Extract from Joint Airworthiness Requirements **JAR E ENGINES**

JAR E SUB-SECTION C3-TURBINE ENGINES FOR AEROPLANES [CHAPTER C3-4 TYPE SUBSTANTIATION]

3 **VIBRATION SURVEYS** Vibration surveys shall be made on the major rotating parts, compressor and turbine blading, and the Engine carcass.

3.1 General

3.1.1 Each survey shall cover all Engine conditions from Ground Idling to at least Maximum Engine Overspeed. Should there be any indication of a stress peak arising at high speed conditions, the survey shall be extended sufficiently to reveal the maximum stress values present, except that the survey need not extend beyond 105% of the maximum speed to be approved (other than Maximum Engine Overspeed) or 2% above Maximum Engine Overspeed, whichever is the higher.

3.1.2 Each survey shall enable an evaluation to be made of the effects, if appropriate to the particular part of the Engine being surveyed, of running with the most adverse compressor intake airflow distortion pattern declared by the constructor and the most adverse exhaust conditions, including the use of a thrust reverser.

3.1.3 The effects of likely fault conditions (such as out-of-balance, turbine entry blockage, fuel nozzle blockage, etc.) shall also be evaluated, if appropriate to the particular part of the Engine being surveyed.

3.1.4 For turbo-propeller Engines a representative flight propeller shall be fitted in cases where the results could be influenced by the presence of the Propeller.

3.2 Compressor and Turbine Rotors. It shall be shown by tests on an Engine or by other acceptable means that no dangerous vibratory stresses are likely to occur in compressor and turbine rotors (ie discs or drums) within the range of rpm covered by the survey.

NOTE: The evaluation of shafts is detailed in C3-4 App..12

3.3 Compressor and Turbine Blades

3.3.1 It shall be shown by strain gauging or other acceptable means that no unacceptable vibratory stresses are likely to occur in the compressor and turbine blading.

NOTES: (1) If, to avoid unacceptable blade vibratory stresses, the constructor declares prohibited speed ranges, these should be agreed by the Authority.

(2) The blade vibration survey and the variation of the incremental running referred to in 6.6.1 may be waived wholly or in part if the Authority is satisfied that the total hours run on the test bed or in flight, under representative conditions, prior to certification, is such as to demonstrate that the vibration stress levels are satisfactory. This may apply particularly in the case of small Engines if the dimensions of the blades make it difficult to complete a satisfactory vibration survey.

3.3.2 The blade rows to be investigated and the number of blades in each row shall be agreed with the Authority. The blade rows will normally include:-

(a) the first compressor rotor blade row, all rows adjacent to variable incidence stator blades, and these stator blades if cantilevered, ie unshrouded,

(b) the last turbine blade row and the adjacent stator turbine blades if cantilevered,

(c) as many other rows of compressor and turbine rotor blades and the adjacent stator blades if they are cantilevered, as may be shown from the test results of (a) and (b) to be necessary.

NOTE: Should the investigation indicate resonances of large amplification factor in the above rows of blading, or should the investigation, development experience, calculation, etc., suggest that such resonances may be expected to occur in other rows of blading, the Authority reserves the right to require the vibration survey to be extended as necessary. In estimating from limited measurements the highest stresses likely to be experienced in the worst blade of any row, allowance should be made for the inevitable scatter in peak amplitudes which will occur when blades have the usual production tolerances on frequency.

3.4 **Engine Carcass.** Acceptable levels of Engine carcass vibrations shall be established from experience of development and type testing, and shall be declared for selected datum positions.

NOTE: These will be used in assessing the vibration characteristics of the Engine when installed in an aeroplane.