00-26

Federal Aviation Agency

ADVISORY CIRCULAR CHANGE

AC NO:	AC 20-26 CH 1
	AIRCRAFT
EFFECTIVE:	9/18/64

SUBJECT: CH 1 TO CIRCULAR AC 20-26, SUBJ: TURBINE AND COMPRESSOR ROTORS TYPE CERTIFICATION SUBSTANTIATION PROCEDURES

1. PURPOSE. This circular transmits a revised page.

2. CHANGE. The overspeed r.p.m. figure in paragraph 4c(2)(a) is revised to read 115 percent. Testing a complete engine to 115 percent is considered substantially equivalent to rig testing rotor components separately to 120 percent.

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George S. Moore
Director
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(c) Testing a rotor in a complete engine, but with the disc(s) having appropriately thinned sections at critical areas to produce maximum critical disc stresses, while developing maximum rated gas temperatures and maximum operating r.p.m.

(d) Turbosupercharger units tested as complete units and driven by a hot gas supply from a special burner rig.

(e) Testing rotors or units separately (complete with blades or dummy weights) by cold spinning, plus acceptable calculated data to ascertain the effects of temperature on critical stresses. For this method to be successful, accurate and extensive disc temperature survey data from operating engines and extensive data on hot strength properties of the disc material are required.

(2) Determination of overspeed r.p.m. for test. The overspeed r.p.m. of all turbine engines, turbosuperchargers and power recovery turbines to which rotor discs are to be tested should be established through failure analyses criteria in determining the effects of reasonably probable and likely remote failures causing engine overspeeds. The failure of structural elements of the engine and its installation need not be considered if the probability of such failure is considered to be extremely remote. The highest r.p.m. of the following should be established as the overspeed r.p.m.:

* (a) 115 percent of the maximum rated r.p.m., if the demonstration is made on a complete engine incorporating standard compressor and turbine assemblies. *

(b) 120 percent of the maximum rated r.p.m., if the demonstration is made under simulated conditions acceptable to the Administrator, such as in rotor component test rigs.

(c) An r.p.m. equal to 105 percent of the highest speed that would result from failure of the most critical component or system in a representative installation of the engine.

(d) An r.p.m. equal to the highest speed, which would result from the combination of two failures of components and/or systems in a representative installation of the engine. For each combination considered, one of the failures causing overspeeding should include a component or system whose failure would not normally be detected during a routine preflight check nor during normal flight operations.

(3) Testing at overtemperatures. Turbine engine rotor assemblies should be operated at least five minutes at the maximum rated r.p.m., with the measured turbine gas temperature (as normally measured in the engine) at least 75° F. in excess of the highest maximum permissible rated temperature value. This test should be accomplished by operating sufficiently long to heat-soak the turbine elements. The strength margin is sufficient only when the condition of the turbine assembly following this test is satisfactory and still within serviceable limits. The purpose of this test is to insure that excess strength is provided to preclude rapid deterioration or failure of turbine rotors in the event of 75° F. overtemperatures, which may result from sudden control or other system failures in a time interval in which a flight crew can be expected to be alerted and take corrective action.

d. Turbosuperchargers and power recovery turbines used with reciprocating engines should be tested at exhaust gas temperatures at least as high as the applicable type of reciprocating engine will produce under extreme conditions. Such temperatures are normally close to that produced when operating at the stoichiometric fuel/air mixtures. The stoichiometric exhaust gas temperature is usually at or above the value at which the unit will be used in service. This testing may be accomplished during endurance testing of the unit. Turbosuperchargers may be tested conveniently on gas producer rigs instead of in conjunction with a reciprocating engine. When a gas producer rig is used, a 75° F. overtemperature margin may be conveniently maintained for the test to provide this desired temperature margin.

for J. N. Whitty
George S. Moore
Director
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Cancelled See 33-3

Federal Aviation Agency

ADVISORY CIRCULAR CHANGE

AC NO: AC 20-26 CH 2	
AIRCRAFT	
EFFECTIVE: 7/8/65	

SUBJECT: CH 2 TO CIRCULAR AC 20-26, SUBJ: TURBINE AND COMPRESSOR ROTORS TYPE CERTIFICATION SUBSTANTIATION PROCEDURES

1. PURPOSE. This advisory circular transmits page changes to AC 20-26 dated 7/22/64 (CH 1 dated 9/18/64).

2. EXPLANATION OF CHANGES.

   a. Paragraphs 1 and 2 are revised to reference only Federal Aviation Regulations since CAR 13 has been officially superseded.

   b. Paragraph 4c has been amended by revising the next to last sentence to read as follows for clarification: "The condition of critical rotor components following this demonstration should be satisfactory for continued use and be within normal service limits."

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for G. W. Walker

George S. Moore
Director
Flight Standards Service

Federal Aviation Agency

ADVISORY CIRCULAR

AC NO:	AC 20-26 CH 2
	AIRCRAFT
EFFECTIVE:	7/8/65

SUBJECT: TURBINE AND COMPRESSOR ROTORS TYPE CERTIFICATION SUBSTANTIATION PROCEDURES

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1. PURPOSE. This circular sets forth acceptable means, not the sole means, by which compliance may be shown with the turbine and compressor rotor substantiation requirements in Federal Aviation Regulations, Part 33.

2. REFERENCE REGULATIONS.

   Federal Aviation Regulations, Part 33, Sections 33.27 and 33.5

3. SCOPE. To provide reliability and safety of turbine and compressor rotors of turbine engines and turbosuperchargers, and power recovery turbines used with reciprocating type engines, their design and construction must provide structural integrity of sufficient strength to withstand specified overspeeds and overtemperatures without failure unless rotor bursts are demonstrated to be contained within their respective housings. To cope with the possibility of critical deterioration of rotor assemblies from service use, acceptable inspection and life limit criteria are to be provided. The substantiation procedures herein are those which have been in use and found to be acceptable.

4. ACCEPTABLE MEANS OF COMPLIANCE FOR SUBSTANTIATING TURBINE AND COMPRESSOR ROTORS

   a. Design and construction. The effects of damage inducing factors, which may effectively reduce the strength of rotor discs, should be minimized by design features to the maximum extent possible, taking into account the reduction of material strength that may be caused by mechanical surface damage, overheating, undetected flaws, substandard metallurgical properties, abnormal dimensional and quality variations, vibration, and fatigue. The engine manufacturer should design for conservative operating stresses. Rotor disc vibration stresses should be measured and allowable stress limits established. Consideration should be given to

adverse effects on the magnitude of stresses, occasioned by airplane inlet distortion, bleed air and exhaust system effects, start-stop cyclic stresses (low-cycle fatigue), and basic vibratory stresses (high-cycle fatigue).

b. Maintenance criteria. Maintenance criteria provided by the engine manufacturer should include appropriate dimensional creep limits and other basic inspection criteria, together with service life limits based on well-established material properties, and service experience when available. Basic service life limits should include fatigue considerations based on the effects of imposing an appropriate number of severe start-stop cycles representative of a typical service period. For a new model engine, at least 1000 start-stop cycles should be conducted for the initial evaluation of service life expectancy. A sound basis for service life extension may be provided from sampling high time-in-service discs for check of metallurgical physical properties and subjecting them to cyclic tests.

c. Overstrength margin testing. Turbine and compressor rotors should be subjected to operation for a stabilized period of at least five minutes' duration, stressed to levels comparable to those obtained during engine operation at the maximum rated temperature conditions and accompanied by an overspeed r.p.m. as determined in the following paragraphs. In demonstrating adequate overstrength margins, evaluation of the effects of actual rotor disc stresses at the specified loading conditions is desired. Knowledge of the stresses in all rotor components is needed, but the most critically stressed discs and the most critical stresses in these discs are of paramount interest. For multistage compressors and turbines, demonstration of only the most critical stages is acceptable. The condition of * critical rotor components following this demonstration should be satisfactory for continued use, and be within normal service limits. * A five-minute stabilized test period is acceptable for the purpose of this test, which is made to evaluate short-term creep and elongation that could lead to rupture.

(1) Testing at overspeed stresses. Overstrength margins relative to overspeeds may be demonstrated by any of the following test techniques:

(a) Rig testing a rotor disc, equipped with dummy blade weights, at maximum overspeed while heated to its usual maximum operating temperature conditions.

(b) Testing rotor assemblies in a complete engine to maximum overspeed while developing the maximum permissible gas temperature for the highest rated speed.