



U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

Subject: SUBSTANTIATION FOR AN INCREASE
IN MAXIMUM WEIGHT, MAXIMUM
LANDING WEIGHT, OR MAXIMUM
ZERO FUEL WEIGHT

Date: 7/1/87
Initiated by: ACE-100

AC No: 23-7
Change:

1. PURPOSE. This advisory circular (AC) provides information and guidance concerning acceptable means, but not the only means of compliance with Part 23 of the Federal Aviation Regulations (FAR) applicable to structural substantiation for an increase in maximum weight, maximum landing weight, or maximum zero fuel weight. Accordingly, this material is neither mandatory nor regulatory in nature and does not constitute a regulation.

2. RELATED REGULATIONS. These acceptable means of compliance refer to certain provisions of Part 23 of the FAR for airplanes for which these regulations are applicable. Listed below are the applicable FAR sections:

§ 23.25	§ 23.147	§ 23.201	§ 23.335
§ 23.45	§ 23.149	§ 23.203	§ 23.443
§ 23.49	§ 23.153	§ 23.205	§ 23.473
§ 23.51	§ 23.155	§ 23.207	§ 23.571
§ 23.65	§ 23.157	§ 23.231	§ 23.572
§ 23.67	§ 23.161	§ 23.233	§ 23.629
§ 23.75	§ 23.171	§ 23.235	§ 23.641
§ 23.77	§ 23.173	§ 23.301	§ 23.723
§ 23.143	§ 23.175	§ 23.305	§ 23.1529
§ 23.145	§ 23.177	§ 23.307	§ 23.1581

3. BACKGROUND. In many cases, due to changes in the operational requirements of an owner/operator, the need arises to modify and substantiate the structure for an increase in maximum weight, in maximum landing weight, or in maximum zero fuel weight. Any one of these increases affects the airplane basic loads and structural integrity and could affect the limitations and performance.

If an airplane was certified with maximum landing weight equal to maximum weight, some applicants, via the supplemental type certificate (STC) process, take advantage of the 5 percent difference between design landing and design maximum weight permitted by § 23.473(b) so that resubstantiation of the landing gear for landing loads is not required when increasing the maximum weight by as much as 5 percent. For those programs involving more than a 5 percent increase in maximum weight, some resubstantiation of the landing gear should be accomplished.

Other applicants are replacing piston engines with turbopropeller engines, thus requiring that gasoline be replaced with jet fuel, which weighs as much as 17 percent more. In some cases, the quantity of fuel is being increased at the same time as engine replacement, but the maximum zero fuel weight remains the same.

All of the above types of modifications should be investigated to verify that critical loads have not increased or that those loads which have increased are capable of being carried by the existing or modified structure.

4. Method of Substantiation. One method, but not the only method, for substantiating the structural integrity of a small airplane modified for an increase in maximum weight, maximum landing weight, or maximum zero fuel weight is as follows:

a. Identify the critical flight, landing, and ground loads. The loads may be obtained from existing type certification data, if made available by the type certificate holder to the applicant, or be derived by the applicant. It should be established that the derivations produce essentially the same results as used for the original type certification. Whether developed using basic loads analysis techniques or the charts in the appendices of Part 23, two sets of loads using the same technique are required to determine the incremental load changes.

The airplane structural design airspeeds as defined in § 23.335 should be re-evaluated to determine if the selected airspeeds are adequate at the increased design weights. Each loading condition that is affected by either a speed or weight increase should be re-evaluated. Lateral gust conditions per § 23.443 should reflect any changes in yaw moment of inertia resulting from revised mass distributions.

b. After the loads are identified or derived, substantiation of all structures affected by increases, however small, in the critical loads should be performed. This may be accomplished by a detailed stress analysis, by static test, or by a combination of static test to limit load and analysis to ultimate load as limited by §§ 23.307 and 23.641. If a static test is used for substantiation, the structure should be inspected after the application of limit load to verify that there is no detrimental permanent set. Any detrimental permanent set would require some redesign.

If an airplane was certified with maximum landing weight equal to maximum weight, an STC applicant may take advantage of the difference between design landing weight and design maximum weight permitted by § 23.473(b), such that no resubstantiation of the landing gear for landing loads is required when increasing the maximum certificated weight only. Any increase in the maximum landing weight requires resubstantiation of the landing gear either by drop tests or analysis as limited by § 23.723(a). The applicant should evaluate any landing gear load increases resulting from taxiing over rough ground at takeoff weight per § 23.235.

Part 23 of the FAR does not require the establishment of a maximum zero fuel weight. However, for airplanes with wing fuel tanks, minimum fuel in these tanks may produce the highest wing bending moment. This condition should be evaluated during the structural substantiation of the airplane to determine that the requirements of § 23.301 are complied with.

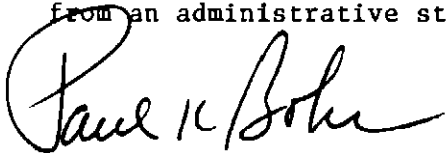
c. The effects of design changes on the performance and flight characteristics which are caused by an increase in maximum weight, revised mass distribution, revised center of gravity limits, etc., should be evaluated to verify that the weight distribution and center of gravity of the airplane are acceptably within the extended weight-CG envelope considering various fuel and payload configurations as well as fuel burnoff.

d. The effects on flutter of an increase in maximum weight or maximum zero fuel weight, any structural modifications, a revision in mass distribution, etc., should be addressed. These may require a ground vibration test and an analysis to ascertain the effect on the vibration and flutter characteristics of the airplane. This subject is thoroughly discussed in AC 23.629-1A, Means of Compliance with Section 23.629, Flutter.

e. A fatigue strength or failsafe strength evaluation should be accomplished if the certification basis includes §§ 23.571 and 23.572. This evaluation may indicate that cyclic tests should be run on a fatigue test specimen with the modifications incorporated.

f. The Airplane Flight Manual and Instructions for Continued Airworthiness (Maintenance Manual) may be affected. Supplements to these manuals should reflect any pertinent changes in weight and balance data, performance, flight procedures, maintenance procedures or practices, life limited parts, etc.

g. Use of a compliance checklist, although not required, may be advantageous from an administrative standpoint for major modifications.



PAUL K. BOHR
Director, Central Region