

DISPOSITION OF ECG FINDINGS IN USAF AIRCREW

The following guidelines standardize the aeromedical evaluation and recommendations for 12-lead electrocardiographic (ECG) findings of individuals who must qualify for any class of flying duties. One goal is to streamline the local evaluation and minimize testing and travel to the Aeromedical Consultation Service (ACS). Aircrew with normal or normal variant ECG findings **as reviewed by the ECG Library** require no further evaluation or follow-up and no waiver action. Additional local studies or an ACS evaluation may be requested by the ECG Library on all individuals with borderline or abnormal ECG findings which are new or not previously evaluated. Originals of all ECGs and any other cardiovascular studies (even if normal) must be forwarded to the ECG library for review and image storage per AFL.

If additional studies are performed at the local level and reviewed through the ECG Library as normal or normal variant, no further workup is needed. If the additional studies are reviewed as borderline or abnormal, further evaluation will be directed through the ECG Library. Unless specified otherwise, borderline and abnormal ECG findings that require additional local workup do not require waiver if the additional workup is reviewed by the ECG Library as acceptable (normal/normal variant). If ACS evaluation or AFMOA/MAJCOM waiver is required for any of the findings, the ECG library will indicate this in its correspondence. **Unless indicated clinically, only the tests requested by the ECG library need to be performed.**

In general, these recommendations are intended to guide the aeromedical evaluation of the asymptomatic aviator with an electrocardiographic finding. **The aviator who presents with symptoms, signs or findings of potential clinical significance must first be managed locally as a clinical patient.** These ECG guidelines are based on historic ACS data as well as the 2017 International criteria for ECG interpretation in athletes. *denotes new aircrew disposition guidelines based on published and ACS data since the last ECG disposition guide.

Electronic submission of cardiac studies to the ECG library is preferred with average disposition time in less than 24 hours. Upload studies at <https://acspacs.area52.afnoapps.usaf.mil/PicomCloud/Default>. You may contact the ECG library to gain access or for any questions at USAFSAM.FECIECGLib@us.af.mil.

Normal or Normal Variant ECG Findings

The following are considered normal or normal variants in our aviator population. **No further evaluation** or follow up is needed for these findings **IF ISOLATED** (two or more normal variant or borderline findings requires additional testing after ACS ECG library disposition).*

- 700. Normal ECG
- 002. Sinus bradycardia (30 to 50 beats per minute)
Note: Aeromedically, normal sinus rhythm is defined as 50-100 bpm
- 007. Sinus arrhythmia
- 028. Ectopic atrial rhythm
- 040. Accelerated junctional rhythm
- 080. Supraventricular rhythm at a rate of less than 100 bpm
- 085. Wandering atrial pacer

- 104. Second degree AV block, Mobitz Type I (Wenckebach)
- 121. Incomplete right bundle branch block
- 123. Terminal conduction delay (S wave in the lateral leads ≥ 40 msec)
- 132. Nonspecific intraventricular conduction delay, QRS ≥ 100 but < 120 msec
- 204. ST segment elevation due to early repolarization
- 221. Persistent juvenile T-waves (T wave inversions in V1-3 in an otherwise normal ECG that have been present on all previous ECG's)
- 737. Indeterminate QRS axis
- 743. S₁, S₂, S₃ pattern (S waves in the inferior limb leads)
- 744. S₁, S₂, S₃ pattern with RSR' pattern in V₁ or V₂ with QRS < 120 msec
- 755. R $>$ S in V₁ without other evidence of right ventricular hypertrophy
- 764. RSR' pattern in V₁ or V₂ with QRS < 120 msec
- 721. Right ventricular hypertrophy (R wave in V₁ plus S wave in V₅ or V₆ $> 10.5mV_1$)

Abnormal or Possibly Abnormal ECG Findings

The following are abnormal or possibly abnormal ECG findings with brief explanations and disposition. Each disposition is based on the associated finding **in isolation** (two or more abnormal findings requires ACS ECG library review).

Marked Sinus Bradycardia: Sinus bradycardia refers to heart rate less than 60 bpm with marked sinus bradycardia heart rate less than 30bpm. Marked sinus bradycardia is usually the result of athletic conditioning with increased vagal tone and is not associated with an adverse prognosis. Past evaluation of this finding in asymptomatic aviators by the ECG Library has consistently failed to uncover evidence of sinus node dysfunction unless heart rate is less than 30bpm. Further evaluation should be pursued as clinically indicated and/or requested by the ECG Library and commonly includes verification of increased heart rate with exercise.

- A02. Marked sinus bradycardia (<30 bpm)*

Sinus Tachycardia: Sinus tachycardia may be transient and due to anxiety, fever, pain, etc. It may occasionally be an indicator of underlying heart disease or a metabolic abnormality. If sinus tachycardia is noted on an ECG, a repeat ECG should be obtained. If this is a persistent finding on the repeat ECG, a Holter monitor should be obtained while the aviator remains on flying status (no DNIF). If sinus tachycardia persists on the Holter, further evaluation should be pursued as clinically indicated and/or requested by the ECG Library.

- 001. Sinus tachycardia (resting heart rate > 100 bpm)

Short PR Interval:

Short PR interval (PR < 120 msec) may be a normal variant but is occasionally evidence for a bypass tract, even without an accompanying delta wave. Before diagnosing short PR interval, one must assure that it is truly sinus rhythm with sinus origin P waves, rather than ectopic atrial or other rhythm. For a PR interval between 100 and 120 msec, it is most likely a normal variant, but could represent a bypass tract. For these cases, a thorough history should be obtained locally with specific questions aimed at the detection of tachyarrhythmias, to include palpitations, rapid heart beat sensations, lightheadedness or syncope. If the history is unremarkable with no suggestion of a possible tachyarrhythmia, then no further evaluation is indicated and the finding should be considered a normal variant. For a PR interval less than 100 msec, the possibility of a bypass tract is much greater and further evaluation should be pursued as clinically indicated and/or requested by the ECG Library

029. Short PR interval (PR interval < 120 msec in all leads)

Wolff-Parkinson-White:

Ventricular Pre-excitation to include Wolff-Parkinson-White pattern on ECG requires ACS evaluation/review. The aviator/aircrew should be placed DNIF pending ACS evaluation/review. See the *Wolff-Parkinson-White (WPW) and Other Pre-excitation Syndromes* Waiver Guide for further details.

704. Wolff-Parkinson-White pattern

705. Lown-Ganong-Levine pattern

Prolonged QT Interval:*

Perform a repeat fasting ECG on a separate day and submit both ECGs to the ECG Library with a list of any prescription or over-the-counter medications and supplements used. Electrolytes to include potassium, magnesium, and calcium should also be checked. Further guidance will follow ECG Library review of this information. Per new ECG guidelines in athletes, corrected prolonged QTc duration has increased from prior guidelines.

215. Prolonged QT defined as a QTc >470 msec in males or >480 msec in females.

Atrial Enlargement/Abnormality:*

The following are nonspecific as isolated ECG findings in isolation. Additional testing (echocardiogram +/- stress test) is necessary only when accompanied by axis deviation, fascicular block, or bundle branch block. Further testing necessary is based on clinical indications by the interpreting physician at the ECG Library.

500. Left atrial enlargement

501. Right atrial enlargement

503. Biatrial enlargement

Ventricular Hypertrophy: An echocardiogram is required for evaluation of all ventricular hypertrophy with the exception of isolated right ventricular hypertrophy. If the echocardiogram is normal or normal variant by ECG Library review, no further workup is necessary. Since the specificity of these findings on ECG is poor, the aviator does not need to be DNIF pending our interpretation of the echocardiogram. For any left ventricular hypertrophy also provide a detailed exercise and blood pressure history for the past 6-12 months.

720. Left ventricular hypertrophy by voltage criteria with associated ST segment abnormalities

727. Biventricular hypertrophy

729. Left ventricular hypertrophy by voltage alone (sum of the S wave voltage in V₁ or V₂ plus the R wave voltage in V₅ or V₆ > 55 millivolts for individuals 35 years old or younger or > 45 millivolts for individuals older than 35 years of age).

First Degree AV Block:

First degree AV block is most often the result of athletic conditioning with increased vagal tone. This finding is common and not associated with an adverse prognosis. Past evaluation of this finding by the ECG Library has consistently failed to uncover evidence of conduction system disease. Therefore, evaluation of this finding is only required if requested by the interpreting physician or for very prolonged PR interval (>400ms).*

100. First degree AV block. (PR interval \geq 220 msec.)

Second Degree Mobitz Type II, and Third Degree AV Block:

The following abnormalities, if confirmed by the ECG Library or local consultant, are disqualifying for flying duties and waiver is not recommended. ACS evaluation is not required. Local medical evaluation and management is mandatory. Mobitz Type I second degree AV block (Wenckebach block) is considered a normal variant and is listed as such above.

105. Second degree AV block, Mobitz Type II
108. Complete heart block. This must be differentiated from A-V dissociation due to sinus bradycardia with a competing junctional rhythm, which may be a normal variant finding.

Right Bundle Branch Block:

This recommendation includes new complete right bundle branch block or complete right bundle branch block that has progressed from previous incomplete right bundle branch block. An echocardiogram is required for evaluation. If a previous echocardiogram is on file at the ACS, it may be acceptable per judgment of the ECG Library physician. The aviator does not need to be DNIF during this evaluation. Reminder - incomplete right bundle branch block in isolation is a normal variant and does not require evaluation.

120. Right bundle branch block with normal QRS axis.

Left Bundle Branch Block:

Left bundle branch block requires ACS evaluation and waiver. The aviator/aircrew should be placed DNIF pending ACS evaluation. The primary physician should insure that the aviator is clinically stable prior to arranging an ACS evaluation. See the *Left Bundle Branch Block Waiver Guide* for further details.

124. Left bundle branch block

Fascicular blocks and Axis Deviation:

Isolated Axis deviation is a normal variant unless accompanied by any other abnormal, borderline, or even normal variant ECG finding (such as complete or incomplete RBBB, atrial enlargement, or ventricular enlargement) then further evaluation should be pursued as requested by the ECG Library.* Fascicular blocks require echocardiogram at all ages and if age >35 then exercise stress. Waiver is no longer required unless the echo or stress test are abnormal after ACS/ECG library review.

The diagnostic criteria and evaluation of hemiblocks and left axis deviation are as follows:

126. Left anterior fascicular block (LAFB):
Displacement of the mean QRS axis in the frontal plane to between -45° and -90° , and
A qR complex in leads I and AVL, an rS complex in leads II, III and AVF, and
normal or only slightly prolonged QRS duration.
128. Left posterior fascicular block (LPFB):
Displacement of the mean QRS axis in the frontal plane to between $+120^\circ$ and $+180^\circ$, and
An rS complex in leads I and AVL, a qR complex in leads II, III and AVF, and

normal or only slightly prolonged QRS duration

- 735. Left axis deviation (LAD):
QRS axis -30° or more negative without full criteria for LAH as above.
- 736. Right axis deviation (RAD)
QRS axis $+120^{\circ}$ or more positive without criteria for left posterior hemiblock

Supraventricular and Ventricular Ectopy and Pairing: Holter monitor is required for one or more paired premature beats and for two or more isolated premature beats on a single page of ECG paper, 12- lead or rhythm strip, regardless of the age of the aviator/aircrew.* Further evaluation should be pursued as clinically indicated and/or requested by the ECG Library after holter monitor review.

- 023. Premature atrial beat (PAC), two or more on a single page of ECG paper, 12- lead or rhythm strip
- 043. Premature junctional beat (PJC), two or more on a single page of ECG paper, 12- lead or rhythm strip
- 083. Premature supraventricular beat, two or more on a single page of ECG paper, 12- lead/rhythm strip
- 063. Premature ventricular beat (PVC), two or more on a single page of ECG paper, 12- lead/rhythm strip
- 032. Paired atrial premature beats, one or more pairs on a single page of ECG paper
- 046. Paired junctional premature beats, one or more pairs on a single page of ECG paper
- 072. Paired ventricular premature beats, one or more pairs on a single page of ECG paper

Supraventricular Tachycardias & Arrhythmias:

Any individual with documented supraventricular tachycardia (three or more supraventricular premature beats in a row at a rate exceeding 100 bpm) or multifocal tachycardia requires holter monitor. Member need not routinely be placed DNIF if there are no associated hemodynamic symptoms. Atrial fibrillation and atrial flutter require cardiology evaluation and DNIF.

- 021. Atrial tachycardia
- 026. Atrial fibrillation
- 027. Atrial flutter
- 036. Multifocal atrial tachycardia (MAT)
- 041. Junctional tachycardia (> 100 bpm)
- 081. Supraventricular tachycardia

Ventricular Tachycardia: An aviator/aircrew with asymptomatic nonsustained ventricular tachycardia should be placed DNIF. One 24 hour Holter monitor should be obtained. ACS review/evaluation is required for waiver consideration of any ventricular tachycardia.

- 061. Ventricular tachycardia (three or more ventricular beats in a row at a rate > 100 bpm)

Ventricular Fibrillation and Ventricular Flutter: The following abnormalities are disqualifying for continued flying duties. Waiver is not recommended, and ACS evaluation is not required.

066. Ventricular fibrillation

067. Ventricular flutter

Findings Suggestive of Myocardial Infarction:

ECG findings diagnostic for or very suggestive of myocardial infarction are disqualifying for continued flying duties pending further evaluation. The individual should have a cardiology evaluation to insure that he is clinically stable. If a true myocardial infarction is confirmed, this is disqualifying for flying duties but may be waiver eligible after ACS evaluation (see waiver guide).

All 600 series codes. Myocardial infarction

The aviator may remain on flying status during evaluation of the following more nonspecific findings:

739. Non-diagnostic Q waves. No further evaluation is required unless directed by the ECG Library.

759. Poor R wave progression. This finding may be due to incorrect chest lead placement or can be a normal variant. It can also be seen in myocardial infarction. Evaluation consists of repeat ECG with attention to chest lead placement and other testing as directed by the ECG Library. Echocardiogram may be requested to rule out wall motion abnormalities.

18. ST Segment and T Wave Abnormalities:

The following diagnoses may be normal variants, or may be findings associated with myocardial ischemia, cardiomyopathy and other disorders. The nonfasting state may cause nonspecific ST-T wave changes on ECG. If these findings represent a serial change and persist after repeat fasting ECG, a treadmill exercise tolerance test and echocardiogram should be performed on aviators aged 35 or older. For aviators younger than 35 years, an echocardiogram should be performed. If a previous screening echocardiogram is on file at the ACS, it may be acceptable per judgment of the ECG Library physician. Since mild ST segment and T wave abnormalities are not very specific, the aviator does not need to be DNIF during this evaluation. However, judgment should be exercised in aviators with more than mild changes or compelling coronary risks.

200. Low T waves less than 2 mm in chest leads V3-V6 or less than 0.5 mm in limb leads I and II.

201. Nonspecific T wave abnormalities

203. Nonspecific ST segment depression

19. Cardiac Inflammation (Pericarditis and Myocarditis):

If pericarditis or myocarditis is clinically present, the aviator should be placed DNIF and should be treated as indicated by the clinical condition. Confirmation should be done locally and studies sent to ACS ECG library for review. If asymptomatic, ECG confirmation can be done through ECG library and further evaluation pursued as clinically indicated and/or requested by the ECG Library

706. Compatible with pericarditis

707. Compatible with myocarditis

Miscellaneous

Treadmill Test Results:

In order to insure a consistent interpretation of all studies and to attain the highest sensitivity, the following criteria were established for classifying treadmill exercise tolerance test results. The ST segment depression will be read at 80 msec after the J point irrespective of ST segment slope. The PQ segment will be used as the baseline. Tests showing less than 0.5 mm of ST segment depression are considered normal. Tests showing 0.5 to 0.9 mm of ST segment depression are considered borderline. Tests showing 1 mm or more of ST segment depression are abnormal. Any studies considered to be abnormal by review at the ECG Library will require an ACS evaluation.

Treadmill testing may also be suggestive of organic heart disease due to findings other than ST segment depression. These may include exercise-induced chest discomfort, hypotensive blood pressure response to exercise, chronotropic incompetence with decreasing heart rate at peak exercise or exercise-induced dysrhythmias. Exercise-induced dysrhythmias should be treated as described in the appropriate sections of this document and corresponding waiver guide.

The treadmill test should be performed in the fasting state. Baseline ECGs should be obtained supine, standing, and after hyperventilation. If ST segment depression is present on any baseline ECG, 1 mm of additional ST segment depression beyond the baseline ST segment will be required to be considered abnormal. The **raw unprocessed tracings and interpreted report** must be forwarded to the ECG Library for review.

Holter Monitor Findings:

A Holter monitor is generally performed to evaluate rhythm or conduction disturbances found on physical exam or 12-lead ECG or subjective complaints of palpitations. It might be requested by the ECG Library or ordered by a local provider. The following discussion assumes no associated hemodynamic symptoms and addresses the aeromedical disposition of isolated ectopy and ectopic pairs. Disposition of other findings, such as supraventricular tachycardia, are discussed in appropriate sections of this document.

By ECG Library review, if isolated ectopic beats on the Holter are frequent or less ($\leq 10\%$ of total beats) and if ectopic pairs are occasional or less (10 total pairs or fewer), no further testing is required and the findings are aeromedically acceptable without waiver.

If ectopic beats are very frequent ($>10\%$ of total beats) and/or ectopic pairs are frequent (>10 pairs total), a treadmill test and echocardiogram should be performed with appropriate reports and tracings/images referred to the ECG Library for review. The aviator does not need to be DNIF during this assessment.

Echocardiograms:*

Actual echocardiogram images must be sent to the ACS for review. Reports without images are not accepted. Echocardiograms must include at minimum M-mode, 2-dimensional and Doppler studies. Studies should be saved in a digital format and preferably uploaded into the ECG library system as above. VHS studies are no longer accepted. CD/DVD studies can be mailed only if unable to upload into ECG library and this can delay processing time by as much as two weeks.

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