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AEROSPACE RECOMMENDED PRACTICE

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Superseding ARP1340

Periodic Surveillance Procedures for Horizontal Dynamic Balancing Machines

RATIONALE

This document has been determined to contain basic and stable technology which is not dynamic in nature.

STABILIZED NOTICE

This document has been declared "Stabilized" by the SAE EG-1A Balancing Committee and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

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1. PURPOSE

To define a standard method for the Periodic Surveillance of Horizontal Dynamic Balancing Machines.

2. SCOPE

This document specifies those requirements and procedures for periodic tests to insure maintenance of balance machine capabilities for balancing jet engine components.

It will specify:

(a) Requirements for tests
(b) Calibration tests
(c) Residual unbalance and accurate angle and amount indication tests
(d) Plane separation test
(e) End-drive system unbalance disturbance test

2.1 Reference Standard: See ARP 587A, Balancing Machines for Jet Engine Components - Compressors and Turbines - Rotating Type - For Measuring Unbalance in More than One Transverse Plane.

3. REQUIREMENTS FOR CALIBRATION OF BALANCING MACHINES

3.1 Each balancing machine shall be checked periodically for conformance with tests described herein and/or when repairs require recheck.

3.2 Proving (test) Rotors and Test Weights Required:

Machine Capacity (lb)	Rotor Class *1	Rotor Weight (lb) *2	Test Weights Req. Ref. ARP 587A	Quantity Required
45 - 450	300 lb Machine	51.75	2.5 A	2
150 - 1500	1000 lb Machine	170	30 A	1
450 - 4500	3000 lb Machine	452.65	40 A	1

*1 Ref. ARP 587A Fig. 4 *2 ARP 587A Appendix 1

NOTE: Rotor must be centered between supports with a minimum of 1/16 in. clearance between rotor flanges and faces of support bearings. Recommended width of drive belt for 300 lb and 1000 lb class rotors is .250 in., for 3000 lb class rotor .500 inch.

3.3 Readout instruments such as amount of unbalance meters and angle meters not having full 360° scale should be checked for calibration periodically and marked with month, day and year for next calibration. Wattmeters on machines should be similarly checked. Electronic tachometers should be marked indicating ranges calibrated. Angle meters with 360° scale and having three or more series windings for continuous path operations vectometers, and selsyn repeaters or memory synchros do not require calibration checks as the accuracy of these instruments is substantiated by the proving rotor tests.

3.4 Documentation of balancing machine calibrations should be maintained and each machine should be tagged indicating the month, day and year when the machine is due to be checked again.

3.5 Tests and Rechecks:

3.5.1 A machine which fails to conform during a test run shall have one recheck in which it must conform. The recheck is required only on that portion of the test that was unacceptable unless repairs or adjustments have invalidated earlier test results.

4. PROCEDURE FOR CALIBRATION TEST

4.1 Position proving (test) rotor in supports of balancing machine and check for sufficient clearances.

4.2 Run proving rotor at test speed for at least 15 minutes to stabilize prior to test. No physical contact except to position weights should be made to the proving rotor during tests. Each traverse check must be completed with rotor in continuous rotation excluding minimal time used to shift position of weights. Rotor speed for variable speed machines shall be 900 rpm minimum. For fixed step speed machines, use nearest available speed and note on test log sheet. A portable tachometer may be used for this reading.

4.3 Set machine for calibration, using compensators as directed by machine manufacturer's instructions.

4.3.1 If machine is equipped with electronic filter dials, install 30A test weight on rotor, run machine, and peak filters to give highest reading on amount readout meter.

4.4 Adjust the Amount of Unbalance calibration dials of the machine to give a readout directly in units of A. (One A unit is equal to that weight in ounces calculated to cause a displacement of the rotor bearing midpoints a distance equal to specified machine sensitivity in microinches if the rotor were rotated in free space without any restraint. It is a calculated weight value derived from the design of the particular proving rotor. It is vital to the conduct of a test to use the correct set of A unit test weights calibrated for both the proving rotor and the machine tested.) Use a 30A test weight for initial plane separation and calibration in A units, applied alternately in each correction plane. Remove 30A weight after calibration and switch compensator to off position.

4.5 Run machine with no test weights on the proving rotor and measure the unbalance which should be less than 0.5A in both planes. If necessary, add balancing clay to obtain readings of less than 0.5A.

4.6 Residual Unbalance and Accurate Angle and Amount Indication Tests:

4.6.1 Place one 2.5A weight at any one of the following locations in plane 1 (left plane of machine): 15°, 165°, 195°, 345°. The actual location is selected from one of those listed. Call this location angle "E". The weight remains at this location on the proving rotor for the following series of tests except for readings marked (**) on the test Log Sheet. At (**) marks the weight is removed. It is permissible to run plane 1 and plane 2 simultaneously if 2 sets of 2.5A weights are available.

4.6.2 Place another 2.5A test weight at each of the locations in plane 1. The weight is located on the proving rotor at positions calculated in the test Log Sheet, column G. Record the amount and angle of the resultant unbalance as indicated by the balancing machine in plane 1 for each of the locations listed in column G. Repeat test series twice. It is permissible to run plane 1 and plane 2 simultaneously if two sets of 2.5A weights are available.

4.6.3 Plot the results of 4.6.2 on polar graph paper with symbols shown on test Log Sheet. Use scale shown in Figure 6 of ARP 587A to correspond with transparent overlay (Figure 7 of ARP 587A). Darken a line from origin pointing in direction of angle E.

4.6.4 Evaluation I: Place the transparent overlay over the plotted points. Adjust the overlay, keeping the reference lines parallel to the direction of E until all plotted points are enclosed in their respective regions. The regions are indicated by symbols on Log Sheet and overlay. Check any points which fall outside regions for correct plotting. If more than one point falls outside its region, the machine does not conform due to one or more of the following:

(a) Lack of repeatability
(b) Angle or amount of unbalance indicating error
(c) Failure of machine to indicate at low level of unbalance

4.6.5 Evaluation II: If center of overlay falls within a radius equal to 0.5A on scale shown in figures after adjusting for evaluation I, the machine conforms for residual unbalance.

4.7 Repeat Steps 4.6.1 through 4.6.5 for plane 2 (right plane of machine). First remove test weights from plane 1. (Omit this paragraph if both planes have been run simultaneously).

4.8 Plane Separation Test:

4.8.1 With proving rotor set and balanced as for test 4.6, remove all 2.5A test weights.

4.8.2 Apply a 40A test weight to plane 2 at the locations indicated by the test Log Sheet and read the indicated unbalance and angle in plane 1. Plot the results with the symbol shown on the same graph used in 4.6 and 4.7.

4.8.3 With the overlay located in the same position as for tests 4.6.5 and 4.7, check the position of the points just plotted. If the points are all within the plane separation circle, the machine conforms. (It is permissible to adjust the position of the overlay, if necessary, to obtain conformance provided that the previous tests with overlay results in conformance simultaneously).

4.8.4 Repeat 4.8.1 through 4.8.3 but apply test weight to plane 1 and read unbalance in plane 2.

4.9 Drive System Unbalance Disturbance Test for Machines Using End Drive:

4.9.1 Remove all test weights from proving rotor.

4.9.2 Start balancing machine. Record angle and amount of unbalance in plane 1 (left plane of machine) and plane 2 (right plane of machine) opposite run 1 and drive angle 0° on test Log Sheet.

4.9.3 Uncouple machine end-drive with adapter from the proving rotor, index balancing machine 180°, then recouple end drive to proving rotor.

4.9.4 Start balancing machine. Record angle and amount of unbalance in plane 1 and plane 2 opposite run 2 and drive angle 180° on test Log Sheet.

4.9.5 Re-index balancing machine coupling 180° returning to position of 4.9.2. Recouple drive to proving rotor again.

4.9.6 Start balancing machine. Record angle and amount of unbalance in plane 1 and plane 2 opposite run 3 and drive angle 0° on test Log Sheet.

4.9.7 Index balancing machine coupling 180° to position of 4.9.4. Recouple drive to proving rotor.

4.9.8 Start balancing machine. Record angle and amount of unbalance in plane 1 and plane 2 opposite run 4 and drive angle 180° on test Log Sheet.

5. EVALUATION OF DRIVE SYSTEM UNBALANCE DISTURBANCE TEST

5.1 Sequence:

5.1.1 Plot the data from test Log Sheet under plane 1 on polar graph paper (Fig. 6 - ARP 587A) with symbols shown on Log Sheet.

5.1.2 Locate point P, the bisector of the line segment joining the + symbols.

5.1.3 Locate point Q, the bisector of the line segment joining the O symbols. (See illustration on test Log Sheet).

5.1.4 Connect points P and Q. If the length of line PQ is less than 1A, the machine conforms.

5.1.5 Repeat 5.1.1 through 5.1.4 for plane 2, using the symbols ☐ and △ from plane 2 on test Log Sheet. The length of line PQ must be less than 1A to have the machine conform.

5.2 Requirements for Static and Couple Unbalance Separation, Stable End Point, and Static and Couple Unbalance Tests:

NOTE: For machines which have passed all tests with inboard proving rotor it has been determined that this test is NOT required for Periodic Surveillance.

6. For machines equipped with several different size supports it shall be necessary to run a complete test for each set that is to be tested.

6.1 For machines equipped with three identical work supports the tests shall be run as follows:

6.1.1 Set up proving rotor in left and intermediate support and follow procedures previously outlined.

6.1.2 Move proving rotor to intermediate and right supports and follow procedure for residual unbalance, accurate angle and amount tests, and plane separation paragraphs 4.6, 4.7 and 4.8.

PREPARED BY
SAE COMMITTEE EG-1, AEROSPACE PROPULSION SYSTEMS SUPPORT EQUIPMENT

TEST LOG SHEET FOR 4.6, RESIDUAL UNBALANCE AND ACCURATE ANGLE AND AMOUNT INDICATION TESTS

E = Plane 1 or 2

Symbol	Angle H Degrees	Location G Degrees	Indicated Unbalance					
			1st Run		2nd Run		3rd Run	
		G = H + E (or H + E - 360)	Location Degrees	Amount A Units	Location Degrees	Amount A Units	Location Degrees	Amount A Units
⊙	15							
⊡	60							
△	90							
⊙	120							
⊡	150							
△	165							
⊙	* *	N.A.						
⊡	195							
△	210							
⊙	240							
⊡	270							
△	300							
+	330							

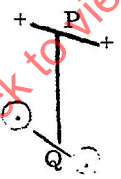
TEST LOG SHEET FOR 4.8.2 and 4.8.4

SYMBOL +

Location of 40A Weight Degrees	Indicated Unbalance	
	Location Degrees	Amount A Units
Plane 2	Plane 1	
0		
90		
180		
270		
Plane 1	Plane 2	
0		
90		
180		
270		

TEST LOG SHEET FOR 4.9, DRIVE DISTURBANCE SYSTEM UNBALANCE
TEST FOR MACHINES USING END DRIVE

Run #	Drive Angle Degrees	Indicated Unbalance					
		Plane 1			Plane 2		
		Amount A Units	Location Degrees J		Amount A Units	Location Degrees M	
1	0		+			⊡	
3	0		+			⊡	
				Reversed Location Degrees K = J ± 180°			Reversed Location Degrees N = M ± 180°
2	180			⊙			△
4	180			⊙			△



P bisects + +

Q bisects ⊙ ⊙