

Exemption No. 9997

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
WASHINGTON, DC 20591

In the matter of the petition of

CESSNA AIRCRAFT COMPANY

for an exemption from §§ 23.1549(a),
(b), and (c)
of Title 14, Code of
Federal Regulations

Regulatory Docket No. FAA-2009-1170

GRANT OF EXEMPTION

By letter dated November 04, 2009, Mr. Kim Hackett, Cessna Aircraft Company, One Cessna Boulevard, P.O. Box 7704, Wichita, Kansas 67277-7704 petitioned for an exemption with time-limited conditions from §§ 23.1549(a), (b), and (c) of Title 14 of the Code of Federal Regulations (CFR) to permit type certification of the Cessna model 525C airplanes without oil pressure and temperature indications specified in the rule. The proposed exemption would permit relief from the requirements for arrangement, visibility, and colors for the engine oil temperature and pressure indications for the model 525C airplanes. The current design of the low pressure rotary group shaft speed (N1) and interstage turbine temperature (ITT) indication of the model 525C airplanes provides conflicting color indications in certain operational regimes. The proposed exemption, if granted, would permit type certification approval of the model 525C airplanes with this non-compliant type design for a limited time.

The petitioner requests relief from the following regulation[s]:

Sections 23.1549(a), (b), and (c), in pertinent part, require certain arrangement, visibility, and colors for N1 and ITT indications.

The petitioner supports its request with the following information:

Cessna Aircraft Company requests an exemption with time-limited conditions from the requirements of 14 CFR 23.1549(a), (b), and (c) for the model 525C to the extent necessary to allow type certification of the Cessna model 525C airplanes with the current N1 and ITT displays. As a condition for granting the requested time-limited exemption, Cessna Aircraft will design and certify engine N1 and ITT displays that are

compliant with the current FAA interpretation of 14 CFR § 23.1549(a), (b), and (c) within 15 months of the granting of this exemption. Cessna Aircraft will provide a service bulletin to all field aircraft after certifying the new display.

14 CFR Reference

14 CFR § 23.1549: Powerplant and auxiliary power unit instruments.

For each required powerplant and auxiliary power unit instrument, as appropriate to the type of instruments--

- (a) Each maximum and, if applicable, minimum safe operating limit must be marked with a red radial or a red line;
- (b) Each normal operating range must be marked with a green arc or green line, not extending beyond the maximum and minimum safe limits;
- (c) Each takeoff and precautionary range must be marked with a yellow arc or a yellow line

Background

The current installation of the Rockwell Collins Proline 21 system on the model 525C airplane contains static warning bands for L and R N1 and for L and R ITT. Similar installations are installed and certified on other part 23 Cessna airplanes including the models 525, 525A, and 525B that have incorporated the Collins Proline 21.

The static warning bands for the engine N1 and ITT have considerable field experience; the model 525 airplanes which incorporate the Proline 21 system have over 426,000 flight hours, the model 525A has over 517,000 flight hours, and the model 525B has over 250,000 flight hours. This is approximately 1.2 million flight hours for this type of display. There have been no reports of issues in the field related to how the engine N1 or ITT are displayed.

N1 Display Discussion:

The current model 525C N1 indication is displayed on the Multifunction Display (MFD), which is centrally located on the instrument panel. The visibility and location of the N1 display is similar to other previously certified Citation aircraft, and has been evaluated during flight testing of the model 525C. The caution and warning N1 limits are transmitted by the Full Authority Digital Electronic Control (FADEC) as listed in Table 1.

Table 1: FJ44-4A N1 Limits

N1 Limits	N1 percent
Max Steady State	104.76 percent
Max Permissible Transient	105.76 percent
Max Transient Duration	(120 Sec)

The N1 display consists of an analog scale and digital display for each engine. N1 is displayed on a tape/pointer display as a percentage of rpm. The data is also displayed digitally below the N1 scale. The analog scale range is 10 percent to 110 percent with tick marks at 20, 40, 60, 80, 85, 90, 95, 100, 105, and 110 percent. Scaling is linear between 10 percent and 80 percent, and between 80 percent and 110 percent. The N1 digital display is a boxed digital readout below the N1 scale with a range of 0 percent to 120 percent and a resolution of 0.1 percent.

As described below, the scale is static and will display the same marking during all engine operations. This scale marking consists of a red line at the Max Steady State Limit of 104.76 percent. (Refer to Figure 1.)

As an alternative to this display, the red line for the scale could be drawn at the Max Transient Limit of 105.76 percent. This would then require an amber band to be drawn between 104.76 percent and 105.76 percent. Due to the small size of this amber band and the limited visibility on this scale, and due to the engine being an N1 FADEC controlled engine, which would require a failure of the FADEC system to ever reach an N1 of this value, Cessna decided to draw the red line at 104.76 percent. This choice results in a conservative display marking for N1.

The tape/pointer on the display will change colors based on the FADEC provided limits.

Figures 1 through 4 show both the current and proposed N1 display configuration. These figures represent the operation of the N1 displays for different operating conditions. Each figure is preceded by a discussion for the specific operating condition.

For N1 speed below the Max Steady State Limit (refer to Figure 1):

For both the current and proposed displays, the tape/pointer on the analog scale is colored white and the N1 digital display is colored green.

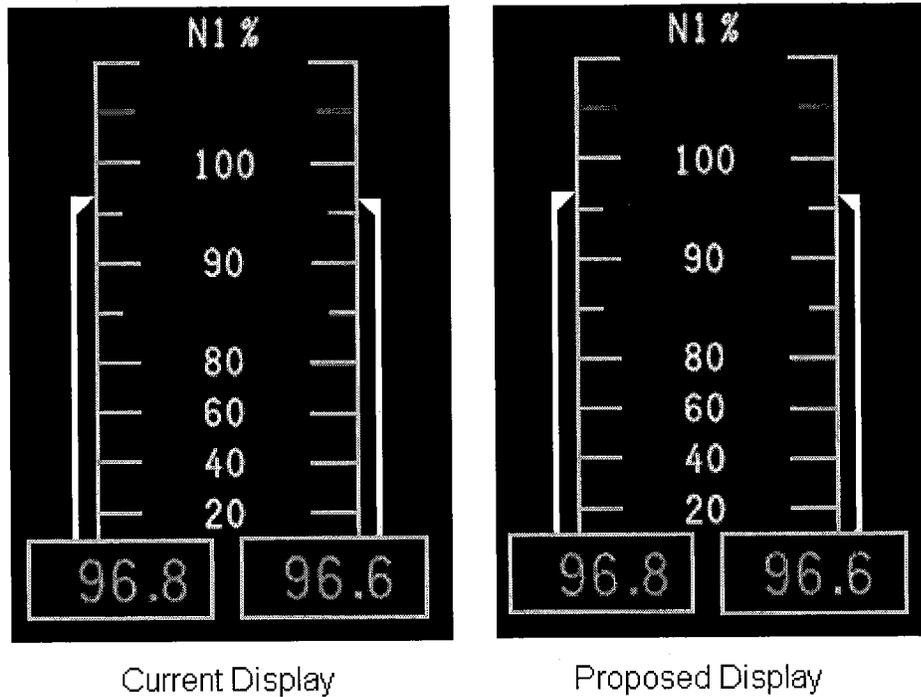
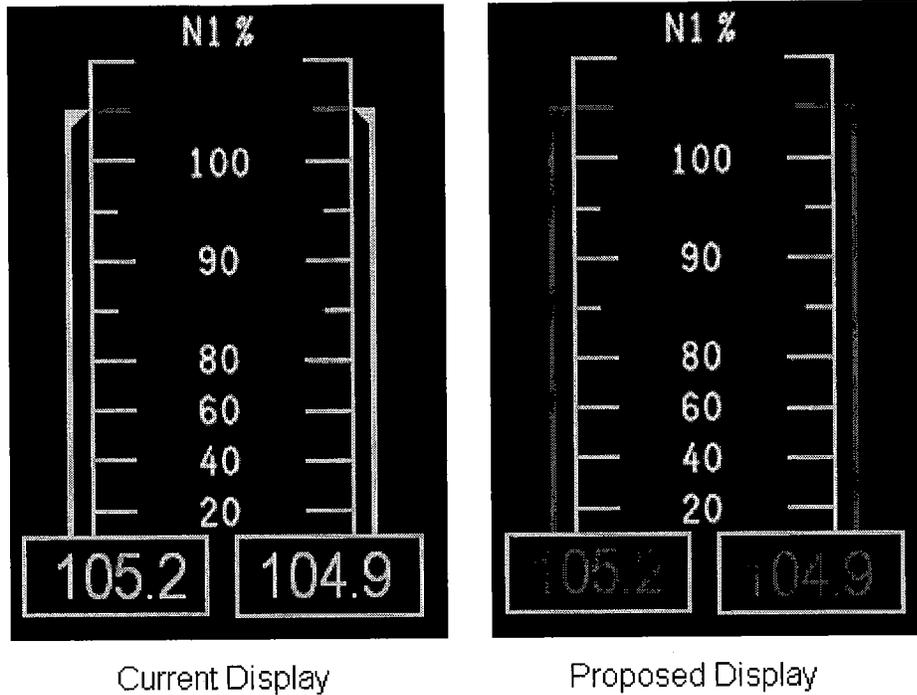


Figure 1: N1 below Max Steady State Limit

For N1 speed between the Max Steady State Limit and the Max Transient Limit for less than 120 seconds (refer to Figure 2):

For the current display, the tape/pointer and digital digits will turn amber and flash for five seconds and then go steady amber.

For the proposed display, the tape/pointer and digital digits will turn red and flash for five seconds and then go steady red.



Current Display Proposed Display
Figure 2: N1 between the Max Steady State Limit and the Max Transient Limit for less than 120 sec

For N1 speed between the Max Steady State Limit and the Max Transient Limit for greater than 120 seconds (refer to Figure 3):

For the current display, the tape/pointer and digital digits will turn red and flash for five seconds and then go steady red.

For the proposed display, the tape/pointer and digital digits will remain red due to already having been turned red per above.

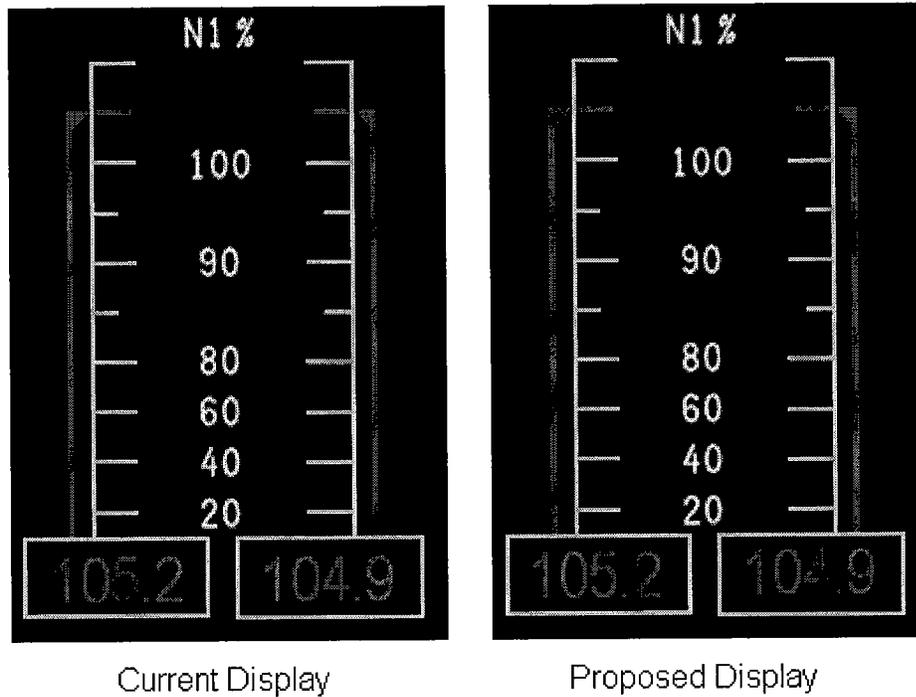
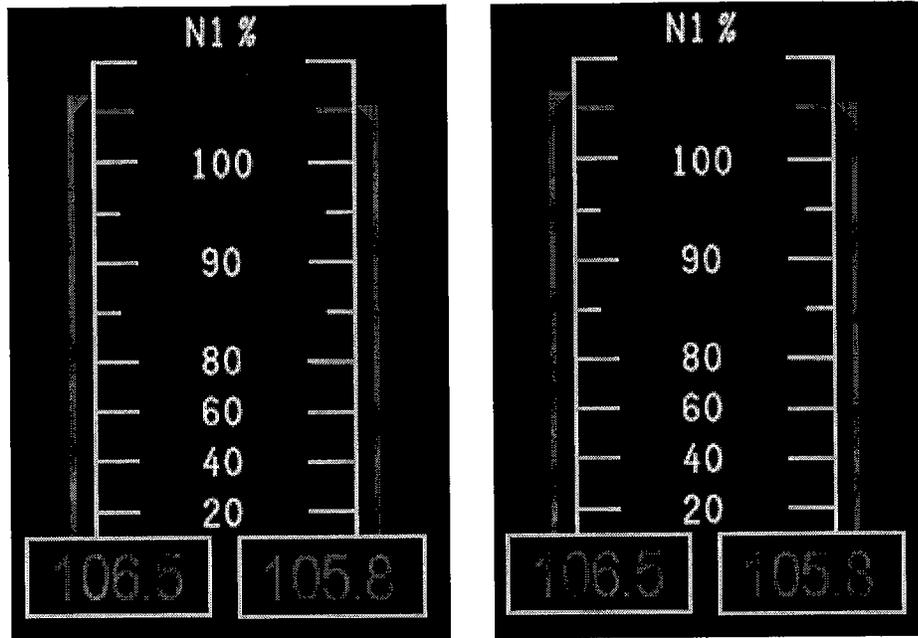


Figure 3: N1 between the Max Steady State Limit and the Max Transient Limit for greater than 120 sec

For N1 speeds above the Max Transient Limit (refer to Figure 4):

For both the current and proposed displays, the tape/pointer and digital digits will turn red and flash for five seconds and then go steady red. If the pointer, tape and digital display and have already turned red due to being in the transient zone for more than 120 seconds the pointer, tape and digital display will remain a steady red and not flash.



Current Display

Proposed Display

Figure 4: N1 above the Max Transient Limit

ITT Display Discussion:

The current model 525C ITT indication is displayed on the MFD, which is centrally located on the instrument panel. The visibility and location of the ITT display is similar to other previously certified Citation aircraft, and has been evaluated during flight testing of the model 525C. The caution and warning ITT limits are transmitted by the FADEC as listed in Table 2.

Table 2: FJ44-4A ITT Limits

ITT Limits	Engine Running	Engine Starting
Max Steady State Limit	835°C	840°C
Transient Limit 1:	855°C (0 sec)	1000°C (15 sec)
Transient Limit 2:	855°C (Dual Engine – 5 min Single Engine – 10 min)	900°C (30 sec)

The display of ITT consists of an analog scale and tape/pointer for the respective engine. The ITT tape/pointer only shows when ITT is above 100 °C. Scale range is 100 °C to 1,050 °C, with tick marks at 200, 400, 600, 650, 700, 750, 800, 850, 900,

950, 1,000, and 1,050 °C. Four linear scale portions exist, with scaling change above 600 °C, 800 °C, and changing again above 900 °C.

As described below, the ITT limits are dynamic and will display different markings based on the engine state (run or starting) and based on the value of ITT. These markings change as required to meet the FADEC provided ITT limits as shown in Table 2. Additionally, the tape/pointer will change colors based on the FADEC provided limits.

The following discussion provides details on the current ITT display with respect to the dynamic scale and the tape/pointer color operation. Due to the complexity of the ITT limitations with respect to various transient temperature and time limits, Cessna is not able to provide a proposal for a compliant display at this time. In addition, FAA/Cessna coordination is required before a proposal for display of ITT can be presented. However, Cessna Aircraft Company is committed to incorporation of a display compliant to the related regulations.

ITT Display with Engines Running

Figures 5 through 9 show the current ITT display configuration with engines in the run mode. These figures represent the operation of the ITT displays for different operating cases. Where necessary, each figure is preceded by a discussion for the specific case.

Note that for Cases 1 – 5, ITT display operation is discussed with respect to dual engine operation. For One Engine Inoperative (OEI) conditions, the ITT display operates the same except that the engine running transient limit is ten minutes instead of five as shown in Table 2.

Case 1 – ITT below Max Steady State Limit (refer to Figure 5)

Display Item	Display Characteristic
Tape/Pointer	White
Scale Markings	Amber Band – 835°C to 855°C Red Line – 855°C

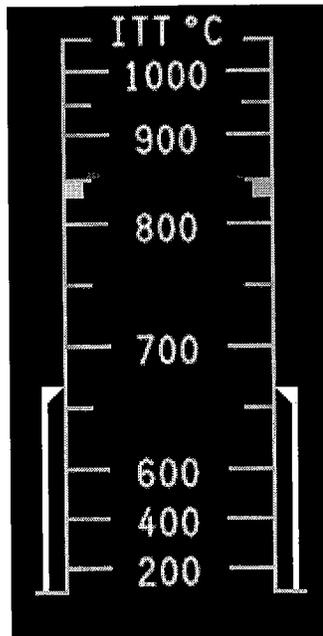


Figure 5: ITT below Max Steady State Limit

Case 2 – ITT between the Max Steady State Limit and the Transient Limit for less than three minutes (refer to Figure 6)

For Cases 2 through 4, the FADEC is transmitting a dual engine operation transient time limit of five minutes. Since there are operating conditions when an engine may operate for a brief time in the cautionary range, Cessna does not immediately turn the tape/pointer to amber when operating between 835 °C and 855 °C. The tape/pointer will remain white for three minutes. After three minutes, the tape/pointer will then turn amber and flash for five seconds after which it stays amber. This allows the pilot to operate in the cautionary range if required due to hot day conditions but provides sufficient notification prior to exceeding the five minute transient limit for the pilot to take corrective action by reducing the throttle. This display philosophy is consistent with other model 525 series displays and eliminates the possibility of the distraction of a flashing amber ITT tape/pointer during takeoff, especially considering that a full five minutes of operation is allowed in this transient region.

Display Item	Display Characteristic
Tape/Pointer	White
Scale Markings	Amber Band – 835°C to 855°C Red Line – 855°C

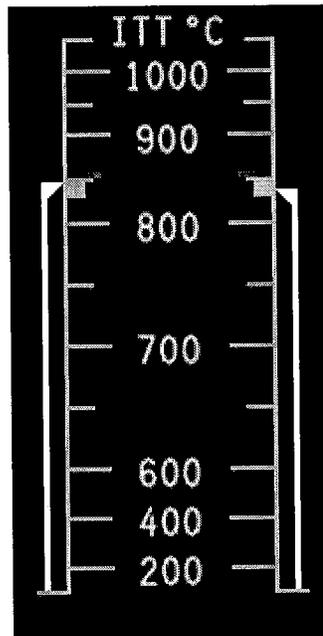


Figure 6: ITT between the Max Steady State Limit and the Transient Limit for less than three minutes

Case 3 – ITT between the Max Steady State Limit and the Transient Limit for three to five minutes (refer to Figure 7)

Display Item	Display Characteristic
Tape/Pointer	Amber (Flashes for 5 sec then steady)
Scale Markings	Amber Band – 835°C to 855°C Red Line – 855°C

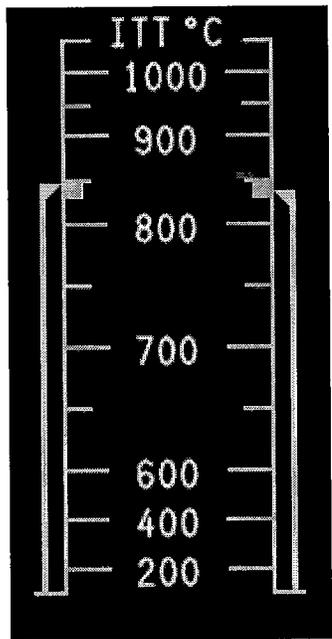


Figure 7: ITT between the Max Steady State Limit and the Transient Limit for three to five minutes

Case 4 – ITT between the Max Steady State Limit and the Transient Limit for greater than five minutes (refer to Figure 8)

Display Item	Display Characteristic
Tape/Pointer	Red (Flashes for 5 sec then steady)
Scale Markings	Amber Band – 835°C to 855°C Red Line – 855°C

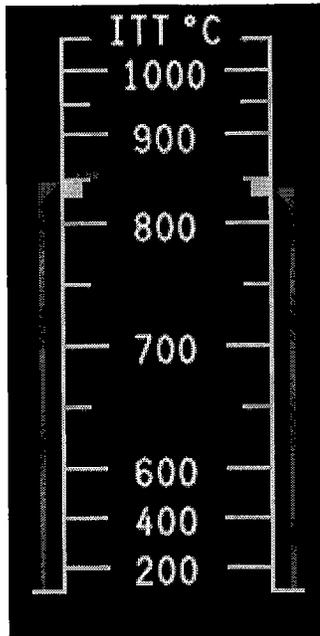


Figure 8: ITT between the Max Steady State Limit and the Transient Limit for greater than five minutes

Case 5 – ITT above the Transient Limit (refer to Figure 9)

Display Item	Display Characteristic
Tape/Pointer	Red (Flashes for five sec then steady)*
Scale Markings	Amber Band – 835 °C to 855 °C Red Line – 855 °C

* If the pointer and tape have already turned red due to being in the transient zone for more than five minutes, the pointer and tape display will remain a steady red and not flash.

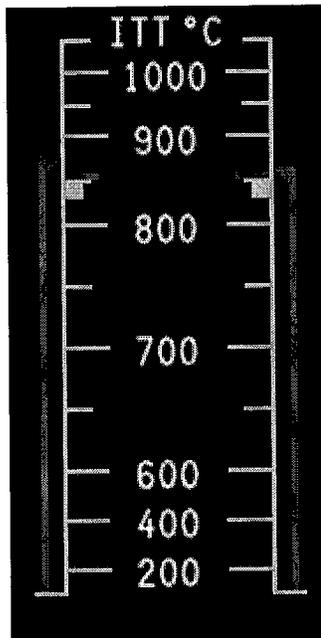


Figure 9: ITT above the Transient Limit

ITT Display during Engine Start:

The ITT display with respect to scale markings and tape/pointer operation is the same as described above in the ITT Display with Engines Running Discussion section of this document.

Figures 10 through 12 show the current ITT display configurations with engines in the start mode as determined by the FADEC. These figures represent the operation of the ITT displays for different operating cases.

Per the Airplane Flight Manual (AFM), the pilot is responsible for ensuring ITT limits are not exceeded. This philosophy is consistent with the rest of the model 525 series airplanes as well as Cessna airplanes certificated under the requirements of 14 CFR part 25. Cessna experience with the FJ44 Series engines in general, as well as with the FJ44-4A installed on the model 525C in particular, is that hot engine starts are very unusual and infrequent.

Case 6 – ITT at or below Max Steady State Starting Limit (refer to Figure 10)

Display Item	Display Characteristic
Tape/Pointer	White
Scale Markings	Amber Band – 835 °C to 855 °C Red Line – 855 °C Red Triangle – 1000 °C

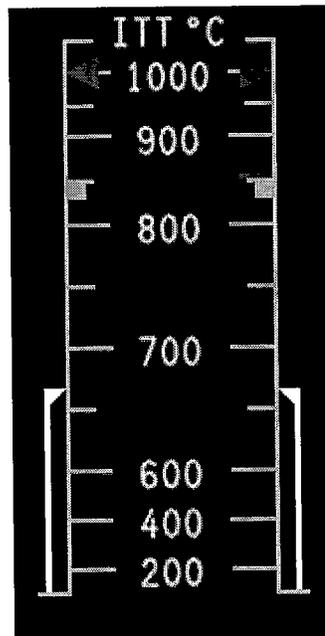


Figure 10: ITT at or below Max Steady State Starting Limit

Case 7 – ITT above Max Steady State Starting Limit (refer to Figure 11)

Display Item	Display Characteristic
Tape/Pointer	White
Scale Markings	Amber Band – 835 °C to 855 °C Red Line – 855 °C Red Triangle – 1000 °C

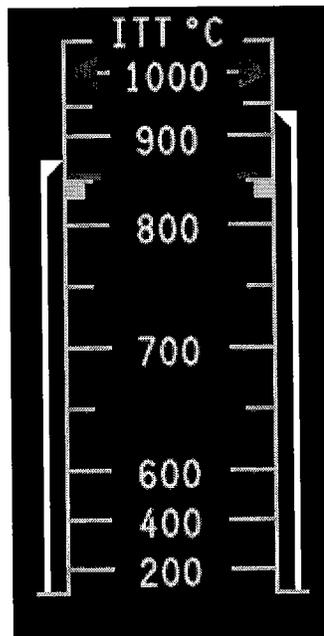


Figure 11: ITT above Max Steady State Starting Limit for any Length of Time

Case 8 – ITT above Max Starting Transient Limit (refer to Figure 12)

Display Item	Display Characteristic
Tape/Pointer	Red (Flashes for five sec then steady)
Scale Markings	Amber Band – 835 °C to 855 °C Red Line – 855 °C Red Triangle – 1000 °C

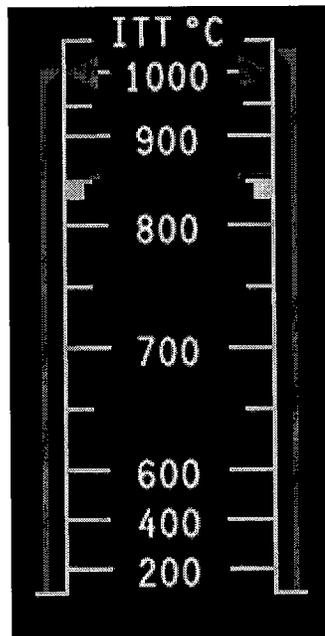


Figure 12: ITT above Max Starting Transient Limit

Petition

Cessna Aircraft Company requests an exemption with time-limited conditions from the requirements of 14 CFR § 23.1549(a), (b), and (c) for the model 525C for the engine N1 and ITT displays on the model 525C. This exemption would allow type certification of the Cessna model 525C airplanes with the current N1 and ITT displays,

while permitting adequate time to design and certify the proposed scale display in order to establish full compliance with the latest interpretation of the requirements of 14 CFR § 23.1549(a), (b), and (c).

As a condition for granting the requested exemption, Cessna Aircraft will design and certify engine N1 and ITT displays that are fully compliant with the latest interpretation of 14 CFR § 23.1549(a), (b), and (c) within 15 months of the granting of this exemption.

The next scheduled version of the display software from Collins (v2.0) has a certification schedule for TSO receipt by end of year 2010. Due to current manpower constraints at Collins, it is not feasible to incorporate the new N1 and ITT displays prior to v2.0 without significantly delaying v2.0. Collins display software v2.0 is required for EASA certification and any delay in EASA certification could result in significant financial penalties for Cessna Aircraft Company.

Cessna Aircraft will provide a service bulletin to all model 525C field aircraft after certifying the new display

Further, prior to the installation of the service bulletin to install the new N1 and ITT displays, Cessna Aircraft will include notes in the Airplane Flight Manual (AFM) to help clarify the band and tape/pointer colors. The notes will be removed once the service bulletin is installed. The essence of the note will be to address the following item; the specific wording is to be agreed upon between Cessna and FAA as part of the AFM approval process.

- The color bands on the vertical tape for N1 and ITT will not change to red as the transient duration limits expire even though the tapes will change color.

Petitioner's Public Interest Statement

Cessna Aircraft Company states that granting this exemption would be in the public interest for the following reasons.

1. The FJ44-4A engine FADEC includes many safety features to prevent the engine from exceeding the N1 and ITT limits. These include the following:
 - Automatically reducing fuel flow as required during a start to actively limit ITT.
 - For engine speed above idle, the FADEC actively governs the N1 speed to the set N1 schedule.
 - The FADEC will shutdown the engine if it detects an N1 overspeed condition.

2. The current engine N1 display allows for safe operation of the engine within its operational limits as shown by the 1.2 million flight hours of similar displays on other model 525 series aircraft. The current display provides two visual cues that will alert the pilots that an engine N1 limit has been exceeded.
 - The tape/pointer for that engine will turn the appropriate warning color and flash for five seconds.
 - The digital readout for that engine will be displayed in the appropriate color, flashing for five seconds.
3. The current engine ITT display allows for safe operation of the engine within its operational limits as shown by the 1.2 million flight hours of similar displays on other model 525 series aircraft. The current display provides two visual cues that will alert the pilots that an engine ITT limit has been exceeded.
 - The tape/pointer for that engine will turn the appropriate warning color flashing for five seconds.
4. Similar engine N1 and ITT displays are currently in use on other model 525 series aircraft models with over 1.2 million flight hours of field service experience. There have been no reports by the pilots of confusion in reading and understanding the engine N1 or ITT displays and no reports of engine damage caused by misinterpreting the engine N1 or ITT displays. Therefore field experience has shown that the current engine N1 and ITT displays do not cause a hazard to the aircraft.
5. The denial of this petition for exemption would result in the delay of the certification of model 525C airplanes for approximately 15 months. Cessna would experience a loss of revenue of at least \$140 million in 2010 and \$120 million in 2011 due to this delay. This could also result in numerous aircraft order cancellations increasing the financial loss significantly. This would also result in the loss of revenue for partners and suppliers and the potential need for workforce reductions, all of which would be counter to the public interest.
6. Cessna's customers have made utilization plans based on the agreed upon delivery schedule of these airplanes. Delay in the delivery date due to the redesign and retrofit of the engine N1 and ITT displays would impose significant financial penalties upon our customers and their businesses without a commensurate safety benefit, which is also counter to the public interest.

Notice and Public Procedure Provided

A summary of the petition was published on December 29, 2009 (74 FR 68914). No comments were received.

The FAA's analysis is as follows:

To obtain this exemption, the petitioner must show, as required by 14 CFR part 11, §§ 11.81(d) and 11.81(e): “(1) the reasons why granting your request would be in the public interest; that is, how it would benefit the public as a whole, and (2) the reasons why granting the exemption would not adversely affect safety, or how the exemption would provide a level of safety at least equal to that provided by the rule from which you seek the exemption.”

The FAA has carefully reviewed the information contained in the petitioner's request for exemption.

The FAA agrees with the petitioner's request for the following reasons:

1. The FJ44-4A engine FADEC includes many safety features to prevent the engine from exceeding the N1 and ITT limits. These include the following:
 - a. Automatically reducing fuel flow as required during a start to actively limit ITT.
 - b. For engine speed above idle, the FADEC actively governs the N1 speed to the set N1 schedule.
 - c. The FADEC will shutdown the engine if it detects an N1 overspeed condition.
2. The current engine N1 display allows for safe operation of the engine within its operational limits as shown by the 1.2 million flight hours of similar displays on other model 525 series aircraft. The current display provides two visual cues that will alert the pilots that an engine N1 limit has been exceeded.
 - a. The tape/pointer for that engine will turn the appropriate warning color and flash for five seconds.
 - b. The digital readout for that engine will be displayed in the appropriate color, flashing for five seconds.
3. The current engine ITT display allows for safe operation of the engine within its operational limits as shown by the 1.2 million flight hours of similar displays on other model 525 series aircraft. The current display provides two visual cues that will alert the pilots that an engine ITT limit has been exceeded.
 - a. The tape/pointer for that engine will turn the appropriate warning color, flashing for five seconds.

- b. Similar engine N1 and ITT displays are currently in use on other model 525 series aircraft models with over 1.2 million flight hours of field service experience. There have been no reports by the pilots of confusion in reading and understanding the engine N1 or ITT displays and no reports of engine damage caused by misinterpreting the engine N1 or ITT displays. Therefore field experience has shown that the current engine N1 and ITT displays do not cause a hazard to the aircraft.
4. The denial of this petition for exemption would result in the delay of the certification of model 525C airplanes for approximately 15 months. The economic impact to Cessna Aircraft Corporation would be severe and result in significant reductions in Cessna's workforce. Additionally, the economic impact to Cessna's suppliers and customers would also be significant.

The FAA's Decision

In consideration of the foregoing, I find that a grant of exemption is in the public interest. Therefore, pursuant to the authority contained in 49 U.S.C. §§ 40113 and 44701, delegated to me by the Administrator, Cessna Aircraft Company is granted an exemption with time-limited conditions from §§ 23.1549(a), (b), and (c) to the extent necessary to allow type certification of the Cessna model 525C airplanes with low pressure rotary group shaft speed (N1) and interstage turbine temperature (ITT) indications not in compliance with the requirements of §§ 23.1549(a), (b), and (c) as they relate to the arrangement, visibility, and colors. For the model 525C airplanes, this exemption is subject to the following conditions and limitations:

Conditions and Limitations

1. Cessna Aircraft Company must certify and incorporate into the production line requirements low pressure rotary group shaft speed (N1) and interstage turbine temperature (ITT) indications fully compliant with the requirements of §§ 23.1549(a), (b), and (c), into the model 525C airplanes no later than April 30, 2011.
2. Cessna Aircraft Company must retrofit the model 525C airplanes delivered under the terms of the exemption with the new low pressure rotary group shaft speed (N1) and interstage turbine temperature (ITT) indications described in Condition 1 above no later than April 30, 2012.
3. Until the incorporation of the changes required in the above Conditions 1 and 2 of this exemption have been completed, Cessna Aircraft Company add to the airplane flight manual (AFM) a description of the indications and their conflicting color guidance, and the necessary instructions for properly interpreting the requirements low pressure rotary group shaft speed (N1) and interstage turbine temperature (ITT) indications.
4. For airplanes subject to Condition 2 of this exemption, the operating limitations section of the airplane flight manual (AFM) must include the following statement:

“No person may operate this airplane after April 30, 2012, unless the low pressure rotary group shaft speed (N1) and interstage turbine temperature (ITT) indications have been modified in accordance with the terms of Exemption No. 9997.”

This statement may be removed from the AFM after the required modification has been made.

This exemption terminates on April 30, 2011, unless sooner superseded or rescinded.

Issued in Kansas City, Missouri on January 26, 2010.



John Colomy
Acting Manager, Small Airplane Directorate
Aircraft Certification Service