Designation: F3432 – 20

Standard Practice for Powerplant Instruments[1]

This standard is issued under the fixed designation F3432; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This standard practice provides the minimum required powerplant instruments along with information on how that information is provided to the flight crew or pilot of Normal Category Level 1, 2, 3, or 4 aeroplanes. The material was developed through open consensus of international experts in general aviation. This practice does not consider remotely piloted aeroplanes, nor does it consider electric or hybrid-electric aeroplanes. The content may be more broadly applicable; it is the responsibility of the applicant to substantiate broader applicability as a specific means of compliance.

1.2 An applicant intending to propose this information as Means of Compliance for a design approval must seek guidance from their respective oversight authority (for example, published guidance from applicable CAAs) concerning the acceptable use and application thereof. For information on which oversight authorities have accepted this standard (in whole or in part) as an acceptable Means of Compliance to their regulatory requirements (hereinafter "the Rules"), refer to the ASTM Committee F44 web page (www.astm.org/COMMITTEE/F44.htm).

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F3062/F3062M Specification for Aircraft Powerplant Installation

F3063/F3063M Specification for Aircraft Fuel Storage and Delivery

F3064/F3064M Specification for Aircraft Powerplant Control, Operation, and Indication

F3066/F3066M Specification for Aircraft Powerplant Installation Hazard Mitigation

F3117/F3117M Specification for Crew Interface in Aircraft

2.2 *EASA Standard:*[3]

CS-23.1305 Normal, Utility, Acrobatic, and Commuter Aeroplanes, Amendment 4

2.3 *FAA Standard:*[4]

14 CFR 23.1305 Airworthiness Standards: Normal Category, Utility, Acrobatic, and Commuter Category Aeroplanes, Amendment 23-62

3. Terminology

3.1 *Definitions:*

3.1.1 *altitude engine, n*—a reciprocating aircraft engine having a rated takeoff power that is producible from sea level to an established higher altitude.

3.1.2 *crew, n*—for the purposes of this practice, the pilot and any personnel required onboard for the safe operation of the aeroplane.

3.1.3 *electronic engine control, EEC, n*—a digital computer that controls aspects of engine performance.

[1] This practice is under the jurisdiction of ASTM Committee F44 on General Aviation Aircraft and is the direct responsibility of Subcommittee F44.40 on Powerplant.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from the European Union Aviation Safety Agency (EASA), Konrad-Adenauer-Ufer 3, D-50668 Cologne, Germany, https://www.easa.europa.eu/.

[4] Available from Federal Aviation Administration (FAA), 800 Independence Ave., SW, Washington, DC 20591, http://www.faa.gov.

3.1.4 *indicator, n*—a means to provide parameter information to the flight crew or pilot such that it includes current state of operation, rate of change information, direction of change information, and relative proximity to any limits.

4. Significance and Use

4.1 This practice provides designers of general aviation aeroplanes with a list of previously accepted required powerplant instruments, and a method for the powerplant information to be provided to the crew based on the type of powerplant installation. Criteria for mitigating the need for rate of change, direction of change, and proximity to limits information for some required powerplant instruments is also provided. This practice applies to reciprocating and turbine engine powerplant requirements. This practice provides a method of compliance to Section 6 of Specification F3064/F3064M.

5. Traditional Powerplant Instrument Requirements

5.1 The following are required powerplant instruments for all aeroplanes using internal combustion based engines and nondigital displays:

5.1.1 With the exception of auxiliary transfer tanks defined in Specification F3064/F3064M, a fuel quantity indicator for each fuel tank shall be installed in accordance with Specification F3064/F3064M.

5.1.2 Oil pressure indicator for each engine.

5.1.3 Oil temperature indicator for each engine.

5.1.4 A fire warning means for those aeroplanes required to comply with Specification F3066/F3066M.

5.1.5 Fuel low level alert means for any tank that should not be depleted of fuel in normal operations. The alert shall provide indication to the flight crew or pilot that awareness (caution) or immediate action (warning) is required based upon the level of fuel within the tank. The level of the alert (caution or warning) is dependent upon factors inherent to each aeroplane and its intended use. Historically, for traditional general aviation aeroplanes and their missions, a caution alert at approximately 30 min of usable fuel remaining has been accepted. Fuel low level alerts greater than 45 min require careful consideration to avoid unnecessary alerts to the flight crew during typical operations.

5.2 *For Reciprocating Engine-powered Aeroplanes*—In addition to the powerplant instruments required by 5.1, the following powerplant instruments shall be provided:

5.2.1 An induction system air temperature indicator for each engine equipped with a preheater, and having induction air temperature limitations that can be exceeded with preheat.

5.2.2 A tachometer indicator for each engine.

5.2.3 Cylinder head temperature indicator for each air-cooled engine with cowl flaps or level 4 aeroplanes.

5.2.4 For each pump-fed engine, a means to indicate continuously to the pilot the fuel pressure or fuel flow; or a means that continuously monitors the fuel system, and warns the pilot of any fuel flow trend that could lead to engine failure.

5.2.5 Manifold pressure indicator for each altitude engine, and for each engine with a controllable propeller.

5.2.6 For each turbocharger installation:

5.2.6.1 If limitations are established for either carburetor (or manifold) air inlet temperature, or exhaust gas, or turbocharger turbine inlet temperature, indicators shall be furnished for each temperature for which the limitation is established, unless it is shown that the limitation will not be exceeded in all intended operations.

5.2.6.2 If its oil system is separate from the engine oil system, oil pressure and oil temperature indicators shall be provided.

5.2.7 Coolant temperature indicator for each liquid-cooled engine.

5.3 *For Turbine Engine-powered Aeroplanes*—In addition to the powerplant instruments required by 5.1, the following powerplant instruments shall be provided:

5.3.1 Gas temperature indicator for each engine.

5.3.2 Fuel flowmeter indicator for each engine.

5.3.3 Fuel low pressure warning means for each engine.

5.3.4 A tachometer indicator (to indicate the speed of the rotors with established limiting speeds) for each engine.

5.3.5 An oil low pressure warning means for each engine.

5.3.6 An indicating means to indicate the functioning of the powerplant ice protection system for each engine.

5.3.7 For each engine, an indicating means for the fuel strainer or filter required by Specification F3063/F3063M to indicate the occurrence of contamination of the strainer or filter before it reaches the capacity established in accordance with Specification F3063/F3063M.

5.3.8 For each engine, a warning means for the oil strainer or filter required by Specification F3062/F3062M, if it has no bypass, to warn the pilot of the occurrence of contamination of the strainer or filter screen before it reaches the capacity established in accordance with Specification F3062/F3062M.

5.3.9 An indicating means to indicate the functioning of any heater used to prevent ice clogging of fuel system components.

5.4 *For Turbojet/Turbofan Engine-powered Aeroplanes*—In addition to the powerplant instruments required by 5.1 and 5.3, the following powerplant instruments are required:

5.4.1 For each engine, an indicator to indicate thrust or a parameter that can be related to thrust, including a free air temperature indicator, if needed for this purpose.

5.4.2 For each engine, a position indicating means to indicate to the flight crew when the thrust reverser, if installed, is in the reverse thrust position.

5.5 *For Turbopropeller-powered Aeroplanes*—In addition to the powerplant instruments required by 5.1 and 5.3, the following powerplant instruments are required:

5.5.1 A torque indicator for each engine.

5.5.2 A position indicating means to indicate to the flight crew when the propeller blade angle is below the flight low pitch position, for each propeller, unless it can be shown that such occurrence is highly improbable.

6. Nontraditional Powerplant Instrument Rationale

6.1 A digital-only display may be used for powerplant instruments that traditionally require rate and direction of change, and proximity to limits information if it is shown that information is not needed. To support this showing, a rational

argument shall be provided for each digital-only powerplant instrument that identifies all compensating features along with justification of how those features mitigate the pilot need to directly monitor rate of change, direction of change, and proximity to limit information to prevent a limit exceedance or unsafe operating conditions. The following are several examples of digital-only powerplant instrument arguments that justify digital-only presentation. Digital-only displayed powerplant instruments, at a minimum, shall provide a numerical readout of each parameter, including colored digits or colored background identifying normal, caution, and warning operating ranges in accordance with Specification F3117/F3117M to indicate current operating state and limit exceedance information.

6.1.1 For gas generator speed, if the instrument is not required to set power, the primary concern is preventing overspeed and potential engine failure. If a redundant automatic overspeed protection system is provided, and the likelihood of an overspeed is addressed for both normal and latent failure operating conditions, the design mitigates the need for reliance on the indicating system for immediate flight crew or pilot action to prevent an overspeed.

6.1.2 For propeller speed, even though it is part of the primary power setting procedure, a speed governor prevents the need for the flight crew to constantly monitor or adjust propeller speed to adjust power. If in addition to a speed governor, an overspeed protection means is provided that protects against limit exceedance and potential engine failure, the design mitigates the need for rate and direction of change, or proximity to limit information being provided to the pilot.

6.1.3 For engine oil temperature, the rate of change is relatively slow, not directly controlled by flight crew or pilot (except by airspeed or power changes), and is generally controlled by a thermostat such that immediate pilot action is not necessary to prevent an exceedance. Additionally, short term oil temperature exceedances do not typically present an immediate hazard. This design configuration typically mitigates the need for rate and direction of change, or proximity to limit information needed for immediate flight crew or pilot action to prevent a hazardous condition. Flight crew or pilot action based on indication of a limit exceedance at or shortly after its occurrence is typically sufficient.

6.1.4 Fuel flow typically does not include any limitations, and only requires verification of positive flow during some engine start procedures. This mitigates the need for rate and direction of change, or proximity to limits information needed for immediate flight crew or pilot action to prevent a hazardous condition.

6.2 Noncontinuous display of powerplant instruments may be permitted for those instruments that are only needed during certain phases of flight. If it is desired to inhibit some powerplant instruments from full-time display, a human factors evaluation that shows the system is functionally equivalent to a full-time display should be demonstrated. The following shall be provided and evaluated for any powerplant instrument that is not continuously displayed:

6.2.1 A determination that continuous display of the powerplant instrument is not required for safety of flight in all normal flight phases.

6.2.2 Automatic display of the powerplant instrument in phases of flight where it is required.

6.2.3 Automatic monitoring of the instrument when inhibited, that before reaching any operating limit, returns continuous display of the required powerplant instrument without pilot action. The monitoring function should automatically provide the same level of monitoring that would exist if there were continuous display of the individual powerplant instruments. The display of the powerplant instruments or alerts shall allow the flight crew or pilot to identify and carry out the necessary and appropriate actions. The required powerplant indications should be presented continuously during the critical takeoff and landing phases of flight to minimize flight crew or pilot distraction until an established rate of climb or minimum altitude is achieved.

6.2.4 Capability for the flight crew or pilot to manually display any inhibited powerplant instrument at any time without interfering with the display of other required information.

6.2.5 Displays that provide multiple powerplant instruments shall be designed such that any instrument, display, or alert will not suppress or inhibit another display or alert that also requires immediate flight crew awareness necessary to conduct safe operation of the aeroplane and engine(s). Alerts that could cause subsequent activation of other displays or alerts should be presented in a manner and form to ensure appropriate identification and prioritization of all significant hazards, and require flight crew/pilot actions.

6.2.6 Failure of all inhibited/noncontinuous powerplant instruments to be displayed when required shall be included in the aeroplane safety analysis, and meet the requirements of the applicable regulations.

7. Previously Accepted Powerplant Instruments for Reciprocating and Turbine Engine Installations

7.1 See Figs. 1 and 2.

8. Keywords

8.1 CAS message; digital display; engine indication system; glass panel; powerplant indications; powerplant instruments