QUADRO COMPARATIVO

33.27		Justificativa
RBAC 33 Emenda 33-30	**RBAC 33 Emenda 33-31**	
§33.27 Turbine, compressor, fan, and turbosupercharger rotor. (a) Turbine, compressor, fan, and turbosupercharger rotors must have sufficient strength to withstand the test conditions specified in paragraph (c) of this section. (b) The design and functioning of engine systems, instruments, and other methods, not covered under §33.28 must give reasonable assurance that those engine operating limitations that affect turbine, compressor, fan, and turbosupercharger rotor structural integrity will not be exceeded in service. (c) The most critically stressed rotor component (except blades) of each turbine, compressor, and fan, including integral drum rotors and centrifugal compressors in an engine or turbosupercharger,	**33.27 Turbine, compressor, fan, and turbosupercharger rotor overspeed.** (a) For each fan, compressor, turbine, and turbosupercharger rotor, the applicant must establish by test, analysis or a combination of both, that each rotor will not burst when operated in the engine for 5 minutes at whichever of the conditions defined in paragraph (b) of this section is the most critical with respect to the integrity of such a rotor. (1) Test rotors used to demonstrate compliance with this section that do not have the most adverse combination of material properties and dimensional tolerances must be tested at conditions which have been adjusted to ensure the minimum specification rotor possesses the required overspeed capability. This can be accomplished by increasing test speed, temperature, and/or loads. (2) When an engine test is being used to demonstrate compliance with the overspeed conditions listed in	A mudança no requisito foi extensa e objetivou a harmonização com os requisitos da EASA

as determined by analysis or other acceptable means, must be tested for a period of 5 minutes— (1) At its maximum operating temperature, except as provided in paragraph (c)(2)(iv) of this section; and (2) At the highest speed of the following, as applicable: (i) 120 percent of its maximum permissible r.p.m. if tested on a rig and equipped with blades or blade weights. (ii) 115 percent of its maximum permissible r.p.m. if tested on an engine. (iii) 115 percent of its maximum permissible r.p.m. if tested on turbosupercharger driven by a hot gas supply from a special burner rig. (iv) 120 percent of the r.p.m. at which, while cold spinning, it is subject to operating stresses that are equivalent to those induced at the maximum operating temperature and maximum permissible r.p.m.	paragraph (b)(3) or (b)(4) of this section and the failure of a component or system is sudden and transient, it may not be possible to operate the engine for 5 minutes after the failure. Under these circumstances, the actual overspeed duration is acceptable if the required maximum overspeed is achieved. (b) When determining the maximum overspeed condition applicable to each rotor in order to comply with paragraphs (a) and (c) of this section, the applicant must evaluate the following rotor speeds taking into consideration the part's operating temperatures and temperature gradients throughout the engine's operating envelope: (1) 120 percent of the maximum permissible rotor speed associated with any of the engine ratings except one-engine-inoperative (OEI) ratings of less than 2½ minutes. (2) 115 percent of the maximum permissible rotor speed associated with any OEI ratings of less than 2½ minutes. (3) 105 percent of the highest rotor speed that would result from either:	

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(v) 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. (vi) The highest speed that would result from the failure of any component or system in a representative installation of the engine, in combination with any failure of a component or system that would not normally be detected during a routine preflight check or during normal flight operation. Following the test, each rotor must be within approved dimensional limits for an overspeed condition and may not be cracked.	(i) The failure of the component or system which, in a representative installation of the engine, is the most critical with respect to overspeed when operating at any rating condition except OEI ratings of less than 2½ minutes, or (ii) The failure of any component or system in a representative installation of the engine, in combination with any other failure of a component or system that would not normally be detected during a routine pre-flight check or during normal flight operation, that is the most critical with respect to overspeed, except as provided by paragraph (c) of this section, when operating at any rating condition except OEI ratings of less than 2½ minutes. (4) 100 percent of the highest rotor speed that would result from the failure of the component or system which, in a representative installation of the engine, is the most critical with respect to overspeed when operating at any OEI rating of less than 2½ minutes. (c) The highest overspeed that results from a complete loss of load on a	

	turbine rotor, except as provided by paragraph (f) of this section, must be included in the overspeed conditions considered by paragraphs (b)(3)(i), (b)(3)(ii), and (b)(4) of this section, regardless of whether that overspeed results from a failure within the engine or external to the engine. The overspeed resulting from any other single failure must be considered when selecting the most limiting overspeed conditions applicable to each rotor. Overspeeds resulting from combinations of failures must also be considered unless the applicant can show that the probability of occurrence is not greater than extremely remote (probability range of 10−7 to 10−9 per engine flight hour). (d) In addition, the applicant must demonstrate that each fan, compressor, turbine, and turbosupercharger rotor complies with paragraphs (d)(1) and (d)(2) of this section for the maximum overspeed achieved when subjected to the conditions specified in paragraphs (b)(3) and (b)(4) of this section. The applicant must use the	

	approach in paragraph (a) of this section which specifies the required test conditions. (1) Rotor Growth must not cause the engine to: (i) Catch fire, (ii) Release high-energy debris through the engine casing or result in a hazardous failure of the engine casing, (iii) Generate loads greater than those ultimate loads specified in §33.23(a), or (iv) Lose the capability of being shut down. (2) Following an overspeed event and after continued operation, the rotor may not exhibit conditions such as cracking or distortion which preclude continued safe operation. (e) The design and functioning of engine control systems, instruments, and other methods not covered under §33.28 must ensure that the engine operating limitations that affect turbine, compressor, fan, and turbosupercharger rotor structural integrity will not be exceeded in service.	

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	(f) Failure of a shaft section may be excluded from consideration in determining the highest overspeed that would result from a complete loss of load on a turbine rotor if the applicant: (1) Identifies the shaft as an engine life-limited-part and complies with §33.70. (2) Uses material and design features that are well understood and that can be analyzed by well-established and validated stress analysis techniques. (3) Determines, based on an assessment of the environment surrounding the shaft section, that environmental influences are unlikely to cause a shaft failure. This assessment must include complexity of design, corrosion, wear, vibration, fire, contact with adjacent components or structure, overheating, and secondary effects from other failures or combination of failures. (4) Identifies and declares, in accordance with §33.5, any assumptions regarding the engine installation in making the assessment	

	described above in paragraph (f)(3) of this section. (5) Assesses, and considers as appropriate, experience with shaft sections of similar design. (6) Does not exclude the entire shaft. (g) If analysis is used to meet the overspeed requirements, then the analytical tool must be validated to prior overspeed test results of a similar rotor. The tool must be validated for each material. The rotor being certified does not have lower burst and growth margins than rotors used to validate the tool.	