

If recently acquired, left anterior hemiblock raises the possibility of ischaemia or progressive conduction defect.

The same applies to left posterior hemiblock, though the latter is ten times less frequent and often of little significance.

3.1.17.2 Information to be provided

On the first occasion that an applicant presents with a left anterior or posterior hemiblock, a cardiologist report to include:

- The result of an echocardiogram;
- A stress ECG if the applicant is aged 45 years old or above, or if required under the General Directions, or as clinically indicated.

On subsequent occasions that an applicant presents with a left anterior or posterior hemiblock:

- Routine investigations as prescribed by the General Directions, provided no change to the ECG has occurred;
- A cardiologist report if a change to the ECG has occurred.

3.1.17.3 Disposition

On the first occasion that an applicant presents with a left anterior or posterior hemiblock, that applicant may be considered as having a condition that is not of aeromedical significance if:

- No myocardium anatomy abnormality has been identified;
- Ischaemia has been excluded by stress testing if the applicant is 45 years old or above, or if required under the General Directions, or as clinically indicated.

On subsequent occasions that an applicant presents with a left anterior or posterior hemiblock, that applicant may be considered as having a condition that is not of aeromedical significance if:

- The ECG has not changed;
- The applicant's cardiovascular risk estimate is assessed as being acceptable under the GD.

3.1.18 QT Prolongation

3.1.18.1 Considerations

Long QT syndrome is transmitted as an autosomal recessive condition when associated with deafness or as an autosomal dominant condition without this association. The syndrome may be marked by sudden loss of consciousness due to tachyarrhythmia and possibly death due to torsade de pointe. The QT measurement should be corrected by dividing its value by the RR² interval to obtain the QTc. The longer the QTc, the greater the risk of an acute event. The QT may be influenced by medication so that moderately prolonged QT intervals may become symptomatic in some circumstances.

3.1.18.2 Information to be provided

- ECG tracing(s) and cardiologist interpretation;
- Detailed of any applicant's fainting or near fainting episode;
- Detailed of any family member fainting episode or sudden cardiac event.

3.1.18.3 Disposition

- An applicant presenting with a prolonged QTc > 450 ms for males and >460 ms for females should be considered as having a condition that is of aeromedical significance.

Note:

An ME who is unsure if the QTc is prolonged should send the ECG to a cardiologist for interpretation, as prescribed in the GD 'Examination Procedures.

If a prolonged QTc is confirmed or if the ME is still uncertain about the tracing characteristics, the ME may seek a further ECG review by CAA prior to deciding whether to proceed via the section 27B(1) pathway. Alternatively the ME may consider outright to assess the application under section 27(B2).

The ME should also consider any medication used by the applicant, capable of affecting the QT and QTc duration.

3.1.19 Brugada syndrome

3.1.19.1 Considerations

This condition is named after three cardiologists, the Brugada brothers, who have described this syndrome. The syndrome is characterised by the possibility of sudden death in people who present with a particular ECG pattern.

The Brugada brothers have published a long term follow up study (Circulation 2002;105:73-78). They studied three groups of patients with Brugada pattern ECGs, some of whom have had cardiac arrests, some of whom had presented with syncope and some who were asymptomatic. Of the symptomatic group more than 70% had a family history of sudden cardiac death. The paper states that they would not diagnose Brugada syndrome in an individual with a “saddle-like” ECG without inducing a coved type ECG on pharmacological testing. The ECG pattern may vary from time to time, making the diagnosis difficult. It is also difficult to predict its aeromedical significance.

3.1.19.2 Information to be provided

An applicant presenting with a history of Brugada syndrome or showing a Brugada pattern of their ECG should provide:

- Copy of all previous ECG tracings unless already submitted to CAA;
- Copy of any cardiologist report or cardiac investigation that may have been carried out unless already submitted to CAA;
- ECG at each application unless stated otherwise by CAA;
- For a first application, a copy of the GP notes for the past five years;
- Detailed of any family member fainting episode or sudden cardiac event.

3.1.19.3 Disposition

- An applicant with an ECG pattern suggestive of, or a diagnosis of Brugada syndrome should be considered as having a condition that is of aeromedical significance.

The possible outcomes following an AMC are:

Diagnostic Features	Certification Disposal
Definite Brugada pattern, and syncope or family history of sudden death	Ineligible
Definite Brugada pattern; but no syncope, and no family history of sudden death, and asymptomatic.	Class 1: No Single Pilot Air Operations carrying passengers
Brugada pattern not definite	Class 1 & 2: Unrestricted

However, every conclusion is made on a case by case consideration and may differ from this advice. An electrophysiology study may be required.

3.1.20 Implantable Devices - Pacemaker

3.1.20.1 Considerations

Pacemakers have a failure rate well below 1% per annum. The leads have a higher risk of failure, of around 1% per annum. Regular pacemaker checks will often detect failing leads in good time. Modern pacemakers will also record episodes of arrhythmia that can be identified by downloading the data during checks.

Unipolar pacemakers may interfere with aircraft systems and are usually not acceptable. Bipolar pacemakers are not likely to interfere with aircraft systems. They are generally acceptable. Implanted Cardiac Defibrillators of any kind (ICD) are not acceptable unless deactivated and no longer necessary.

3.1.20.2 Information to be provided

On the first occasion that an applicant presents with a history of pacemaker implantation:

- Copy of all cardiologists' reports; and
- Copy of all investigations reports;
- Copy of all pacemakers check reports;

On subsequent occasions:

- Copy of all subsequent cardiologists' reports;
- Copy of all interim pacemaker check reports;
- Report of investigations as recommended by the treating cardiologist and / or requested by CAA.

3.1.20.3 Disposition

An applicant with an implanted cardiac defibrillator (ICD):

- Should be considered as having a condition that is of aeromedical significance. A certificate is unlikely to be issued.

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

- An earlier AMC allowed for an unrestricted medical certificate in regard to the implanted device;
- There has been no change of condition;
- There is no associated cardiac condition that is of aeromedical significance;
- The device is fitted with bipolar leads;
- The applicant is not pacemaker dependant;

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- The applicant undergoes pacemaker checks as recommended by the treating physician, at least 6 monthly;
- A recent pacemaker check was normal and did not reveal concerning arrhythmia.

3.1.21 Cardiomyopathy

3.1.21.1 Considerations

In this subchapter we consider cardiomyopathy as a myocardial disorder not caused by hypertension, valvular disease or ischaemia. It is characterised by systolic and, or diastolic dysfunction. The cardiomyopathy may be dilated or hypertrophic. Cardiomyopathy can be due to alcohol, viral infection, or infiltration by amyloid or sarcoid granuloma. This list is not exhaustive. There might be fibrosis or eosinophilic heart disease. Infiltrative disease commonly leads to arrhythmia and may cause sudden death.

Cardiac sarcoidosis for instance may result in atrioventricular block or ventricular rhythm disturbance. Cardiac sarcoidosis has a high rate of sudden death (see also the respiratory chapter).

Dilated cardiomyopathy

This type of cardiomyopathy may result from myocarditis, alcohol abuse, be idiopathic or even congenital. Medication such as Adriamycin and radiotherapy delivered to the left chest are possible cause of dilated cardiomyopathy. Symptoms are those of exercise intolerance, fatigue and breathlessness. The condition may remain stable for prolonged period or be progressive despite optimal management. Medication usually includes an ACE inhibitor or Angiotensin II Receptor Blocker (ARB). Dilated cardiomyopathy can lead to sudden death.

There is a high risk of atrial or ventricular arrhythmia and embolism. Right ventricular cardiomyopathy is frequently arrhythmogenic.

Hypertrophic Cardiomyopathy (HCM)

Previously called hypertrophic obstructive cardiomyopathy (HOOCM), this is hypertrophic cardiomyopathy not due to hypertension or outflow obstruction such as exists in aortic stenosis. It has a genetic etiology with multiple genes identified. It is often asymmetrical. Outflow obstruction may result and this will be made worse by volume depletion or catecholamines release. Ventricular arrhythmias are common. Beta-blockers are useful in limiting the risk of obstruction.

3.1.21.2 Information to be provided

- All cardiologist consultations reports;
- All investigations reports, to include images and full tracing of any stress ECG and Holter monitoring;
- Copy of GP notes for the past 12 months.

3.1.21.3 Disposition

- An applicant with a history of cardiomyopathy should be considered as having a condition that is of aeromedical significance.

3.1.22 Pericarditis

3.1.22.1 Considerations

Pericarditis may be caused by bacterial or viral infection, ischaemic heart disease, collagen disease, metabolic abnormality, medication, cancer etc.

Pericarditis may be recurrent and there is evidence that Colchicine can reduce the likelihood of relapse. This is sometimes prescribed.

Acute non-infective or non-viral pericarditis usually, but not always, follows a benign course and resolves within weeks. Full resolution usually allows a return to flying within months.

3.1.22.2 Information to be provided

- A recent ECG;
- Copy of all cardiologist consultation reports;
- Copy of any discharge summary;
- Copy of all investigations reports and images, to include echocardiogram and full tracing of any stress ECG or Holter monitoring;
- Copy of GP notes for the past 6 months.

3.1.22.3 Disposition

An applicant who has suffered an episode of pericarditis should be considered as having a condition that is of aeromedical unless:

- The pericarditis was acute, non-infective and non-viral;
- The pericarditis has occurred more than two years ago;
- The ECG is normal;
- The cardiac function, as demonstrated by subsequent cardiac imaging, is normal;
- There is no history of arrhythmia;
- The applicant has been free of relapse during that period.

In doubt the ME should consult with CAA.

3.1.23 Aortic Aneurysm

3.1.23.1 Consideration

The incidence of aortic aneurysm increases with age. There is evidence that this condition is becoming more frequent. Aortic aneurysm has the potential to result in sudden and complete incapacitation.

Coming out of the heart, the thoracic aorta has a maximum dimension of 3.7 cm at the root, < 3.5-3.8 cm by the time it becomes the ascending aorta and 3.0 cm at the arch. The descending aorta's diameter should not exceed 2.5 cm. The normal size for the aorta depends on body surface area.

Aortic dilatation may remain static for long periods, particularly if causal factors such as hypertension have been well addressed. On average however, if aortic dilatation is present, the diameter is reported to increase by 1 mm per year for the ascending aorta, 3 mm for the descending thoracic aorta and 1.2 mm for the abdominal aorta. These figures are highly variable. However one cannot confidently determine the ascending aorta diameter better than within a 2 - 3 mm margin of error. This is true for echocardiography, MRI or CT as the measurement is technically difficult. This makes the assessment of diameter stability difficult.

For asymptomatic thoracic aneurysms, and those with bicuspid aortic valve, an ascending aorta diameter of 55 mm is generally an indication for intervention as the risk of the procedure becomes less than the risk of doing nothing. The threshold is 5.0 cm for patients with Marfan syndrome, and those with a family history of aortic dissection, but recent recommendations suggest a threshold of 5.5 cm for these patients also. Dissection may happen at smaller size and the risk of this occurring is not negligible.

3.1.23.2 Information to be provided

- A cardiologist report;
- A recent echocardiogram, cardiac MRI or cardiac CT.

3.1.23.3 Disposition

Applicant with dilated aorta of 40 mm or more:

- An applicant with an ascending aorta of 40 mm or more or with a history of symptomatic aortic disease, or aortic surgery should be considered as having a condition that is of aeromedical significance.

An applicant with a dilated ascending aorta diameter of less than 40 mm may be considered as having a condition that is not of aeromedical significance if:

- The applicant does not have Marfan syndrome, bicuspid aortic valve or a family history of aortic dissection;
- The applicant has well controlled blood pressure; and

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- The applicant undergoes a cardiologist review, to include an echocardiogram or MRI, at least every two years, or more frequently as may be advised by the cardiologist or CAA.

3.1.24 Peripheral Vascular Disease

3.1.24.1 Considerations

Peripheral vascular disease refers in this subchapter to vascular disease other than coronary artery disease. It relates to lower limbs arterial disease, carotid vessel and cerebral vessel disease, mesenteric ischaemia and renal artery disease.

A diagnosis of peripheral vascular disease implies an elevated cardiovascular risk. For instance, an applicant with femoral artery stenosis, successfully stented, should be considered as having an elevated 5-year cardiovascular risk of over 10%, possibly suffering from myocardial ischaemia or carotid artery disease.

In the case of cerebral ischaemia the probability of recurrence of stroke is of aeromedical significance. An information sheet [“Strokes and Transient Ischaemic Attacks”](#) is available on the CAA website. Please refer also to the neurology chapter of this manual.

3.1.24.2 Information to be provided

- All specialists' reports relating to any peripheral vascular disease manifestation, to include any imaging reports and operating notes;
- A cardiologist report, to include evidence of absence of cardiac ischaemia;
- Up to date specialists' reports and investigations results are likely to be requested by CAA.

3.1.24.3 Disposition

- A history of peripheral vascular disease should be assessed as being of aeromedical significance.

3.1.25 Venous Thrombo-Embolic and Anticoagulation

3.1.25.1 Considerations

Venous thrombo-embolism (VTE) disease includes deep vein thrombosis (DVT) and pulmonary embolism. The incidence is 0.1 to 0.2% per annum in the general population. The risk increases with age. A pulmonary embolism may result in subtle or sudden incapacitation, including death and is likely to affect flight safety.

Thrombo-embolic disease has a high risk of recurrence of 5 -7% per year following a first episode, or about 50 times the risk of someone who has not suffered an episode of DVT. The risk is much higher following a recurrent episode. The risk decreases over time.

Since anticoagulation has its own risks, an episode of VTE currently treated with anticoagulants implies an increased risk to flight safety.

A *provoked VTE* episode means an occurrence in the presence of a temporary risk factor, for instance pregnancy, surgery, trauma or prolonged immobilisation.

An *unprovoked or idiopathic VTE* episode means an occurrence where no temporary clinical risk factor can be identified. DVTs due to malignancy and congenital coagulopathy are not idiopathic but should generally be considered as unprovoked when making treatment decisions.

Treatment is by anticoagulants. The American College of Chest Physicians (ACCP) Guidelines recommends the following anticoagulation treatment duration, taking into account the risk versus benefit of treatment.

Provoked distal DVT	<ul style="list-style-type: none"> 3 months
Unprovoked isolated distal DVT	<ul style="list-style-type: none"> 3 months, then evaluation of risk-benefit of extended therapy
Provoked proximal DVT	<ul style="list-style-type: none"> 3 months
Unprovoked proximal DVT	<ul style="list-style-type: none"> At least 3 months, then evaluation of risk-benefit of extended therapy High risk of bleeding: 3 months Low/moderate risk: extended anticoagulation
Second provoked DVT	<ul style="list-style-type: none"> Low risk of bleeding: extended anticoagulation Moderate risk of bleeding: extended anticoagulation
DVT and active cancer	<ul style="list-style-type: none"> Low, moderate and high risk of bleeding: extended anticoagulation

The following parameters need considering since they do increase the risk of recurrence (J Fahrni and al; *Assessing the risk of recurrent venous thromboembolism – a practical approach*; Vascular Health and Risk Management 2015:11 451-459). The relative risk (RR) is between 1.5 and 2.8 depending on the parameter considered. These are:

Unprovoked proximal DVT, Obesity, Male sex, positive D-dimer test, residual thrombosis, hereditary thrombophilia, inflammatory bowel disease and antiphospholipid antibody.

Male sex and positive D-dimer test following anticoagulation have the highest relative risk (RR) of 2.8 and 2.6 respectively while Asian and Pacific Islander ethnicity decreases the risk, with a RR = 0.7

3.1.25.2 Information to be provided

Following an episode of VTE:

- Complete medical notes relating to the thrombo-embolic episode;
- A recent D-dimer test if anticoagulants have been discontinued within the past 12 months;
- A recent Ultra-Sound of the affected limb may be required;
- A haematologist report may be required.

3.1.25.3 Disposition

An applicant who has suffered from a recent thromboembolic episode, currently treated with anticoagulants:

- Should be considered as having a condition that is of aeromedical significance.

An applicant who has suffered a first thromboembolic episode more than 6 months ago and who is no longer requiring anticoagulants or is only requiring an anti-coagulant for prophylactic reasons may be considered as having a condition that is not of aeromedical significance if:

- A D Dimer test is normal;
- A follow up ultra-sound is showing resolution of the thrombus;
- A thrombophilia screen, completed at least one month after cessation of anticoagulants is normal;
- If taking prophylactic treatment with Warfarin, is assessed by following the guidelines “use of Warfarin”, in subchapter 3.1.18 of this manual;
- If taking prophylactic treatment with a novel oral anticoagulant (NOAC), is assessed by following the guidelines “use of NOACs”, in subchapter 3.1.19 of this manual;
- If the application is for a Class 1 certificate and the applicant is taking anticoagulants, a “Not valid for single pilot air operations carrying passengers is imposed”.

3.1.26 Congenital Heart Disease

3.1.26.1 Considerations

Surgical progress is now allowing many subjects to lead a reasonably normal life following successful surgical treatment. Some conditions do not require surgery because of small defects only but may still pose a risk to aviation safety due to an elevated risk of symptomatic conduction defect abnormality.

Congenital heart diseases often leave subjects with functional cardiac impairment, including risk of arrhythmia, that are of aeromedical significance. Congenital heart disease may be part of a syndrome encompassing other abnormalities.

3.1.26.2 Information to be provided

On the first occasion that an applicant presents with a history of congenital heart disease

- A recent cardiologist report;
- Copy of all cardiologist reports;
- Copy of any operating reports;
- Copy of most recent investigations reports, to include echocardiogram or MRI images and full tracing of any stress ECG or Holter monitoring;
- Copy of GP notes for the past two years.

On subsequent occasions:

- A recent cardiologist report;
- Copy of most recent investigations reports;
- Investigations reports as recommended by the cardiologist or advised by CAA.

3.1.26.3 Disposition

An applicant with a history of congenital heart disease should be considered as having a condition that is of aeromedical significance; unless:

- A previous Accredited Medical Conclusion has concluded that the condition is no longer of aeromedical significance;
- There is no evidence or suspicion of change in the applicant's condition.

An applicant with a history of closed **patent ductus arteriosus** may be considered as having a condition that is not of aeromedical significance if:

- A cardiologist report indicates normal cardiac function; and
- Absence of pulmonary hypertension.

3.1.27 Marfan's Syndrome

3.1.27.1 Considerations

Marfan's syndrome is usually transmitted via an autosomal dominant gene with variable expression.

The condition may lead to progressive aortic and mitral valve regurgitation and aortic aneurysm. For those reasons the condition is of aeromedical significance and the ability to maintain a medical certificate is likely to be compromised in the long term, assuming that a certificate can be issued.

3.1.27.2 Information to be provided

On the first occasion that an applicant presents with Marfan syndrome:

- A cardiologist report;
- An echocardiogram report;
- Copy of all previous specialists and investigations reports.

On subsequent occasions;

- Copy of any Interim cardiologist report;
- Investigations reports as recommended by the cardiologist or advised by CAA.

3.1.27.3 Disposition

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

3.1.28 Use of Warfarin

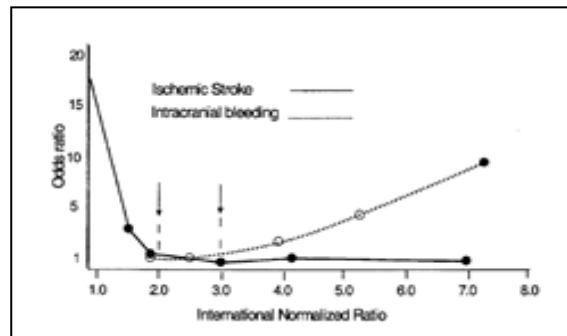
3.1.28.1 Considerations

In recent years CAA has authorised the use of Warfarin by Air Crew and Air traffic Controllers. This has paved the way for the acceptance of conditions that would otherwise carry an excessive risk of incapacitation without antithrombotic prophylaxis.

The use of Warfarin however does carry risks. Too low an INR and the risk posed by the condition being treated becomes excessive. Too high an INR and the risk inherent to Warfarin becomes excessive. This is illustrated in the following graph in the case of AF.

Thus it is critical, when certifying anyone on Warfarin, to ensure perfect compliance with:

- dosage, and
- INR testing, and
- Any condition or restriction imposed on the Medical Certificate.



3.1.28.2 Information to be provided

- INR results, dates of determination and doses for the past 6 months; at least the last 6 results should be provided;
- Confirmation of absence of any complication relating to the use of Warfarin or the condition being treated;
- All information relating to the condition being treated, in accordance with any relevant guidelines outlined in other parts of this manual.

3.1.28.3 Disposition

An applicant taking Warfarin should be considered as having a condition that is of aeromedical significance, unless:

- The condition being treated is not of aeromedical significance while being treated;
- There has been no episode of spontaneous or major bleeding;
- A condition of surveillance is imposed, requiring regular INR determinations, at least once a month and within 10 days prior to flying, and a diary kept;
- Four out of the last five INR determination results are within the therapeutic range for the condition being treated (i.e.: 2.0 - 3.0 or 2.5 - 3.5 as appropriate);
- A restriction is imposed preventing the exercises of the licence holder's privileges four out of the last five INR results are within the appropriate therapeutic range;
- A restriction "not valid for single pilot air operations carrying passengers" is imposed in the case of a Class 1 medical certificate.

3.1.29 Use of novel anticoagulants (NOACs)

3.1.29.1 Considerations

NOACs such as Dabigatran, Rivaroxaban, Apixaban and others have rapidly taken over from the use of Warfarin when anticoagulation is recommended. The exception is mechanical valve replacement for which Warfarin is recommended but this may change.

NOACs have been showed to be as effective as Warfarin, and to have a lesser risk of bleeding generally. While the gastrointestinal risk of bleeding is a little higher than for Warfarin, there is lower risk of intracranial haemorrhage. The NOACs have however a number of characteristics which are of aeromedical concern, for these reasons not all states accept the use of NOACs by pilots. These characteristics are:

- Compliance cannot be reliably ascertained;
- Their biological effect in a particular individual is not well known;
- Overdose may occur, for instance if there is decreased renal function or small body mass for the dose prescribed;
- Long haul pilots flying through multiple time zones may have difficulties taking their medication at the appropriate time. This is not unique to this medication;
- While the effects of Dabigatran can be reversed rapidly (i.e. with Praxbind®), the availability of the antidote and its cost are a barrier to access.

3.1.29.2 Information to be provided

- Medication generic name and dose;
- Renal function;
- Confirmation of absence of any complication relating to the use of NOACs;
- All information relating to the condition being treated.

3.1.29.3 Disposition

An applicant taking NOACs should be considered as having a condition that is of aeromedical significance, unless:

- The condition being treated may be considered as not being of aeromedical significance while being treated;
- The renal function is not significantly impaired: i.e. eGFR ≥ 60 ml/min/1.73m²;
- The dose is appropriate for the body size;
- There have been no episodes of spontaneous or major bleeding;
- A restriction “not valid for single pilot air operations carrying passengers” is imposed in the case of a Class 1 medical certificate and the exercise of the privileges conferred by the certificate is not permitted if any the medication has been omitted in the past 48 hours.