23.733 Tires

The corresponding rule in CAR 3 is CAR 3.362.

The corresponding airworthiness criteria is section 4.27, Airship Design Criteria, FAA-P-8110-2, Change 2.

Original Issue and Subsequent (see the following NOTE)

The following is a recommended test procedure for installing tires on a part 23 airplane:

1. Inflate an inboard main tire to the minimum allowable inflation pressure for the airplane weight.

2. Inflate the outboard main tire on that same landing gear to the maximum allowable inflation pressure for the airplane weight.

3. Using white shoe polish or equivalent, mark a two-inch wide stripe on the brake (inboard) side of the outboard tire sidewall adjacent to the wheel rim.

4. Conduct at least two maximum efforts; non-skidding taxi turns into the minimum inflation side of the airplane.

5. Check for evidence of brake wheel housing abrasion contact on the tire sidewall.

   NOTE: Above applies to a dual tire installation for landing gear. For a single tire per gear, inflate either side to the minimum pressure and the opposite side to maximum, and turn into the minimum pressure side.

In a revision to Amendment 23-17, the final rule adopted the proposed change in NPRM 75-10, that added § 23.733(c) with the following explanation: *"The proposed rule would require that the selection of tires for installation on retractable landing gear mechanisms take into account the tire production tolerance and size increases that would be expected to result from service. The FAA believes compliance with the proposed rule could prevent accidents that might result from jamming of landing gear mechanisms by oversize tires."*

Tundra Tires

1. **PURPOSE.** This guidance serves several purposes. First, it summarizes the results of flight tests recommended by the National Transportation Safety Board (NTSB) and conducted by the FAA to examine the effects of tundra tires installed on a Piper PA-18. Second, it provides information on possible hazards associated with the type of operations common for tundra tire users and potential adverse effects of untested installations. Third, it provides general information about the certification process for oversized "tundra" tires, as well as an example "compliance checklist" for the installation of such tires on light airplanes that have CAR, part 3 for a certification basis.

2. RELATED READING MATERIAL

a. Part 23, CAR part 3, and CAR part 03.

b. "National Transportation Safety Board (NTSB) Safety Recommendation A-95-13," dated February 7, 1995.

c. Technical Standard Order (TSO)-C62e, "Aircraft Tires," September 24, 2006.

d. AC 43.13-1B, Change 1, "Acceptable Methods, Techniques, and Practices—Aircraft Inspection and Repair," September 27, 2001.

3. BACKGROUND. In Safety Recommendation A-95-13, dated February 7, 1995, the NTSB shared some of their safety concerns about tundra tires with the FAA and requested the possibility of problems with tundra tires be investigated.

The NTSB stated the following:

"Since the early 1960s, hundreds of airplanes operating in Alaska have been equipped with tundra tires, and dozens of versions of tundra tires—some exceeding 35 inches in diameter—have been marketed. The Safety Board is concerned that field approvals and STCs have been granted for use of these tires without flight test or other data on the aerodynamic effects of the tires and wheels. The Piper PA-18 is the airplane most frequently equipped with tundra tires. The Safety Board believes that the FAA should conduct a demonstration flight test to determine the effects of tundra tires on the PA-18s flight characteristics—including cruise, climb, takeoff, and landing performance—and, in both straight and turning flight, stall warning and aircraft stability at or near the critical angle of attack. Further, if the tests of the PA-18 indicate the need, the FAA should take corrective action and expand testing to other airplane types equipped with oversized tires."

4 SUMMARY OF FLIGHT TEST RESULTS FOR PIPER PA-18 EQUIPPED WITH TUNDRA TIRES

The FAA's flight tests of tundra tires and their results are detailed in Appendix 1 following this guidance. As can be seen in the report, the tundra tire installations on the Piper PA-18 "150" caused no observable adverse effects on stall or stall characteristics during the FAA tests. Although there was some degradation of handling qualities associated with increasing the tire size, the effect was not significant for safety. Rate of climb and cruise speed was degraded with the larger tire sizes; however, the aircraft still met certification requirements. Added tests conducted by an independent Designated Engineering Representative (DER) flight test pilot showed the same lack of effect on stall characteristics with the main landing gear fabric covering removed. It should be remembered that these results are valid **only** for the Piper PA-18 "150" and for tires no larger than those tested. It should also be noted that, although tundra tires did not cause a safety problem, the stall characteristics of the basic Super Cub (and most other airplanes) make low altitude turning stalls hazardous, especially in uncoordinated flight. Also although washout was not varied during these flight tests, previous FAA experience has shown that stall characteristics are further aggravated when operators of the PA-18 remove the 2.5 degrees of washout at the wing tip, which is not an approved change. This condition will result in a rapid roll when the airplane is stalled during turning flight.

5. POTENTIAL ADVERSE EFFECTS OF TUNDRA TIRE INSTALLATIONS ON AIRPLANES

a. Performance

Tundra tire installations on airplanes **may** produce one or more of the following effects on performance characteristics:

(1) Increased stall speed.

(2) Reduced stall warning margin.

(3) Reduced rate of climb.

(4) Reduced maximum angle of climb.

(5) Reduced maximum level flight speed.

(6) Reduced cruise speed.

(7) Reduced range.

Tundra tires reduce climb, cruise, and range performance more when installed on relatively “clean,” well streamlined airplanes than they do when installed on less streamlined airplanes.

b. Flight and Ground Handling Characteristics

Tundra tire installations on airplanes **may** produce one or more of the following effects on handling characteristics:

(1) Reduced ability of brakes to hold against takeoff power.

(2 Reduced brake effectiveness during rejected takeoff and braked landing.

(3) Reduced stability and controllability during rejected or balked landing and go around.

(4) Change in either trim range or trim authority, or both.

(5) Reduced directional stability and control during takeoff and landing ground rolls, with consequent increased tendency to ground loop.

(6) Increased tendency to nose over during landing.

(7) Reduced stall warning margin, change in either aerodynamic stall warning characteristics (warning buffet) or reduced effectiveness of stall warning system, or both, in both level and turning flight with power either on or off, or both.

(8) Changes in stalling and stall recovery behavior in both level and turning flight with power either on or off, or both. Stalls may become more abrupt and altitude loss before recovery may increase.

(9) Increased tendency to enter an inadvertent spin and reduced ability to recover from the spin.

(10) Reduced longitudinal**,** lateral, and directional stability.

(11) Increased airframe vibration and buffet.

Tundra tires: 1) reduce the airplane's directional stability and controllability during takeoff and landing ground rolls, 2) increase its tendency to ground loop during takeoff and landing ground rolls, and 3) increase its tendency to nose over during landings on paved surfaces more than during landings on gravel, grass, or other surfaces that allow the tires to skid more easily.

c. Potential Propulsion Systems Effects

(1) Fuel flow may be affected by changes in normal flying attitude.

(2) Unusable fuel may be affected by changes in normal flying attitude.

(3) The fuel tank sump may be affected by change in ground attitude.

(4) Fuel drains may be affected by change in ground attitude.

(5) Engine cooling may be affected by performance or flying attitude changes.

(6) Changes in tires may affect the air induction system certification for operation on wet runways.

(7) Changes in tires that change ground attitude may affect the induction system icing protection.

6. CERTIFICATION OF TUNDRA TIRES FOR USE ON LIGHT AIRPLANES

The certification process for tundra tires is the same as for any other tire to be used in aviation.

a. A manufacturer may obtain a technical standard order authorization (TSOA) for the tire using the requirements in TSO-C62e. TSO-C62e contains minimum performance standards for aircraft tires. The TSOA, which covers design and manufacturing of the tire only, is not an installation approval. The tire should be approved for installation on a specific airplane model either by TC, STC, or FAA field approval in accordance with HBAW 97-01B, "Flight Standards Handbook Bulletin for Airworthiness" or later revision. The applicable requirements for installation of a tire on a given airplane should be determined based on the original certification basis specified in that airplane's type certificate data sheet (TCDS). Developing a compliance checklist, as described in item 7 below, should be accomplished by the applicant and the FAA engineer.

b. An alternative certification method exists for a tire that does not have a TSOA. The tire design approval may be obtained concurrently with the installation approval for specific airplane models by TC or STC. The requirements of the TSO can be used for a determination of acceptable tire performance in such a project. The applicable requirements for installation of a tire on a given airplane should be determined based on the original certification basis specified in that airplane's TCDS. Developing a compliance checklist, as described in item 7, should be accomplished by the applicant and the FAA engineer. Before offering tires approved by this method for sale, the tire manufacturer would need a parts manufacturing approval (PMA).

7. COMPLIANCE CHECKLIST

See Appendix 2 for an example of the "Compliance Checklist," to CAR part 3 as amended to November 1, 1949. This checklist is intended to show all aircraft certification requirements that **could** be affected by a tundra tire installation. Many of these requirements may be unaffected by a given installation. The compliance checklist for a specific installation should be determined at the start of a project. (See Appendix 2 in this section, which is applicable to § 23.733 Tundra Tires.)

APPENDIX 1

FAA TEST RESULTS/EFFECTS OF TUNDRA TIRES ON THE HANDLING QUALITIES/STALLS/STALL CHARACTERISTICS OF THE PIPER PA-18

1. Tests

Recent accidents in Alaska involving airplanes equipped with tundra tires prompted the NTSB to recommend to the FAA that they conduct flight tests to determine the effects of tundra tires on aircraft performance, stalls, and handling qualities. The following five tires were evaluated at various combinations of Center of Gravity (CG)/weight:

a. Factory installed (8.00-6).

b. McCreary Tundra Tires (8.50-10).

c. McCreary Tundra Tires (29x11.0-10).

d. Schneider Racing Slicks (14.0x32.0x15).

e. Goodyear Airwheels (35x15.0-6).

2. Results

Quantitative/qualitative data obtained from testing the four tundra tires were compared to the data obtained from testing the factory-installed tire. The following is a summary of the findings:

a. Ground Handling

Forward field of view during taxi is inversely related to tire size. As the tire size increases, the ability to see over the nose decreases requiring the pilot make “S” turns with the airplane. Ground handling during takeoff from a gravel runway is satisfactory for all configurations. Ground handling during landing on a gravel runway is also satisfactory for all configurations tested, although there is a noticeable nose down pitching moment when the tire(s) contact the ground. This is most obvious when making a main wheel only landing. Crosswind landings on runway 13 at Lake Hood Strip, a 2,200 feet x 80 feet gravel runway next to Lake Hood three miles southwest of Anchorage, Alaska, were demonstrated for tire configurations items 1a, 1b, and 1c in winds from 180 degrees (from ahead and to the right of the airplane at an angle of 50 degrees to its flight path) at 14 knots gusting to 16 knots. The wind thus had a crosswind component of approximately 10.7 knots gusting to approximately 12.3 knots and a head wind component of approximately 9.0 knots gusting to approximately 10.3 knots. No crosswinds were available during tests for configurations d and e. No tests for ground handling were accomplished on paved runways. The ground handling characteristics of airplanes equipped with tundra tires are known to be substantially poorer on pavement than on gravel, grass, and other surfaces that allow the tires to skid easily.

b. Performance

Tundra tires adversely affect airplane performance. For example, the uncorrected average rate of climb (tested at 1.05 times maximum gross weight) for the standard tire was 526-feet per minute. The uncorrected average rate of climb for configurations items 1d and 1e (tested at 1.05 times maximum gross weight) was 449 and 464-feet per minute.

3. Stalls/Stall Characteristics

a. The purpose of the stall tests was to determine whether there are any differences between the stalling speed and stall characteristics of a PA-18 "150" airplane equipped with tundra tires and the stalling speed and stall characteristics of the same airplane equipped with standard tires. The data obtained from the stall tests do not confirm the theory that tundra tires increase the PA-18 "150" stalling speed.

b. Stall characteristics (all configurations) are normal when the airplane is stalled in balanced flight. In a turning stall, the airplane rolls slowly to a near wings level attitude. In maneuvering flight, the tendency is for the nose to drop as the bank angle is increased. If the pilot uses top rudder (right rudder in a left turn) to compensate for this and then stalls the airplane, the airplane may roll rapidly over the top. This could result in a departure or the incipient phase of spin. If the airplane is maneuvering at low altitude when this sequence of events occurs (for example, while circling to spot moose), the airplane may impact the ground before recovery. Also, although washout was not varied during these flight tests, previous FAA experience has shown that stall characteristics are further aggravated when operators of the PA-18 remove the 2.5 degrees of washout at the wing tip, which is not an approved change. This condition will result in a rapid roll when the airplane is stalled during turning flight.

4. Handling Qualities

For any given CG/weight, the lateral and directional stability deteriorates as tire size is increased.

5. Stall Warning

Installation of the artificial stall warning system on the PA-18 is optional. Most of the PA-18s in Alaska do not have the system installed. The airplane tested did have the artificial stall warning system, and several test points were obtained with the system deactivated. The airplane as tested does not have an aerodynamic stall warning.