U.S. Department
of Transportation

**Federal Aviation
Administration**

Advisory Circular

Subject: RATINGS AND OPERATING LIMITATIONS FOR TURBINE ENGINES (SECTIONS 33.7 AND 33.8)

Date: 6/28/10

Initiated by: ANE-111

AC No: 33.7-1

1. Purpose. This advisory circular (AC) provides information and guidance on turbine engine compliance under part 33 of Title 14 of the Code of Federal Regulations (14 CFR), specifically §§ 33.7, Engine ratings and operating limitations, and 33.8, Selection of engine power and thrust ratings. This AC also provides information on preparing the data needed for the type certification data sheet (TCDS) specified in § 33.7(a).

2. Applicability.

a. The guidance provided in this document is directed to applicants requesting certification of turbine engines, except that no specific guidance is provided for the augmented power or thrust (refer to § 33.7, paragraphs (c)(1)(i) and (iii)) and supersonic engines. For the purpose of this AC, any reference to power or thrust is for unaugmented power or thrust (refer to § 33.7, paragraphs (c)(1)(ii) and (iv)).

b. This material is neither mandatory nor regulatory in nature and does not constitute a regulation. It describes acceptable means, but not the only means, for demonstrating compliance with the applicable regulations. The FAA will consider other methods of demonstrating compliance that an applicant may elect to present. Terms such as “should,” “shall,” “may,” and “must” are used only in the sense of ensuring applicability of this particular method of compliance when the acceptable method of compliance in this document is used. While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the relevant regulations. On the other hand, if the FAA becomes aware of circumstances that convince us that following this AC would not result in compliance with the applicable regulations, we will not be bound by the terms of this AC, and we may require additional substantiation as the basis for finding compliance.

c. This material does not change, create any additional, authorize changes in, or permit deviations from existing regulatory requirements.

3. References.

a. FAA Policy Memorandum, PS-ANE33-ACE23-2006-1 titled "Policy Statement on Approval for 10-Minute Rated Takeoff Thrust/Power during Takeoff with One-Engine Inoperative (OEI) under 14 CFR Parts 23 and 14 CFR Part 33," dated August 30, 2006.

b. FAA Policy Memorandum, PS-ANE100-1994-00008 titled "Engine Inoperative Ten-Minute Takeoff Thrust/Power Rating (Revision to 6/28/94 Memorandum)," dated August 19, 1994.

4. Background.

a. When pursuing a type certificate (TC), the applicant selects the engine ratings (refer to §§ 33.7 and 33.8) and associated operating limitations (refer to § 33.7). Each rated power or thrust is defined in the definitions of 14 CFR part 1 (§ 1.1) and is associated with engine operating limitations related to shaft torque, rotor speeds, and gas temperatures (refer to § 33.7(c)). These ratings and limitations are then applied to show compliance with part 33 regulations, some of which are engine tests. At the conclusion of part 33 compliance, the applicant may find the operating limitations have been validated or need to be modified or additional limitations may be necessary. The FAA then approves the engine ratings and limitations based on demonstrated compliance with the airworthiness standards of part 33.

b. The engine rated power or thrust is part of the engine identification data (refer to 14 CFR 45.13, paragraph (a)(6)). It is identified in the TCDS, which is part of the TC (refer to 14 CFR 21.41), and marked on the engine data plate (refer to §§ 45.11(a) and 45.13(a)).

5. TCDS - § 33.7(a).

a. The TCDS documents the engine rated power or thrust and the associated operating limitations for which compliance with the airworthiness standards in part 33 was demonstrated. The applicant must provide the information for inclusion in the TCDS, specifically the ratings and associated limitations addressed in paragraphs 6 through 22 of this AC, and any additional limitations established during showing of compliance with part 33. Some data, such as complex or lengthy data, may be included in the TCDS by reference to other approved documentation, such as installation or operation manuals.

b. Along with the ratings and operating limitations required in § 33.7, the TCDS must also identify any rating limitation in the definitions of § 1.1. For example, identify time limits, the number of occurrences, or inspection requirements when these limitations are listed in the definitions of § 1.1. For each certified engine, the applicable definitions for the ratings are those effective or associated with part 33 amendments in the certification basis. Since rating

definitions in § 1.1 have changed several times over past decades, the current definitions may not apply to previously certified engines. For example, part 33 amendment 25 effective October 17, 2008, revised the definition for rated 2½ -minute one engine inoperative (OEI) power. That revision removed the restriction for a "period of use" and allowed "periods of use" of this rating during a single flight. Engines certified before this amendment are restricted to a single period of use of the rated 2½ -minute OEI power within one flight; engines certified to this amendment may use 2½ -minute OEI power more than once within one flight.

c. The TCDS is prepared in partnership with the applicant and issued by the certificate management aircraft certification office (CMACO). This is the ACO that manages the original type certificate project and maintains and updates the document as long as the engine is in service. The TCDS must be revised to include subsequent amended TC models or any changes to the ratings and operating limitations approved by the FAA.

d. The TCDS may document other information resulting from part 33 compliance, and may go beyond the compliance with § 33.7. This AC only addresses the TCDS information related to engine ratings and operating limitations. On the other hand, the TCDS is not the only certification document that identifies the ratings and operating limitations. For example, the applicant must identify the ratings and operating limitations in the installation and operating instructions required under § 33.5. Since this AC only addresses compliance with §§ 33.7 and 33.8, annotations of manuals are not discussed here.

6. Engine Ratings - General.

a. Engine ratings are established by power for turboshaft and turbopropeller engine applications, and by thrust for turbojet and turbofan engine applications. The ratings are defined in § 1.1 and they are either continuous or limited to specific time durations. The applicant selects the ratings from those listed in § 33.7, paragraphs (c)(1)(i) through (x). Of these, the takeoff and maximum continuous ratings are mandatory, while the OEI ratings for rotorcraft engines are not mandatory. The OEI ratings are selected by the applicant to support rotorcraft operating requirements. The applicant should establish the rated power or thrust by engine test and for the conditions specified by the definition for that rating in § 1.1. All engine ratings must be declared in the TCDS.

b. When a rating other than those listed in § 33.7, paragraphs (c)(1)(i) through (x) is desired, the applicant may request that rating in a special condition (refer to § 21.16). For example, the FAA issued special condition SC No. 33-005-SC for "rated 30-minute power," a new rating for rotorcraft engines. In part 33, the only non-OEI ratings available for rotorcraft engines were the rated takeoff power limited in use to periods of 5 minutes and the rated maximum continuous power. The rated 30-minute power provided a power level greater than maximum continuous power for use up to 30 minutes. The rating was requested by the applicant to provide the power needed for the rotorcraft to hover for extended periods of time during search and rescue flight

missions. The rated 30-minute power was a novel and unusual engine rating, so the FAA issued a special condition.

c. For each selected engine rating, the applicant must establish limits for the power or thrust, shaft torque, engine rotational speed, and gas temperature as specified in § 33.7(c)(1). In addition, for each rating the applicant must establish limits for the operating parameters specified in § 33.7, paragraphs (c)(2) through (c)(18), as applicable, and any other limitations found necessary for safe operation for the engine as specified in § 33.7(a). The applicant should substantiate the operating limitations associated with each rating when showing compliance with part 33.

d. The applicant must establish the power or thrust for each rating at the minimum value expected from all manufactured engines of the same model (see additional guidance in paragraph 23.b. of this AC).

e. For amending existing TCs, applicants must consider that earlier certifications were based on rating definitions available at that time. The definitions have changed since the earlier part 33 amendments, or the preceding Civil Aviation Regulation (CAR) 13. When amending a TC to the current or later part 33 amendments, the applicant should examine the changes in rating definitions and regulatory requirements. To better understand these changes, the history since CAR 13 is provided in appendix 2 of this AC.

f. For each rated power or thrust, the applicant must identify and list in the TCDS the corresponding engine configuration and engine running conditions used to demonstrate that power or thrust. The rated takeoff power and thrust must be defined at standard sea level conditions, the rated maximum continuous power and thrust at applicant specified altitudes and standard atmosphere, and the power for all OEI ratings at applicant specified altitudes and temperatures (refer to § 1.1). All rated power and thrust must be defined for static conditions, except the maximum continuous power and thrust may be defined for either static or in-flight conditions. The engine configuration must include the status of load extraction (accessory loads) and air extraction (bleed air), inlet and exhaust configurations, and any facility or installation configurations affecting the engine performance. See appendix 1 of this AC for an example of engine configuration annotation in the TCDS.

7. Rated Takeoff Power or Thrust (unaugmented) - § 33.7(c)(1)(iv).

a. For each type certificated engine, the applicant must establish the power or thrust associated with the takeoff rating that can be achieved at static standard sea level conditions and within the engine operating limitations established under part 33. The applicant must then demonstrate the rated takeoff power or thrust by engine test. When the engine test ambient conditions are different from the standard atmosphere at sea level, the applicant must apply the appropriate corrections. The rated takeoff power or thrust is limited in use to periods of not over 5 minutes for takeoff operations (refer to § 1.1).

b. The FAA often found the “rated takeoff power” or “rated takeoff thrust” required under § 33.7(c)(1)(iv) is incorrectly exchanged for “takeoff power” or “takeoff thrust” as defined in § 1.1. The rated takeoff power and thrust were first adopted under parts 1 and 33, amendment 3 in 1967. Prior to this amendment, the only available definitions were for “takeoff power” and “takeoff thrust,” applicable to both engine and aircraft certifications. The preamble to amendment 3 notice of proposed rulemaking (NPRM) provides the rationale for introducing the “rated takeoff power” and “rated takeoff thrust” and states this rating is for engine type certification under part 33, while the “takeoff power” and “takeoff thrust” are intended for aircraft certification only. The NPRM further states that approved power or thrust for takeoff are ratings for engines and operating limitations for aircraft. Therefore, only the “rated takeoff power” and “rated takeoff thrust” are ratings approved under § 33.7; the “takeoff power” and “takeoff thrust” are not engine ratings under § 33.7. See appendix 2 of this AC for the chronological revisions of takeoff rating definitions.

c. When requested by the applicant, the FAA may approve extension of the time limit for the rated takeoff power or thrust from 5 minutes to 10 minutes for an airplane operation when one engine becomes inoperative during takeoff. The FAA issued two policy memoranda addressing the extended use of the rated takeoff power or thrust for turbine engines installed on airplanes certificated under parts 23 and 25 (see paragraphs 3.a. and 3.b. of this AC). The FAA determined the 5 minute limit for rated takeoff power or thrust in § 1.1 applies to routine or normal takeoff operations, and this time limit may be extended for abnormal OEI takeoff operations.

(1) At the time of engine TC application, the applicant must request the time extension and include this feature in the certification plan. Specifically, the applicant must make a written request for each engine model to the engine CMACO. Only turbojet, turbofan, and turbopropeller engines are eligible, while turboshaft and reciprocating engines are not. The methods to obtain approval are contained in the policy memoranda referenced in paragraphs 3.a. and 3.b. of this AC.

(2) The time extension is limited to the following:

(a) Engine operation at rated takeoff power or thrust for periods not to exceed 10 minutes during takeoff. That is an extension of up to 5 minutes to the normal 5 minute takeoff time limit.

(b) In the event one engine becomes inoperative during takeoff.

(3) The applicant must include in their substantiation plans the extension of the rated takeoff power or thrust to 10 minutes, and reference the applicable FAA policy. The engine TCDS (and engine manuals) must contain the following note:

"The rated takeoff power (or thrust) may be used for up to 10 minutes in the event one engine on a multi-engine airplane becomes inoperative during takeoff, with the following limitations: [list limitations, if any]".

(4) See appendix 1 of this AC for an example of TCDS annotation.

d. The rated takeoff power or thrust corrected to the conditions specified in the TCDS must be achievable at any time; otherwise the engine does not comply with its type design. In addition, the applicant must ensure the rated power or thrust can be reached by a simple power lever move or its equivalent. Design configurations that limit the takeoff power or thrust to less than its rated value are not acceptable. Any engine installer who wants to limit the engine power or thrust to less than the rated takeoff values, also known as "derated takeoff power or thrust," may request FAA approval under the aircraft certification and in accordance with the aircraft regulations. Alternately, the applicant may request FAA approval for a change in engine design and designate a new model for the lower rated takeoff power or thrust. See paragraph 23.b. of this AC for additional guidance.

8. Rated Maximum Continuous Power or Thrust (unaugmented) - § 33.7(c)(1)(ii).

a. For each type certificated engine, the applicant must determine the value for the rated maximum continuous power or thrust. The applicant must demonstrate by engine test that the rated maximum continuous power or thrust is achieved without exceeding the operating limitations established in compliance with part 33 and required in § 33.7(c). The ambient conditions for which the engine must produce the rated maximum continuous power or thrust are specified in § 1.1.

b. The rated maximum continuous power or thrust corrected to the conditions specified in the TCDS must be achievable at any time; otherwise the engine does not comply with its type design. In addition, the applicant must ensure the rated power or thrust can be reached by a simple power lever movement or its equivalent. Design configurations that limit the maximum continuous power or thrust to less than its rated value are not acceptable.

9. Rotorcraft Engine OEI Ratings.

a. OEI ratings for rotorcraft engines (turboshafts) are non-mandatory ratings. They are selected by applicants from those available in § 33.7, paragraphs (c)(1)(v) through (ix) based on rotorcraft design needs. Once selected, the applicant must follow the associated part 33 requirements for each rating. The requirements in part 33 for 30-second and 2-minute OEI ratings are significantly different from all other OEI ratings, including 2½-minute OEI. For example, inspection and maintenance actions are required at the end of each flight when 30-second OEI power or 2-minute OEI power are used, while there is no such requirement for any

other OEI ratings. Refer to the 30-second and 2-minute OEI ratings definitions in § 1.1 and specific requirements in part 33, including appendix A33.4.

b. In an OEI event, the highest engine power available for continuation of flight is the highest OEI rated power for that engine. For example, subsequent to a rotorcraft OEI event, the operating engine having 30-second and 2-minute OEI ratings may use the 30-second OEI power to attain a safe altitude followed by the 2-minute OEI power to continue into a climb-out. Thereafter, the engine may use the next available rated power that, depending on the engine rating structure, could be 30-minute OEI followed by continuous OEI power, or 30-minute OEI followed by maximum continuous power.

c. The 30-second and 2-minute OEI ratings should be selected together, meaning the 30-second OEI rating cannot be selected without the 2-minute OEI rating, and vice versa. When introduced to part 33, the two ratings were intended to always be selected together since engines having any of these two ratings without the other would not be acceptable under the rotorcraft regulations of parts 27 and 29. Although part 33 does not specifically state the two ratings must be selected together, part 33 requirements were constructed around that assumption. For example, the test schedule in § 33.87(f) is prescribed for the combined 30-second and 2-minute OEI ratings, and there is no test schedule for only 30-second or only 2-minute OEI rating.

d. The definitions and requirements related to rotorcraft engine OEI ratings have changed several times since they were first adopted, making it difficult to establish a commonality between engines certified across several decades. Historically, rotorcraft engine OEI ratings were added to CAR 13 and part 33 in response to requests from the industry. For example, the 30-second OEI and 2-minute OEI ratings combination was introduced as a higher power alternative to the 2½ -minute OEI rating, and the continuous OEI rating was introduced as a longer duration alternative to the 30-minute OEI rating. See appendix 2 of this AC for a summary of revisions to rating definitions since they were first adopted.

10. Auxiliary Power Unit (APU) Mode of Operation - § 33.7(c)(1)(x). APU mode of operation is available for a turbopropeller engine with “free-turbine” design. This mode of operation is a turbopropeller engine design feature where the engine is equipped with a propeller brake. The brake allows the propeller to stop operating while the gas generator portion of the engine continues to operate as an APU. The APU generates mechanical shaft power to drive engine accessories, such as the electric generator or the hydraulic pump, for the ground operation of the aircraft. The APU mode may also be used for the purpose of bleed air extraction. The applicant must establish the operating limitations associated with the APU mode, for example speed, torque, temperature, and bleed airflow, and identify them in the TCDS.

11. Operating Limitations – General.

a. The applicant must specify the engine operating limitations associated with each of the ratings in § 33.7, paragraphs (c)(1)(i) through (x). For each rating, specify the torque, rotor

speed (R.P.M.), gas temperature, and time limits required in § 33.7(c)(1). In addition, specify the limitations in § 33.7, paragraphs (c)(2) through (c)(18). These operating limitations may be established by design, or may result from findings during engine certification. During certification, the applicant has numerous opportunities to demonstrate the validity and acceptability of these operating limitations. At no time is an engine allowed to exceed its operating limitations for the purpose of producing the corresponding rated power or thrust. In addition to those listed in § 33.7(c), the FAA may establish operating limitations when necessary because of certification results (refer to § 33.7(a)).

(1) At the rated power or thrust, new production engines usually operate below the rating's operating limitations, thus having margins to the actual limits. These margins are usually called performance margins. Older engines may have diminished performance margins, a condition known as "engine deterioration." Deteriorated engines must continue to produce the rated power or thrust within the approved operating limits. Deteriorated engine performance margins may be recovered through engine overhaul and/or engine maintenance actions.

b. The operating limitations must be listed in the TCDS. Certain limitations, such as speed, temperature, and torque, should be identified in association with each engine rating, when applicable.

12. Torque, Rotational Speed (R.P.M.) and Gas Temperature for Each Rating - § 33.7(c)(1).

a. For each rating, the applicant must determine and list in the TCDS the limits for engine shaft torque, rotational speeds, and gas temperature.

(1) Shaft torque limits must be prescribed for the turboshaft and turbopropeller engines. In addition to the limits, indicate the location where the shaft torque is limited. For example, for a turbopropeller engine indicate whether the shaft torque is measured before or after the gear box.

(2) The limits for engine rotational speeds may be for a single engine module, such as for the fan speed, or multiple engine modules, such as for the low, intermediate, and high pressure rotors.

(3) For gas temperature limits, the location where the temperature is measured should be identified as either turbine inlet temperature (TIT), or inter-turbine temperature (ITT), or exhaust gas temperature (EGT).

b. The limits for engine shaft torque, rotational speeds, and gas temperature in § 33.7(c)(1) are for steady state values and do not include transients. When transient limits are established, they must be identified separately as transients and noted in the TCDS (see paragraphs 21 and 22 of this AC for further guidance).

13. Fuel, Oil and Hydraulic Fluid Specification - § 33.7, Paragraphs (c)(2), (c)(3) and (c)(4).

a. The FAA adds to the TC, as operating limitations, specifications for fuels, oils, and hydraulic fluids based on evidence from engine tests or acceptable data as part of the type certification program. The specifications should be U.S. industry or military specifications or their equivalent. Fuel additives, such as anti-ice, anti-corrosion, or anti-static additives, must also be FAA approved on an individual basis for each type of fuel. Examples of specifications accepted by the FAA are:

(1) For fuels: ASTM D 1655 grade Jet A, or Jet A-1, or MIL-DTL-83133 grade JP-8.

(2) For oils: SAE AS5780 gas turbine lubricants; also FAA approved commercial brand and type of oil.

b. All specifications for fuels, oils, and hydraulic fluids must be listed in the TCDS. Fuels, oils, or hydraulic fluids that are not in conformance with the TCDS specification are not eligible for use in a certified engine. For emergency use, the applicant may specify a substitute fuel and its usage time limit. The applicant must obtain FAA approval for adding or removing specifications from the TCDS or engine manuals, as well as for changes to an FAA approved specification.

c. Fuel, oil, or hydraulic fluid limitations, including the temperature and pressure discussed in paragraphs 14 and 15 of this AC, must be listed in the TCDS.

14. Temperature of Oil, Fuel and Engine Surface - § 33.7, Paragraphs (c)(5)(i), (c)(5)(iv) and (c)(5)(v).

a. Temperature of oil at a location specified by the applicant, § 33.7(c)(5)(i). The applicant must establish oil temperature limits that should include maximum steady state, maximum transient with time duration limit, and minimum values. The oil temperature limits must be specified in the TCDS together with the location where the oil temperature is measured and, when applicable, the associated engine operating conditions such as starting, relighting, or acceleration for takeoff. The location must be explicitly identified, such as “oil temperature at the outlet of oil pump.” A statement such as “oil inlet” is not sufficiently descriptive.

b. Temperature of fuel at a location specified by the applicant, § 33.7(c)(5)(iv). The applicant must establish fuel temperature limits that should include maximum steady state, maximum transient with time duration limit, and minimum values. When applicable, the applicant must specify whether the temperature limits are related to certain engine operating conditions such as starting or relighting. The fuel temperature limits must be specified in the TCDS together with the location where the fuel temperature is measured. The location must be explicitly identified, such as “maximum fuel temperature at low pressure fuel pump inlet.”

A statement such as “fuel inlet” is not sufficiently descriptive. When additives are used for anti-ice and other reasons, the applicant must specify the fuel temperature which requires the additive.

c. Temperature of external surfaces of the engine, if specified by the applicant, § 33.7(c)(5)(v). When the applicant determines that a temperature limit for the external surfaces of the engine is necessary, the limit must be specified in the TCDS. The maximum engine external surface temperatures may include the temperatures of engine cases, external plumbing (such as lines, fittings, valves, etc.), and external accessories and components. Alternately, the applicant may specify the nacelle temperature limit for the environment in which the engine cases, accessories and components are exposed.

15. Pressure of Fuel, Oil and Hydraulic Fluid - § 33.7, Paragraphs (c)(6)(i), (c)(6)(ii) and (c)(6)(iv).

a. Pressure of fuel at the fuel inlet, § 33.7(c)(6)(i). The fuel pressure limits may include the minimum and maximum pressures, and when applicable, the associated ambient conditions or vapor-to-liquid ratio. Different sets of limits may be established for different engine operating conditions, such as for ground starting, operation, and air starting. The fuel pressure limits, the associated engine and ambient conditions, and the location(s) on the fuel inlet where they are measured must be listed in the TCDS. The location(s) must be explicitly identified, such as “maximum fuel pressure at high pressure fuel pump exit.” A statement such as “fuel inlet” is not sufficient.

b. Pressure of oil at a location specified by the applicant, § 33.7(c)(6)(ii). The oil pressure limits may include the minimum and maximum steady state values, transient values and associated time duration, ambient temperatures, or engine operating conditions. These limits, the associated conditions, and the location(s) where the oil pressure is measured must be listed in the TCDS. The location(s) must be explicitly identified, such as “minimum oil pump exit pressure.” A statement such as “oil inlet” is not sufficiently descriptive.

c. Pressure of hydraulic fluid, § 33.7(c)(6)(iv). The limits for hydraulic fluid pressures should include maximum and minimum hydraulic fluid pressures at sea level and altitude conditions, as applicable. These limits and the location(s) in the engine where the hydraulic fluid pressure is measured must be listed in the TCDS. The location(s) must be explicitly identified, such as “maximum hydraulic fluid pressure at hydraulic fluid pump exit.” A statement such as “hydraulic fluid inlet” is not sufficiently descriptive.

16. Accessory Drive Torque and Overhang Moment - § 33.7(c)(7). This requirement applies to the accessory drives provided for installation of components that are not part of engine type design. These drives, usually called customer drives, provide power to components such as starters, generators, alternators, pumps, and propeller gearbox. For each drive, the applicant must identify in the TCDS the component types and indicate the power extraction, torque,

overhang moment, and any additional information needed for its installation, such as drive direction of rotation and speed.

17. Component Life, and the Number of Start-Stop Stress Cycles Approved for Each Rotor Disc and Spacer - § 33.7, Paragraphs (c)(8) and (c)(12). For the approved ratings, the applicant must identify (1) the life-limited components and establish their life limits by the number of start-stop cycles, or number of hours in operation, as applicable, and (2) any mandatory inspections. The applicant must establish the life limits and mandatory inspections for the components required in part 33 including, but not limited to, § 33.64 Pressurized engine static parts, § 33.70 Engine life-limited parts, and A33.4 the Airworthiness limitations section. Components lives must be identified in the TCDS by reference to the airworthiness limitation section of the instructions for continued airworthiness (ICA).

18. Fuel and Oil Filtration - § 33.7, Paragraphs (c)(9) and (c)(10). Any operating limitation established for the fuel and oil filtration, such as filter requirements, filter part number or identification, must be listed in the TCDS or identified by reference to FAA approved documentation, such as installation or operation manuals. Such limitations may result from compliance with the requirements of § 33.67 for the fuel system and § 33.71 for the oil system.

19. Bleed Air - § 33.7(c)(11). The applicant must determine the limitations associated with the use of bleed air, and identify all such limitations in the TCDS. For each bleed port, specify the airflow extraction limits, such as the maximum allowable airflow rate and the related engine conditions, such as the engine operating environment (rotating speeds, ambient conditions) or the relative usage of other bleed ports. Bleed ports must be identified in the TCDS by their exact locations. Examples of aircraft system bleed use are wing and cowling anti-ice, aircraft environmental control systems (air conditioning), and engine cross-bleed starting.

20. Inlet Air Distortion at the Engine Inlet - § 33.7(c)(13). The applicant must define the inlet distortion limit(s) for which the engine is shown to comply with part 33 requirements. The inlet air distortion must be identified in the TCDS.

21. Transient Rotor Shaft Overspeed, Gas Overtemperature, and Engine Overtorque - § 33.7, Paragraphs (c)(14), (c)(15), and c(16).

a. The transient limit for rotor shaft overspeed, gas overtemperature, or shaft overtorque is intended for speed, temperature, or torque overshoots above the limits in § 33.7(c)(1), usually occurring during engine acceleration and prior to reaching the steady state limit value. The applicant must define each overspeed, overtemperature, or overtorque transient by its value, time duration limit, and maximum number of occurrences. Each transient must be noted in the TCDS. The time duration for a transient should not exceed 10 seconds for the 2½-minute, 2-minute, and 30-second OEI ratings and 30 seconds for all other ratings. When a transient limit only applies

to a specific rating or cannot be used in conjunction with other ratings, note the restriction in the TCDS.

b. The applicant must determine whether overspeed, overtemperature, or overtorque transients should be defined for each rating or for only the takeoff rating. All transients and associated limitations must be listed in the TCDS.

c. Transient overspeed, overtemperature, and overtorque limits are established and validated based on the endurance test in § 33.87 and any other applicable part 33 requirements. For differences between the transient overtorque limits and maximum engine overtorque, see paragraph 22.b. of this AC.

22. Maximum engine overtorque for turbopropeller and turboshaft engines incorporating free power turbines - § 33.7, Paragraph (c)(17).

a. The maximum engine overtorque, as defined in § 1.1, applies to turbopropeller and turboshaft engines incorporating free power turbines and is limited in use to periods of up to 20 seconds. The applicant may establish a maximum engine overtorque limit for any engine rating, except OEI ratings of two minutes or less. The applicant must list in the TCDS the maximum engine overtorque value and its associated time duration, not to exceed 20 seconds.

b. The applicant may select a maximum engine overtorque limit based on the engine design needs and compliance with applicable part 33 requirements, such as §§ 33.84 and 33.87. In addition, the applicant must establish the maximum engine overtorque per requirements in § 1.1. The maximum engine overtorque differs from the transient engine overtorque with respect to the cause and required actions. The maximum engine overtorque is an allowance for the engine exceeding the shaft torque limits because of a failure and its occurrence requires correction of the failure cause. The transient engine overtorque occurs during normal engine operation, such as following acceleration, and does not require any specific maintenance action.

23. Selection of Engine Power and Thrust Ratings - § 33.8.

a. The applicant selects the engine power and thrust ratings as part of the TC application from those in § 33.7, paragraphs (c)(1)(i) through (x). When a rating other than those listed in § 33.7, paragraphs (c)(1)(i) through (x) is desired, the applicant may request that rating in a special condition or may request use of existing special conditions when applicable. For an example of additional ratings the FAA has approved, see paragraph 6.b. of this AC.

b. Each rated power or thrust must be for the lowest value that all engines of the same type (that is, same model) may be expected to produce within the engine operating limitations associated with the rating and under the conditions used to determine the rating (refer to § 33.8(b)). These conditions are identified in § 1.1 for each rating, and include ambient conditions and engine configuration (see paragraph 6.f. of this AC). All engine configurations of

the same engine model must be able to achieve the rated power or thrust for compliance with these requirements. For example, an engine model may have several power or thrust management configurations realized by what are known as "rating plugs." These configurations are acceptable only if the engine is able to obtain the rated power or thrust without exceeding the operating limitations. In other words, the rating plugs should not restrict obtaining the rated power or thrust, otherwise the engine is not compliant with § 33.8(b).

c. The applicant should provide the means by which to determine that any engine, regardless if new or in-service, can produce the type certificate rated power or thrust within the rating's operating limitations. For example, engine acceptance tests or performance check tests may satisfy this requirement when included or referenced in the type certification documentation. The power or thrust verified through these tests should be corrected to the conditions used to determine the rating and listed in the TCDS (refer to § 33.8 (b) and paragraph 6.f. of this AC). The corrected power or thrust should not be less than the rated value listed in the TCDS; otherwise, the engine is not compliant with its type design.

d. The applicant must also include in the TCDS the variation of the rated power or thrust with the ambient temperature. For example, for a flat rated engine, the rated power or thrust remains constant up to the ambient temperature when one or more operating limitations are reached. Beyond this temperature, known as "corner point," the available power or thrust decreases.

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APPENDIX 1: Examples of TCDS Annotations for Engine Ratings and Operating Limitations per § 33.7(c)(1)

The type certificate data sheet (TCDS) is part of a type certificate (TC), and includes ratings and operating limitations. The following are examples of how to annotate the TCDS for turbojet and turboshaft engine ratings and operating limitations.

1. Example of TCDS annotations for the rated thrust of a turbojet engine with extended takeoff thrust (up to 10 minutes for OEI events):

RATINGS - Sea level static thrust (lbs) - Note 1	ENGINE MODELS		
	MODEL 1	MODEL 2	MODEL 3
Rated takeoff (5 minute) - Note 2	60,000	55,000	65,000
Rated maximum continuous	54,000	48,000	59,000

Note 1: Engine ratings are based on calibrated engine test stand for the following conditions:

- Static sea level standard conditions based on the International Civil Aviation Organization (ICAO) Standard Atmosphere conditions.
- No customer bleed-air extraction and no customer power extraction.
- No anti-icing airflow; no inlet distortion; no inlet screen losses; and 100% ram recovery.
- Production engine inlet [P/N] and exhaust [P/N].

Note 2: The rated takeoff thrust may be used for up to 10 minutes in the event one engine on a multi-engine airplane becomes inoperative during takeoff.

2. Example of TCDS annotations for turbojet engine maximum permissible speeds:

Maximum permissible speeds (R.P.M.)	ENGINE MODELS		
	MODEL 1	MODEL 2	MODEL 3
High Pressure Rotor (N2)			
Rated takeoff	15,450	15,400	15,600
Rated maximum continuous	15,200	15,400	15,300
Low Pressure Rotor (N1)			
Rated takeoff	7,700	7,400	7,800
Rated maximum continuous	7,400	7,300	7,500

3. Example of TCDS annotations for turbojet engine maximum permissible gas temperatures:

Maximum permissible gas temperature - inter-turbine temperature (T4.5 - ITT) (°F)	ENGINE MODELS		
	MODEL 1	MODEL 2	MODEL 3
Rated takeoff	1,690	1,630	1,740
Rated maximum continuous	1,600	1,560	1,650
Starting	1,470	1,470	1,470

4. Example of TCDS annotations for the rated power of a turboshaft engine with continuous OEI and 30-second/2-minute OEI ratings:

RATINGS - Sea level shaft horsepower (SHP) - Note 1	ENGINE MODELS		
	MODEL 1	MODEL 2	MODEL 3
Rated takeoff (5 minute)	1,650	2,000	2,500
Rated maximum continuous	1,500	1,750	2,000
Rated continuous OEI	1,600	1,950	2,450
Rated 2-minute OEI, Note 2	1,650	1,970	2,470
Rated 30-second OEI, Note 3	2,000	2,700	2,850

Note 1: Engine ratings are based on calibrated engine test stand for the following conditions:

- Static sea level standard conditions based on ICAO Standard Atmosphere conditions.
- No customer bleed-air extraction and no customer power extraction.
- No anti-icing airflow; no inlet distortion; no inlet screen losses; and 100% ram recovery.
- Production engine inlet [P/N] and exhaust [P/N].

Note 2: Limited in use for up to three periods no longer than 2 minutes each in any one flight, and followed by mandatory inspection and prescribed maintenance action.

Note 3: Limited in use for up to three periods no longer than 30 seconds each in any one flight, and followed by mandatory inspection and prescribed maintenance action.

5. Example of TCDS annotations for turboshaft engine maximum permissible speeds:

Maximum permissible gas generator speeds (R.P.M.)	ENGINE MODELS		
	MODEL 1	MODEL 2	MODEL 3
Rated takeoff	44,600	45,000	45,100
Rated maximum continuous	44,000	43,500	44,000
Rated continuous OEI	44,500	43,700	44,200
Rated 2-minute OEI	44,600	44,700	45,000
Rated 30-second OEI	45,700	46,000	46,000
Transient (10 seconds)	47,000	47,000	47,000

6. Example of TCDS annotations for turboshaft engine maximum permissible gas temperatures:

Maximum permissible gas temperature (°F) – exhaust gas temperature (EGT)	ENGINE MODELS		
	MODEL 1	MODEL 2	MODEL 3
Rated takeoff	1,700	1,750	1,800
Rated maximum continuous	1,500	1,550	1,600
Rated continuous OEI	1,660	1,710	1,760
Rated 2-minute OEI	1,720	1,770	1,820
Rated 30-second OEI	1,750	1,800	1,850
Transient (10 seconds)	1,770	1,820	1,870

7. Example of TCDS annotation for turboshaft engine maximum power turbine shaft torque:

Maximum power turbine shaft torque (ft-lb) Note 1:	ENGINE MODELS		
	MODEL 1	MODEL 2	MODEL 3
Rated takeoff	500	550	620
Rated maximum continuous	450	520	560
Rated continuous OEI	500	530	580
Rated 2-minute OEI	520	600	640
Rated 30-second OEI	580	650	670
Transient (10 seconds)	700	700	700

Note 1: Shaft torque is measured at the shaft output location.

APPENDIX 2: Revision History of Definitions for Turbine Engine Ratings

1. The FAA first adopted engine ratings in the Civil Aviation Regulation (CAR) as CAR-13, amendment 1 in 1957. That amendment introduced and defined takeoff power or thrust rating and the maximum continuous power or thrust rating. The information in this appendix is arranged in chronological order, as ratings definitions were revised, starting with CAR 13-1 through part 33, amendment 25.

2. Rated takeoff and maximum continuous thrust, augmented and unaugmented:

a. The definitions first adopted for these ratings were under the nomenclatures of "takeoff thrust" and "maximum continuous thrust" in CAR-13 by amendment 1, effective 8/12/1957.

b. Rating nomenclatures were later changed in § 1.1 by amendment 3 to part 33, effective 4/3/1967, from "takeoff thrust" to "rated takeoff thrust" and from "maximum continuous thrust" to "rated maximum continuous thrust." In addition, the definitions were revised with regard to the test conditions required for developing the rated thrust.

c. The current definitions for these ratings were introduced in § 1.1 by amendment 6 to part 33, effective 10/31/1974. This amendment revised existing definitions as follows:

(1) Revised the "rated takeoff thrust" and "rated maximum continuous thrust" definitions to clarify they are "unaugmented," by adding "without fluid injection and without the burning of fuel in a separate combustion chamber."

(2) Added new definitions for the "rated takeoff thrust augmented" and "rated maximum continuous thrust augmented."

3. Rated takeoff and maximum continuous power, augmented and unaugmented:

a. The definitions first adopted for these ratings were under the nomenclatures of "takeoff power" and "maximum continuous power" in CAR-13 by amendment 1, effective 8/12/1957.

b. Rating nomenclatures were later changed in § 1.1 by amendment 3 to part 33, effective 4/3/1967, from "takeoff power" to "rated takeoff power" and from "maximum continuous power" to "rated maximum continuous power." In addition, the definitions were revised with regard to the test conditions required for developing the rated power. These are the current definitions.

c. No definitions exist in part 1.1 for “rated takeoff power augmented” and “rated maximum continuous power augmented.” However, these ratings are identified in part 33 regulations, including 33.7 and 33.87. Although these definitions were not added during prior amendments, they are similar to the definitions for the “rated takeoff thrust augmented” and “rated maximum continuous thrust augmented.”

4. Rated 30-minute OEI power, § 33.7(c)(1)(v).

a. This rating was adopted in CAR 13 by amendment 5, effective 2/12/1963, and its definition was added in § 13.1.

b. The rating’s nomenclature was later changed in § 1.1 and part 33 by original version, effective 2/1/1965, from “30-minute power for helicopter turbine engines” to “30-minute power.”

c. The next revision to this rating’s definition was introduced in § 1.1 by amendment 3 to part 33, effective 4/3/1967. The “30-minute power” nomenclature was amended by inserting the word “rated” before 30-minute power to read: “rated 30-minute power.”

d. The next revision to this rating’s definition was introduced in § 1.1 by amendment 12 to part 33, effective 10/3/1988. This revision added “OEI” to the rating nomenclature to read “rated 30-minute OEI power” to better identify its intended use.

e. The rating’s definition was later revised in § 1.1 by amendment 25 to part 33, effective 10/17/2008. The OEI condition was revised from “the failure of one engine” to “the failure or shutdown of one engine.” The definition remains unchanged to date.

5. Rated 2½-minute OEI power, § 33.7(c)(1)(vi).

a. This rating was adopted in CAR 13 by amendment 6, effective 4/22/1964, and its definition was added in § 13.1.

b. The rating’s nomenclature was later changed in § 1.1 and part 33 by original version, effective 2/1/1965, from “2 ½-minute power for helicopter turbine engines” to “2½-minute power” with the same definition.

c. The next revision to this rating's definition was introduced in § 1.1 by amendment 3 to part 33, effective 4/3/1967. The "2½-minute power" was amended by inserting the word "rated" before the 2½-minute power to read: "rated 2½-minute power."

d. The next revision to this rating's definition was introduced in § 1.1 by amendment 12 to part 33, effective 10/3/1988. This revision added "OEI" to the rating nomenclature to read "rated 2½-minute OEI power" to better identify its intended use.

e. The rating's definition was later revised in § 1.1 by amendment 25 to part 33, effective 10/17/2008. The OEI condition was revised from "the failure of one engine" to "the failure or shutdown of one engine." This revision also clarified that more than a single 2½-minute period is permitted for one flight by changing from "limited in use to a period of not more than 2½ minutes" to "for periods of use no longer than 2½ minutes each." The definition remains unchanged to date.

6. Rated continuous OEI power, § 33.7(c)(1)(vii).

a. This rating was adopted in § 1.1 and part 33 by amendment 12, effective 10/3/1988.

b. The rating's definition was later revised in § 1.1 by amendment 25 to part 33, effective 10/17/2008. The OEI condition was revised from "the failure of one engine" to "the failure or shutdown of one engine." The definition remains unchanged to date.

7. Rated 2-minute OEI power, § 33.7(c)(1)(viii).

a. This rating was adopted in § 1.1 and part 33 by amendment 18, effective 8/19/1996.

b. The rating's definition was later revised in § 1.1 by amendment 25 to part 33, effective 10/17/2008. The OEI condition was revised from "the failure of one engine" to "the failure or shutdown of one engine." The definition remains unchanged to date.

8. Rated 30-second OEI power, § 33.7(c)(1)(ix).

a. This rating was adopted in § 1.1 and part 33 by amendment 18, effective 8/19/1996.

b. The rating's definition was later revised in § 1.1 by amendment 25 to part 33, effective 10/17/2008. The OEI condition was revised from "the failure of one engine" to "the failure or shutdown of one engine." The definition remains unchanged to date.

9. Auxiliary power unit (APU) mode of operation in § 33.7(c)(1)(x) was adopted in part 33 by amendment 11, effective 4/24/1986. There is no definition for this rating in § 1.1.