SUB-SECTION D3—STRUCTURES

CHAPTER D3—1 GENERAL

Revised, 1st January, 1948

A.C.D 1 INTRODUCTION. Sub-section D3—Structures, prescribes the strength which shall be provided in the aeroplane as a whole and in its component parts. The requirements are directly applicable to the primary structure of the aeroplane.

2 PROOF OF COMPLIANCE. Compliance with the requirements shall be established in conformity with the general principles prescribed in this chapter except in so far as any particular requirement contains over-riding clauses.

3 WEIGHT AND WEIGHT DISTRIBUTION

3.1 Unless otherwise stated, all structural requirements shall be complied with—

at all weights from the Design Minimum weight to the Design Maximum weight (the Design Maximum weight shall be not less than the Design Take-off weight) ;

when the centre of gravity of the aeroplane is in the most adverse positions compatible with the weight assumed, within the range for which certification is sought ;

when the weight is distributed in the most adverse manner, within the operating limitations for which certification is sought.

3.2 **Design Unit Weights.** The following weights shall be used to show compliance with the structural requirements—

petrol	7·2 pounds per Imperial gallon,
kerosene	8·1 pounds per Imperial gallon,
lubricating oil	9·0 pounds per Imperial gallon,
crew and passengers ...	170 pounds per person.

NOTE : True weights may be used when establishing the current operating weight of the aeroplane.

4 STRENGTH REQUIREMENTS—GENERAL

4.1 Strength requirements are, as far as possible, prescribed in terms of flight and ground manoeuvres, and of atmospheric gusts. The external loads arising in such conditions shall be placed in equilibrium with appropriate inertia loads. The air and inertia loads resulting from the prescribed manoeuvres and gusts shall be distributed so that actual conditions are closely approximated or conservatively represented.

4.2 **Limit Loads.** The prescribed loads, except where otherwise stated, are "limit loads."

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4.3 **Factor of Safety.** The ultimate factor of safety shall be at least 1·5 unless otherwise prescribed. Where there is uncertainty about the strength of parts of the structure or where inspection in service is difficult, such parts shall be designed with factors of safety which reasonably can be expected to make them as reliable as the rest of the structure.

NOTE : Main causes of uncertainty may be the absence of tests, likely variability, and possible deterioration in service.

4.4 **Strength and Deformation.** Under all critical loading conditions—

4.4.1 At all loads up to the limit load, no part of the primary structure shall sustain detrimental deformations, and, unless otherwise allowed, moving parts essential to safe operation shall function satisfactorily.

4.4.2 After removal of the limit load no permanent detrimental deformation shall be present in any part of the primary structure.

4.4.3 The primary structure as a whole shall be capable of supporting the ultimate load.

4.4.4 Parts of the primary structure in which the internal loads increase less rapidly than the external loads (e.g. parts with high initial stresses or beams under combined tension and bending loads) shall be investigated for loads below the limit load to ensure that the permanent deformation of such parts does not occur much before the permanent deformation of the remainder of the structure.

4.4.5 Any change in the distribution and magnitude of external or internal loads due to deformation of structure under load, shall be taken into account.

4.4.6 The Board shall be satisfied that adequate allowance has been made for the effects of dynamic loading.

4.5 **Fatigue Strength.** The strength and fabrication of the aeroplane shall be such as to ensure that the probability of disastrous fatigue failure of the primary structure under repeated loads expected in operation is extremely remote. Where a type of construction is used for which experience is not available to show that compliance with static strength requirements will ensure the strength of the structure under repeated loads, its strength under such loads shall be substantiated, so far as is practicable, by suitable investigations.

4.6 **Calculations and Test Procedures**

4.6.1 Where the structure is of a type for which experience has shown such methods to be reliable, calculations may be accepted as proof of compliance with the requirements prescribed in 4.4. The Board reserves the right to require loading tests on the complete structure, or on parts thereof, when in its opinion, this is necessary to give evidence of compliance with the requirements.

4.6.2 Where supporting data justify the use of simplified design criteria, such criteria will be acceptable provided that they will ensure a level of safety not less than that obtainable by a rational investigation of the prescribed conditions.

4.6.3 In making tests to establish compliance with limit load conditions, the limit load shall be supported for at least one minute.

4.6.4 In making tests to establish compliance with ultimate load conditions, the ultimate load shall be applied for a period sufficient to demonstrate that the structure is capable of supporting the ultimate load. This period shall be not less than three seconds.

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4.7 **Properties of Materials.** Those mechanical properties and dimensions of structural elements which are assumed in design calculations, shall be so chosen that the probability of any structure having a strength less than the design value, due to material variation, is extremely remote. To this end, all assumed values of strength and elastic properties shall be suitably related to the values quoted in the specification with which the material complies.

4.8 **Correction of Tests.** The results obtained from strength tests shall be so corrected for departures from the mechanical properties and dimensions assumed in the design calculations as to establish that the probability of any structure having a strength less than the design value, due to material variation, is extremely remote.

NOTE : The Board will accept corrections to test results when based on the following methods—

For simple elements the dimensions and material properties of the test specimen should be measured and the test results adjusted to give the load corresponding to the minimum strength permitted by the material specification.

For other structures in which failure of a particular element results in a redistribution of the load through alternative structural paths, either,

the dimensions and material properties of the test structure should be measured and the test results adjusted to correspond to the use of materials of average dimension and with the minimum strength properties permitted by the material specification, or

the correction should be determined by the designer in consultation with the Board.

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