probability of extremely improbable can not be guaranteed. However, the FAA believes that the applicant has constructed a test program that demonstrates the blade retention features have sufficiently improved reliability to provide an equivalent level of safety to that provided by § 33.94. While extensive testing is required for material certification in accordance with § 33.15 to determine material characteristics and the effects of defects on blade life, additional test requirements were established within the compliance plan to determine the effect of defects and manufacturing variations on material capability.

One commenter suggests adding an additional paragraph to these special conditions as follows:

''(a)(3) By appropriate test and analysis it must be shown that the most adverse blade vibratory stresses, as determined per § 33.83, will not result in failure of the fan blade retention system when consideration is given to the most limiting manufacturing defect which could go undetected.''

The FAA disagrees with the commenter that the suggested paragraph be added, as these considerations are well within the interpretation of § 33.83 and no additional safety standards are deemed necessary.

One commenter suggests adding an additional paragraph to the special condition to minimize the risk of hazard which would result from potential failure of the fan blade retention system as follows:

''(a)(4) Although the above test requires release of the fan blade at the inner flowpath, additional testing and/or analysis shall be performed to define the engine behavior for the case of a fan blade release at the outermost retention groove. The data obtained shall be used when establishing:

(i) Any installation limitations to be included on the Type Certificate Data Sheet; and,

(ii) Load requirements of § 33.23.''

The FAA disagrees. As stated in § 33.75, Safety Analysis, the applicant must consider all probable malfunctions which will cause the engine to catch fire, burst, generate loads greater than those ultimate loads specified in § 33.23(a), or lose the capability of being shut down. These special conditions also require such analyses and tests to show that the failure of the fan blade retention system is not a probable malfunction. Establishment of the maximum stop-start stress cycles for the blade retention system is also required to assure the structural integrity of the blade attachment system.

One commenter states that the requirements should show that the failure rate of the fan blade retention system, for any cause, during the service life of the engine, be extremely improbable and can not be established at the time of type design approval for a new technology composite.

The FAA agrees in part. While the FAA agrees that a failure probability of extremely improbable can not be guaranteed, the FAA remains receptive to advances in technology, approaches, and new test methods which adequately simulate those effects typically verified by in-service experience. Further, the FAA believes that these same principles have been successfully used by engine manufacturers to ensure the airworthiness of rotor structural parts. It should be recognized that failure to demonstrate acceptable reliability of the blade retention features, results in non-compliance with these special conditions and that would require testing to occur at the outer most retention groove.

Two commenters suggest the energy levels and trajectories of any particles that would penetrate the engine cases by conducting an engine test in accordance with the test conditions of current §§ 33.94(a) and 33.94(b) be defined in the Engine Installation Manual or on the Engine Type Certificate Data Sheet. The definition of results should also include determination of the loads that would be transmitted through the engine to airframe interface. One commenter states that the energy levels, trajectories and loads must be included in each airplane type's design precautions taken to minimize the hazards in the event of an engine rotor failure, as required by current FAR 25.903 and JAR 25.903.

The FAA agrees that the requirements for defining energy levels, trajectories of particles, and a resultant loads already exist in §§ 33.19(a) and 33.23. The FAA also agrees that if such energy levels, trajectories, and resultant loads are defined, the appropriate data should be included in the Engine Installation Manual. The FAA does not agree with the commenters suggestion relative to complying with §§ 33.94(a) and 33.94(b) in addition to these special conditions. These special conditions provide safety standards which apply to the composite blade design as an alternative to the requirements of § 33.94. The applicant must demonstrate reliability of the blade root and the blade retention system.

One commenter criticizes the explanations and logic presented for justification of these proposed special conditions. The commenter cites that there was insufficient information in the notice by which to test the validity of the FAA's determination.

The FAA disagrees. The notice of proposed special condition identifies two bases on which the FAA determined that the current requirements of part 33 do not provide adequate or appropriate safety standards because of the novel or unusual design of the GE90 engine. The FAA also determined that additional safety standards were needed to ensure that the GE composite fan blades met an equivalent level of safety established by § 33.94. Given the number and the nature of the comments received, the FAA believes that the notice gave an adequate description of the proposed action to allow critical comment on the basis for that action.

One commenter states that they do not believe that use of graphite composite material for a turbofan blade retention system warrants a departure from the current requirements of § 33.94.

The FAA disagrees. The FAA supports the use of composite technology and the necessary methods of testing and analyses to show that the product meets an equivalent safety standard as established by § 33.94.

One commenter states that the demonstration means for showing ''extremely improbable'' should be specifically part of these proposed special conditions. The commenter suggests to establish and define a methodology by which to rigorously assess the probability of fan blade retention system failure as extremely improbable, and by which to assess the associated level of confidence in the assessment, particularly at the time of initial certification.

The FAA agrees in part. The FAA agrees that the assessment of the fan blade retention system should be conducted rigorously, but disagrees with the need to establish and define a methodology in these special conditions. The FAA believes it should not define a specific means to meet a safety standard, or publish an applicant's proprietary methodology. To publish a specific demonstration means would presume the FAA has predetermined the composite blade material property characterization. The methodology for assessing the fan blade retention system will be proposed by the applicant, and will be evaluated by the FAA.

One commenter states that lightning test conditions should be specifically identified in the special condition.

The FAA disagrees. Existing regulatory guidance material and standard industry practices for lightning