CIVIL AERONAUTICS MANUAL 3

U. S. Department of Commerce — Civil Aeronautics Administratio

Civil Aeronautics Manuals and Supplements thereto are issued by the Office of Aviation Safety, Civil Aeronautics Administration, for the guidance of the public and are published in the Federal Register and the Code of Federal Regulations.

Supplement No. 5 March 8, 1950

SUBJECT: Compilation of CAA rules, policies, and interpretations which apply to Civil Air Regulation 3

PURPOSE. This supplement provides users of Part 3 with a compilation of rules, policies, and interpretations which the CAA has issued in other forms as well as some new material, for Part 3, effective December 15, 1946, as amended.

PUBLICATIONS SUPERSEDED. This supplement supersedes the following publications previously issued by the CAA, explaining or implementing Civil Air Regulation 3:

(a) First and Second Summaries, dated February 1947, and March/Apr 1947, respectively, "Interpretations and Suggested Methods of Complying with Civil Air Regulations, Part 03, as amended, effective December 15, 1946."

(b) Safety Regulation Release No. 206, "Interpretation of CAR 3.301 (previously 03.310)" dated May 15, 1946.

(c) Safety Regulation Release No. 227, "Preparation of Airplane Flight Manuals for Airplanes in the Normal, Utility and Acrobatic Categories," dated February 18, 1947.

(d) Safety Regulation Release No. 243, "Accelerated Service Tests for Aircraft," dated May 13, 1947.

(e) Safety Regulation Release No. 258, "Flight Testing Requirements for Production Aircraft," dated August 22, 1947.

(f) Safety Regulation Release No. 264, "Logging of New Production Aircraft Flight Test Time," dated October 7, 1947.

(g) Aviation Safety Release No. 291, "Approval of Aircraft Components and Materials Under the Technical Standard Order System," dated July 6, 1948.

March 8, 195[illegible]

SUPPLEMENTS ISSUED. The attached sheets, dated March 8, 1950, should be retained as the fifth in a series of similar statements that will be issued explaining or implementing Civil Air Regulation 3. Supplements 1 through 4 of this series have already been issued by the CAA, and are considered part of Civil Aeronautics Manual 3. They cover:

(a) Supplement No. 1, dated July 1, 1949, CAR 3.338 (previously 3.353) "Wing Flap Position Indicators."

CAM 3.353-1 Wing Flap Position Indicators. (CAA policies which apply to section 3.353).

(b) Supplement No. 2, dated July 18, 1949, CAR 3.73 (previously 3.112) "Empty Weight."

CAM 3.112-1 New Production Aircraft - Empty Weight and C. G. Determination. (CAA policies which apply to section 3.112).

(c) Supplement No. 3, dated August 31, 1949, CAR 3.174 (previously 3.203) "Proof of Structure."

CAM 3.174-1 Material Correction Factors. (CAA policies which apply to section 3.174).
(Superseded by CAM 3.174-1 in attached compilation).

(d) Supplement No. 4, dated September 1, 1949, "Cross-Index to Part 3."

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Attachments

Distribution: AIR 1, 2, 3, 13, 14, 40 all tabs
40-B, 40-C, 40-D, 40-E, 40-F-1

"AIRPLANE CATEGORIES"

"CAR 3.6 Airplane categories. (a) In this part airplanes are divided upon the basis of their intended operation into the following categories for the purpose of certification.

"(1) Normal - Suffix 'N'. Airplanes in this category are intended for nonacrobatic, nonscheduled passenger, and nonscheduled cargo operation.

"(2) Utility - Suffix 'U'. Airplanes in this category are intended for normal operations and limited acrobatic maneuvers. These airplanes are not suited for use in snap or inverted maneuvers.

"(3) Acrobatic - Suffix 'A'. Airplanes in this category will have no specific restrictions as to type of maneuver permitted unless the necessity therefor is disclosed by the required flight tests.

"(4) Restricted purpose - Suffix 'R'. Airplanes in this category are intended to be operated for restricted purposes not logically encompassed by the foregoing categories. The requirements of this category shall consist of all of the provisions for any one of the foregoing categories which are not rendered inapplicable by the nature of the special purpose involved, plus suitable operating restrictions which the Administrator finds will provide a level of safety equivalent to that contemplated for the foregoing categories.

"(b) An airplane may be certificated under the requirements of a particular category, or in more than one category, provided that all of the requirements of such categories are met. Sections of this part which apply to only one or more, but not all, categories are identified in this part by the appropriate suffixes, as indicated above, added to the section number. All sections not identified by a suffix are applicable to all categories except as otherwise specified.

"Note: For rules governing the eligibility of airplanes certificated under this part for use in air carrier operations see Parts 40, 41, 42, and 61 of this chapter."

3.6-1 LIMITED ACROBATIC MANEUVERS FOR UTILITY CATEGORY AIRCRAFT. (CAA interpretations which apply to section 3.6, previously 3.02).

The phrase "limited acrobatic maneuvers" as used in CAR 3.6 (a) (2) is interpreted to include steep turns, spins, stalls (except whip stalls), lazy eights and chandelles. These are sufficient to permit the airplane to be used for required pilot instruction and rating tests; further, student pilots are instructed in these maneuvers. Although it is possible in many airplanes to perform other maneuvers, such as loops, without exceeding airspeed and strength limitations, inexperienced or uninstructed pilots are likely to get into difficulty. It is therefore considered unwise to label such maneuver "approved" in the Airplane Flight Manual.

"AIRWORTHINESS CERTIFICATES"

"CAR 3.11 Classification. (a) Airworthiness certificates are classified as follows:

"(1) NC (standard) certificates. In order to become eligible for an NC (standard) certificate, an airplane must be shown to comply with the requirements contained in this part for at least one category, but not the restricted purpose category.

"(2) NR (restricted) certificates. In order to become eligible for an NR (restricted) certificate, an airplane must be shown to comply with the requirements of the restricted purpose category.

"(3) NX (experimental) certificates. An airplane will become eligible for an NX (experimental) certificate when the applicant presents satisfactory evidence that the airplane is to be flown for experimental purposes and the Administrator finds it may, with appropriate restrictions, be operated for that purpose in a manner which does not endanger the general public. Airplanes used in racing and exhibition flying may be issued NX (experimental) certificates under the terms of this section. The applicant shall submit sufficient data, such as photographs, to identify the airplane satisfactorily and, upon inspection of the airplane, any pertinent information found necessary by the Administrator to safeguard the general public.

"(b) An airplane manufactured in accordance with a type certificate (see sections 3.15-3.19) and conforming with the type design will become eligible for an airworthiness certificate when, upon inspection of the airplane, the Administrator determines it so to conform and that the airplane is in a condition for safe operation. For each newly manufactured airplane this determination shall include a flight check by the applicant."

3.11-1 FLIGHT TESTING REQUIREMENTS FOR PRODUCTION AIRCRAFT PRIOR TO CERTIFICATION. (CAA policies which apply to section 3.11 (b), previously 3.03).

(a) This flight test procedure should apply to new aircraft which are assembled and flight tested at the manufacturer's plant, and to those which are delivered unassembled by the manufacturer to an authorized distributor for initial assembly and flight testing by the distributor.

(b) The acceptability of the flight test procedure established and of the flight check-off form utilized will be determined by the Flight Engineering Branch. Flight testing procedure established at the distributor's plant should be equivalent to those established at the manufacturer's plant, including the use of an identical flight test check-off form, and it should be the manufacturer's responsibility to acquaint his authorized distributors with the flight test procedures established at the manufacturer's plant, and to provide these distributors with copies of the accepted flight test check-off form.

(c) It should be noted that aircraft manufactured under a type certificate only should be assembled and flight tested at the manufacturer's plant prior to certification, regardless of whether delivery is by flyaway or shipment.

(d) The flight testing of aircraft manufactured under a type certificate only should be conducted by, or under the supervision of, CAA flight engineering inspectors at the manufacturer's plant. At the discretion of the CAA flight engineering inspector, this responsibility may be delegated to the manufacturer to the extent determined expedient in each individual case.

(e) Airplanes which have been flight tested by the manufacturer (including all airplanes manufactured under a type certificate only), when shipped to, and assembled by, an authorized distributor, should be given an abbreviated functional flight test to determine that the engine or engines perform satisfactorily and that there is no evidence of malfunctioning of the airplane controls, systems, etc.

(f) Having determined that the flight test procedure established by the holder of a production certificate and the flight check-off form utilized are adequate, the CAA will subsequently conduct such periodic checks of this procedure as may be deemed necessary to determine that it continues to be satisfactory and acceptable.

(g) Inasmuch as this test is considered an operational and functional test, the flight test check-off form should provide for at least the following:

(1) A functional check of each part or system normally operated by the crew in flight.

(2) An investigation of the trim, controllability, and other operational characteristics of the aircraft throughout the normal range of operation while in flight.

(3) A check of the operational characteristics of the aircraft on the ground.

(4) A determination that all instruments are properly marked and readings are "normal", and that all gauges and control markings are correct.

(5) Any other items peculiar to the aircraft which can best be checked during the ground operation or flight of the aircraft.

(h) The flight test form, signed by the pilot, should be filed with the manufacturer's or the distributor's record of inspection of the aircraft.

(i) Data to be submitted by the manufacturer or distributor in substantiation of the flight test procedure established should be determined in each instance by the Flight Engineering Division, inasmuch as the procedure will vary at different activities by reason of the size and complexity of the aircraft.

(j) To facilitate compliance with the provisions of CAR 43.10 (b), and in order that the foregoing flight tests may be conducted prior to the issuance of individual airworthiness certificates, as prescribed in CAR 3.11 (b), Dealers' Aircraft Registration Certificates, Form ACA 1707, issued to manufacturers and authorized distributors, should have the following entry made on the reverse side of these certificates:

> "In accordance with the provisions of CAR 43.10 (b), special authority is herewith issued to __________________ (list manufacturer or distributor named on reverse side) to conduct flight tests of new aircraft, as prescribed in CAR 3.11 (b)."

The utilization of the reverse side of the dealer's aircraft registration certificate for this purpose is for convenience only and has no connection with the issuance, validity, or continuation of the dealer's aircraft registration certificate. Accordingly, this entry may be signed by any agent of the CAA authorized to issue an airworthiness certificate. Normally, this is accomplished by the agent responsible for CAA activities at the plant of the agency to which the dealer's aircraft registration certificate is issued.

(k) In the event the manufacturer or an authorized distributor is not in possession of a dealer's aircraft registration certificate, production aircraft, prior to the initial flight, should be registered in accordance with Regulations of the Administrator, Part 501, in the name of the manufacturer or distributor, as the case may be, and the agency should be issued a letter containing the above special authorization and a concluding paragraph indicating that the authorization thus issued may be utilized for the purpose of conducting the tests authorized for a period of one year from the date of issuance. This authorization should be prepared in duplicate, typed and signed in accordance with instructions pertinent to the entry to be made on the reverse side of the dealer's aircraft registration certificate, and the carbon copy should be forwarded to the pertinent regional office and filed. It is the responsibility of the operating agency to request that these authorizations be reissued upon expiration, in the event continuation is desired.

(l) Aircraft flight tested in accordance with the foregoing procedures should, upon satisfactory completion of such tests, be immediately issued a Certificate of Airworthiness, Form ACA 1362, without respect to the status of registration and regardless of whether the aircraft is to be delivered via shipment or flyaway.

(m) Aircraft flight tested in accordance with the foregoing which are intended for domestic registration and certification should display the appropriate identification markings in accordance with regulations and instructions pertinent thereto. New aircraft intended for export which are thus tested should display the foreign identification markings assigned, or, if these markings are not available, should display U. S. identification markings, except that, under the following circumstances, aircraft intended for export may be flight tested without displaying identification markings, provided these flights are confined to a radius of twenty miles of the manufacturer's base, and provided notices of such flights are transmitted to the local municipal, state, or CAA authorities responsible for the enforcement of flight regulations, prior to such flights:

(1) When foreign identification markings have been requested, but not received, for aircraft to be delivered via flyaway, or

(2) When foreign identification markings are not available and the aircraft is to be disassembled and crated for shipment immediately upon completion of the flight test.

3.11-2 LOGGING OF NEW PRODUCTION AIRCRAFT FLIGHT TEST TIME. (CAA policies which apply to section 3.11 (b), previously 3.03).

(a) Operating time, accumulated during flight tests of new production aircraft manufactured under a type or a type and production certificate conducted in accordance with requirements contained in CAR 3.11 (b), should be construed as a part of the inspection accomplished in accordance with CAR 3 for the purpose of determining conformity, airworthiness, and eligibility for certification. Inasmuch as aircraft, pending the completion of inspections and tests prescribed in CAR 3, are operated under "special authorization" instead of a formal certificate, it should not be necessary that a record of the subject flight tests be made a part of the aircraft or aircraft engine records or log books furnished by the manufacturer to accompany such aircraft. (This policy does not apply to time accumulated during accelerated service testing of prototype or modified aircraft.) Once the airplane is certificated, all subsequent flights should be appropriately recorded in accordance with CAR 43.23.

(b) The company flight test check-off form developed by the manufacturer to be utilized in connection with these flight tests, indicating the date or dates and duration of these flights, should be filed at the manufacturer's plant (or, in the event the initial production flight test is conducted by a distributor, will be filed by the distributor), as a part of the aircraft inspection records.

"CAR 3.19 Flight tests. (Applicable to all airplanes certificated as a type on or after May 15, 1947.) After proof of compliance with the structural requirements contained in this part, and upon completion of all necessary inspection and testing on the ground, and proof of the conformity of the airplane with the type design, and upon receipt from the applicant of a report of flight tests conducted by him, there shall be conducted such official flight tests as the Administrator finds necessary to determine compliance with sections 3.61 through 3.780. After the conclusion of these flight tests such additional flight tests shall be conducted as the Administrator finds necessary to ascertain whether there is reasonable assurance that the airplane, its components, and equipment are reliable and function properly. The extent of such additional flight tests shall depend upon the complexity of the airplane, the number and nature of new design features, and the record of previous tests and experience for the particular airplane model, its components, and equipment. If practicable, the flight tests performed for the purpose of ascertaining the reliability and proper functioning shall be conducted on the same airplane which was used in flight tests to show compliance with sections 3.61 through 3.780."

3.19-1 ACCELERATED SERVICE TESTS FOR AIRCRAFT. (CAA policies which apply to section 3.19, previously 3.0421).

(a) ADDITIONAL FLIGHT TESTS. To satisfactorily accomplish the objectives of CAR 3.19 concerning additional flight tests and the extent thereof, the Administrator deems it necessary that:

(1) A comprehensive and systematic check be made in flight of the operation of all components to determine whether they "function properly", i.e., perform their intended function without introducing safety hazards.

(2) Sufficient testing and supplementary experience under actual, or a combination of simulated and actual, experience be obtained and evaluated to give reasonable assurance that the airplane is "reliable", i.e., should continue to function properly in service. (Note: In order to obtain wider experience, manufacturers should be encouraged to cooperate with airlines or other responsible operators in operating experimental airplanes of the same type under service conditions.)

(3) Appropriate corrective action be taken when the need therefore is determined under (1) or (2). (Note: The CAA should be concerned only to the extent that the airplane can be operated safely under suitable inspection and maintenance procedures, but should not be concerned with maintenance costs.)

(b) TERMS. Terms used in CAM 3.19-1 are defined as follows:

(1) T. C. BOARD. The Type Certification Board set up by the CAA Field Offices for each new type aircraft project.

(2) ROUTINE CAR TESTS. The flight tests prescribed in the CAR to determine performance, flight characteristics, power plant characteristics, etc. (e.g. sections 3.61 through 3.780 of Part 3), conducted in accordance with existing procedures.

(3) OFFICIAL FUNCTIONING AND RELIABILITY TESTS. That portion of the flight tests conducted in showing compliance with the Regulations quoted above, which is under the immediate supervision of the T. C. Board, as described hereinafter.

(4) SUPPLEMENTARY EXPERIENCE. Other flight tests and experience with an airplane type which is taken into consideration in establishing the extent of the official portion of the tests. This supplementary experience may be obtained by the manufacturer, military services, airlines, etc.

(5) SIMULATED TESTS. Tests on the ground or in an airplane of components and equipment under conditions simulating those likely to be obtained in service, which are taken onto consideration in establishing the extent of the official portion of the tests.

(c) TEST PROGRAM. The Type Certification Board for each project should decide upon a proposed official test program at the time of the Preflight meeting of the Board (prior to the routine CAR flight tests) and coordinate this with the airplane manufacturer. At the conclusion of the routine CAR tests, the T. C. Board should meet again to review the experience gained in those tests, changes made in the design, and any additional supplementary experience, and to revise the proposed program accordingly.

(d) PLANNING AND EXECUTION OF TEST PROGRAM. The following points should be considered:

(1) The test program should be sufficiently well planned to enable its execution in an efficient manner without overlooking important items. (Note: It is not intended that the "paper work" be over-emphasized to the detriment of the practical results, and it should be reduced to a minimum for small, simple airplanes.) The T. C. Board should review the design features and equipment with respect to the general objectives, and prepare a list showing:

(i) Components and systems [1] to be checked in item (4) below,

(ii) A brief description of the operations to be performed, where these are not obvious (referencing any necessary operating instructions),

(iii) Special checks or likely critical conditions,

(iv) Estimated flight time required.

[1] (Note: Tests of anti-icing systems under actual icing conditions will in many cases be impracticable prior to type certification. A policy is in preparation regarding the approval and use of such systems in air-carrier operations. This will outline the flight testing required at various stages.)

(2) Allowance may be made for the functional tests already required by the routine CAR tests. Allowance may also be made for simulated testing of new features and equipment; however, the flight test program will be planned to determine the adequacy of the simulated tests (e.g. to determine whether the actual environmental conditions of temperature [2], vibration, etc. are covered by the simulated tests) when these may be critical, and to determine whether the installation and connected systems are satisfactory.

[2] (Note: This does not imply that flight tests must be conducted under the most severe outside air temperatures likely to be encountered in service. It should normally be possible to determine the effects of extreme outside temperatures on local temperatures by extrapolation or by suitable correction factors.)

The T. C. Board will then make a consolidated estimate of the total flight time required, allowing for overlapping, and adjust this in accordance with the "Test Time" section outlined in sub-paragraph (e).

(3) The program will be arranged to permit the Aviation Safety Agent in charge to become thoroughly familiar with the characteristics of the airplane, particularly those not specifically covered in the routine CAR tests.

(4) In accordance with sub-paragraph (a) (1), all components of the airplane should be intensively [3] operated and studied under all operating

[3] (Note: Intensive operation means repeated operation of components in various sequences and combinations likely to occur in service.)

conditions expected in service and obtainable within the time and geographic limitations of the tests. Particular attention will be given to the emergency procedures which would be required in the event of malfunctioning of any component, source of crew error, and overtaxing of crew abilities. This intensive type of testing should be conducted in all cases, but the length of time for which it is continued will depend upon the simulated and supplementary experience available for the particular type, as outlined in "Test Time" under sub-paragraph (e).

(5) Ground inspections should be made at appropriate intervals during the test program to determine whether there are any failures or incipient failures in any of the components which might be a hazard to safe flight.

(6) When design changes are made during the course of the test, or when the official test airplane differs from those on which supplementary experience is obtained, or from modified versions of the same basic airplane type, the revised or modified items should be rechecked in accordance with the above procedure, but every effort should be made to include such items in the program in such a way as to avoid unduly extending the over-all test time. To this end, the Administrator may accept, in lieu of additional flight tests:

(i) Special tests of the original and revised components in which the conditions causing failure are intensified, and

(ii) Simulated tests of differing components.

(e) TEST TIME. It is highly desirable that functioning and reliability test programs be administered uniformly in the sense that the program and flight time for a given project would be approximately the same regardless of which T. C. Board administered the project. This is difficult to achieve without establishing fixed arbitrary test times. However, such fixed arbitrary times would obviously be contrary to the intent of the Regulations. The following procedure with regard to establishing the required test time which permits considerable flexibility is, therefore, established for the guidance of T. C. Boards.

(1) The times suggested in this sub-paragraph apply when supplementary experience is not taken into account, and are for airplanes which are conventional in regard to complexity and design features. Those times may be reduced to allow for supplementary experience, as outlined in sub-paragraph (e) (2), and for simulated testing, as outlined

in sub-paragraph (d) (1). In extreme cases of complexity[4] radically new design features, or difficulties in earlier flights, these times may be increased.

Non-Transport (CAR 3) . . . 40 to 150 hours, depending on complexity.

[4] (Note: An example of extreme complexity would be transport intended for operation at 40,000 ft. altitude, with automatic dive recovery flaps, turbos, variable jet exhaust, two speed cooling fans, retractable wind screens, automatic control of engine cooling, turbos, intercoolers, jet exhaust, etc. The test program for such an airplane might require as much as 300 hours if no supplementary experience were available.)

(2) When satisfactory supplementary experience is available and taken into account, the following allowances should be used as a guide and applied with judgment in reducing the official flight test time determined in accordance with the preceding paragraph. However, in any case, the official program should provide sufficient time to accomplish the objective in sub-paragraph (a) (1) in accordance with items (d) (3) and (4).

(i) FOR INTENSIVE EXPERIENCE. When the allowance is based on the total time of any one airplane in airline crew training and similar intensive operations, two hours of such operation may be considered equivalent to one hour of official testing.

(ii) FOR MISCELLANEOUS EXPERIENCE. When the allowance is based on the total time of any one airplane, five hours of such experience may be considered equivalent to one hour of official testing.

(iii) REDUCTION FOR SUPPLEMENTARY EXPERIENCE. Whenever a reduction of official test time is desired on the basis of supplementary experience, such experience must be adequately recorded and submitted to the T. C. Board, as described in sub-paragraph (f).

(f) REPORTS AND RECORDS.

(1) A log should be kept of all flight tests, and accurate and complete records kept of the inspections made and of all defects, difficulties, and unusual characteristics and sources of crew error discovered during the tests, and of the recommendations made and action taken. Items for which design changes may be required will be reported

to the manufacturer and the appropriate CAA engineering division.

(2) If supplementary experience is to be taken into account, similar records of such experience should be kept and submitted to the T. C. Board, together with a list of the differences between the airplane on which the experience was obtained and the official test airplane. When supplementary experience is obtained on a large fleet of airplanes (for example, military operations) of the same or a comparable type (see item 5 under TEST PROGRAM), these records may consist of statistical summaries in lieu of complete records for each individual airplane.

(3) At the conclusion of the official tests, a summary report should be prepared by the T. C. Board and forwarded to Washington for inclusion in the Type Inspection Report.

(g) ADMINISTRATION. The CAA Aviation Safety Agent in charge should act as coordinator of all flight activities of the T. C. Board during the official program and the agent or an alternate designated by him will participate in all flights. He should collaborate with the manufacturers' pilots in all these activities, particularly in regard to flight plans and procedures. The manufacturers' pilot should be in command of all flights, but CAA pilots should fly the airplane at least sufficiently to accomplish item (d) (3) of the test program.

(1) Other CAA personnel (e.g. representatives of other Divisions and specialists) should participate in the flight tests when deemed necessary by the T. C. Board to accomplish the purposes of the tests.

(2) When supplementary experience is obtained in airline operations, a CAA Aviation Safety Agent should be assigned to follow the operations, review the operator's records, and supplement these by reports to the T. C. Board.

(h) TEST AIRPLANE. CAR 3.19 contains the phrase "If practicable, the flight tests . . . . shall be conducted on the same airplane . . ." This phrase will be liberally interpreted to facilitate completion of the type certification procedure. Thus, one airplane may be used for the official functioning and reliability tests while another airplane (or airplanes) is used for the routine CAR tests. In this case the test time on at least one airplane must be sufficient to accomplish the objective of sub-paragraph (a) (2).

(i) MODIFIED TYPES. The procedure outlined above applies to new type designs. When a design employs components identical to those used in previous designs, credit may be given for the supplementary experience available for such components. When a design is modified (for example, several versions of the same basic type with different engines, propellers, etc.) the modified features and components should be treated in accordance with sub-paragraph (d) (6).

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"CHANGES"

"CAR 3.23 Changes. Changes shall be substantiated to demonstrate compliance of the airplane with the appropriate airworthiness requirements in effect when the particular airplane was certificated as a type, unless the holder of the type certificate chooses to show compliance with the currently effective requirements subject to the approval of the Administrator, or unless the Administrator finds it necessary to require compliance with current airworthiness requirements."

3.23-1 CHANGES OF ENGINES. (CAA rules which apply to section 3.23, previously 3.05).

(a) There are currently available newly designed engines of approximately the same size and weight as previously designed engines, but with considerable variations in power. It is possible to interchange these engines with little or no installation changes, and although minor changes in engine weight may be involved, it will still be practical to operate the aircraft at the originally approved gross weight. Under CAR 3.185, the maneuvering load factor is not dependent upon engine power, and under CAR 3.184 the design airspeeds can be independent of engine power. Therefore, a change which involves or permits a practical power increase by exchange of engines shall be approved by the Administrator: Provided, That such exchange of engines is not accompanied by an increase in the gross weight of the aircraft, or an increase in placard speeds. Under those conditions it will not be necessary to restrict the maximum continuous horsepower by a placard because of the airplane speed limitations since the latter are indicated on the speed placards.

(b) Aircraft alterations involving weight or speed changes beyond those set forth above will be approved by the Administrator only if the applicant shows compliance with all of the applicable sections of CAR 4a, or all of the applicable sections of CAR 3, or relies on the provisions of CAR 3.2 by complying with certain particular and related items of the requirements under this part, and certain of the requirements under CAR 4a, i.e., the level of safety for certain particular and related items is equivalent to the requirements under this part and the level of safety for the remaining items is equivalent to the requirements under CAR 4a.

(c) Under CAR 3.23, it will be necessary to require such investigations of local structure, weight and balance, power plant installations and flight tests as are normally involved in a change of engine type. However, every effort will be made by reference to data already on hand to minimize the amount of testing and structural analysis required of the applicant.

"APPROVAL OF MATERIALS, PARTS, PROCESSES, AND APPLIANCES"

"CAR 3.31 Specifications. (a) Materials, parts, processes, and appliances shall be approved upon a basis and in a manner found necessary by the Administrator to implement the pertinent provisions of this subchapter. The Administrator may adopt and publish such specifications as he finds necessary to administer this section, and shall incorporate therein such portions of the aviation industry, Federal, and military specifications respecting such materials, parts, processes, and appliances as he finds appropriate.

"(b) Any material, part, process, or appliance shall be deemed to have met the requirements for approval when it meets the pertinent specifications adopted by the Administrator, and the manufacturer so certifies in a manner prescribed by the Administrator."

3.31-1 APPROVAL OF AIRCRAFT COMPONENTS AND MATERIALS UNDER THE TECHNICAL STANDARD ORDER SYSTEM. (CAA rules which apply to section 3.31, previously 3.06).

(a) PURPOSE OF TECHNICAL STANDARD ORDERS. Technical Standard Orders of the "C" series are intended to be used to set forth Civil Aeronautics Administration requirements for approval of aircraft components and materials for which specific approval standards are not contained in the airworthiness requirements of the Civil Air Regulations.

(1) The approval status of such items formerly was covered by Product and Process Specifications, Equipment Specifications, Letters of Approval, and CAA policy letters. The bases for such approvals were not set forth in any one place or series of publications, thus leading to confusion and unnecessary expense on the part of product manufacturers. The Technical Standard Order system will provide one source of information regarding the basis for approval of components and materials, thereby assuring the product and aircraft manufacturer of standardized approval procedures and also enabling Civil Aeronautics Administration personnel to administer the system uniformly.

(2) Technical Standard Orders of the "C" series are those which the Administrator of Civil Aeronautics is authorized to approve in accordance with CAR 3.31 and Subpart F of CAR 3, CAR 4a.31 and Subpart F of CAR 4a, CAR 4b.41, CAR 6.6, and CAR 6.50 through 6.53 of the Civil Air Regulations.

(b) APPLICATION OF TECHNICAL STANDARD ORDER REQUIREMENTS. Minimum performance requirements established by the Civil Aeronautics Administration and published in Technical Standard Orders serve as a means by which component equipment and materials intended for use in certificated aircraft will be approved. With the exceptions hereinafter noted, component equipment and materials already approved by the Administrator may continue to be installed in aircraft:

(1) For which an application for original type certificate is made prior to the effective date of the TSO,

(2) The prototype of which is flown within one year after the effective date of the TSO, or

(3) The prototype of which is not flown within one year after the effective date of the TSO if due to causes beyond the applicant's control.

(c) EXCEPTIONS. Exceptions to sub-paragraph (b) are:

(1) If the Civil Aeronautics Board specifically establishes mandatory dates for the installation of equipment covered by a TSO, such requirements must be complied with.

(2) If service experience demonstrates that the use of certain equipment or materials in a particular make and model of aircraft renders the plane unairworthy, modification or removal of the equipment or materials may be required by means of an airworthiness directive.

(3) If within nine months after the effective date of the TSO a major change is made in the installation which involves a change in the type or model of equipment or materials, previously approved equipment or materials may be installed. However, in any such change made after the nine months' period, new types of equipment or materials installed must comply with existing TSO requirements.

(d) THE TECHNICAL STANDARD ORDER SYSTEM. The Technical Standard Order (TSO) System has been adopted based upon the following:

(1) Technical Standards Orders reference performance provisions of recognized government specifications, or established industry specifications, which have been found acceptable by the CAA. If no satisfactory specification exists, the orders will include criteria prepared by the Administrator and any item of equipment or material which meets these criteria will be acceptable to the Administrator. In preparing criteria of this type, the Administrator will give consideration to recommendations made by the industry.

(2) TSO's set forth the minimum requirements for safety. Every effort will be made by the CAA to keep the requirements at the minimum levels of safety and TSO's <u>will not</u> be used to set forth "desirable" standards. Industry committees or groups developing specifications

which are intended to become the basis of TSO's have been and will continue to be reminded of this very basic consideration.

(3) When a TSO is issued covering a particular product, the aircraft manufacturer, owner, or operator using such products will be required to use components complying with the TSO (where the TSO is applicable as specified in sub-paragraphs (b) and (c), and except as noted under (d) (4)). However, the CAA will not formally approve such parts as meeting the requirements of TSO's. It will be entirely the responsibility of the product manufacturer to conduct the necessary tests demonstrating compliance, and to state that his product meets the requirements of the TSO. Generally, the CAA will not exercise inspection control over the manufacturer's products. The product manufacturer himself will be responsible for maintaining quality control adequate to assure that products which he guarantees to meet the requirements of a TSO do, in fact, meet these standards. The product manufacturer's statement of conformance with the provisions of a Technical Standard Order normally will be accepted by the CAA as sufficient indication that the applicable requirements have been fulfilled.

(4) The establishment of a Technical Standard Order for any given type of product does not preclude the possibility of establishing the acceptability of a particular product as part of the aircraft, engine, or propeller. In such cases, however, it shall be established that there is a level of safety equivalent to that provided in the Technical Standard Order and the product will be identified as a part of the particular airplane, engine, or propeller.

(e) STATUS OF PRODUCT AND PROCESS SPECIFICATIONS. In placing the Technical Standard Order System into operation, it is planned to discontinue issuance of the present series of "listings" of acceptable products, known as Product and Process Specifications, by establishing a suitable TSO for each product at the time of revision of any of the existing approvals, or as soon as adequate airworthiness criteria are available upon which to base a Technical Standard Order.

(f) CONVERSION TO NEW SYSTEM. From the foregoing, it can be concluded that conversion to the new system will progress slowly. Many items will remain for an indefinite period of time, controlled by either the existing Product and Process Specification or policies by means of which parts, materials, finishes, and related items are approved by the CAA as integral parts of the complete airplane.

(g) STATEMENT OF CONFORMANCE. If a manufacturer has sufficient technical development background on his product to prove to himself that the product as supplied, meets the provisions of the applicable TSO, he may forward a statement of conformance to that effect to the Chief, Aircraft Division, Office of Aviation Safety, Civil Aeronautics Administration, Washington, D. C. He may immediately thereafter make deliveries to his customers of the items covered by this statement of conformance, supplying them, of course, with a similar statement.

(1) The vendor should identify products so supplied in accordance with section (k) below. The presence of such markings on the product will be accepted by CAA personnel as satisfactory evidence that the manufacturer guarantees the provisions of the applicable safety requirements to have been fulfilled.

(2) Where complaints of nonconformity of a product with the applicable TSO are brought to the attention of the CAA, the CAA will investigate and, if necessary, will take appropriate action to restrict or prohibit the use of the product involved in certificated airplanes.

(h) EFFECTIVE DATES. TSO's will generally be made effective approximately 60 days after they are prepared, in order to allow sufficient time for distribution.

(i) DATA REQUIREMENTS. The product manufacturer shall submit to the CAA, data called for in the TSO. Those data will not be used by the CAA for the purpose of issuing an approval for the product, but rather are needed for purposes of administering the TSO System and generally will consist only of installation information. The data called for in the TSO should be forwarded to the Aircraft Division, Civil Aeronautics Administration, Washington 25, D. C., with the statement of conformance.

(1) In investigating complaints of nonconformity, the CAA may request additional data and test reports from the manufacturer.

(j) DEVIATION OR WAIVER. Deviations from or waivers of the literal provisions of a TSO, which obviously do not affect basic airworthiness and which manifestly provide an equivalent degree of safety, may be taken by the manufacturer on his own responsibility, but notice of such should be transmitted in writing to the Chief, Aircraft Division, Civil Aeronautics Administration, Washington 25, D. C., with the statement of conformance. Requests for deviations from or waivers of those provisions which affect the basic standard of airworthiness will be referred by the CAA field offices or the manufacturer to the Washington Office of the Aircraft Division for decision. If granted, these will involve revision of the TSO itself.

(k) IDENTIFICATION OF COMPONENTS OR MATERIALS. Suitable means shall be provided to identify an article manufactured in compliance with a particular Technical Standard Order.

(1) Where practical, the information should be legible and permanently marked either on a nameplate securely attached to the article or on the article itself. Stencils or other means of identification may be used.

(2) If the items are too small for individual identification, this information shall be placed on each package and shipping container.

(3) The necessary identification for each particular product will be specified in the appropriate TSO.

(l) TECHNICAL STANDARD REGISTER. Copies of the Technical Standard Register or index and the various Technical Standard Orders may be obtained by applying to:

Aviation Information Staff
Civil Aeronautics Administration
Department of Commerce
Washington 25, D. C.

(m) NUMBERING OF TECHNICAL STANDARD ORDERS. Each Technical Standard Order shall be assigned a number consisting of the letters "TSO," a series code number "C," relating to technical orders issued by the Aircraft Division, and a serial number to be assigned in sequence for each of the TSO's issued in the "C" series, e.g. TSO-C-1, "Smoke Detectors."

"CAR 3.46 Speeds.

"V_t True air speed of the airplane relative to the undisturbed air.

"In the following symbols having subscripts, V denotes:

"(a) 'Equivalent' air speed for structural design purposes equal to $V_t \sqrt{\rho/\rho_o}$.

"(b) 'True indicated' or 'calibrated' air speed for performance and operating purposes equal to indicator reading corrected for position and instrument errors.

Symbol		Reference sections
V_{s_o}	stalling speed, in the land configuration	3.82
V_{s_1}	stalling speed in the configurations specified for particular conditions	3.82
V_{sf}	computed stalling speed at design landing weight with flaps fully deflected	3.190
V_x	speed for best angle of climb.	
V_y	speed for best rate of climb.	
V_{mc}	minimum control speed	3.111
V_f	design speed for flight load conditions with flaps in landing position	3.190
V_{fe}	flaps-extended speed	3.742
V_p	design maneuvering speed	3.184
V_c	design cruising speed	3.184

		Reference sections
V_d	design dive speed	3.184
V_{ne}	never-exceed speed	3.739
V_{no}	maximum structural cruising speed	3.740
V_h	maximum speed in level flight at maximum continuous power."	

3.46-1 MARGIN BETWEEN V_{no} SPEED AND LEVEL FLIGHT SPEED. (CAA interpretations which apply to section 3.46, previously 3.073).

(a) Airplanes may be approved under CAR 3 even though a large margin exists between the placard V_{no} speed and the level flight speed actually attainable by the airplane. The Regulations specify minimum values for design cruising speed based only on wing loading; no attempt was made nor was it intended to relate the design cruising speed to power or maximum speeds attainable in level flight. (See CAR 3.740 for limits on the range of V_{no}).

(b) On the basis of sub-paragraph (a) it is not necessary to reinvestigate the complete airplane structure for design cruising speed changes when increased power is installed provided the original placard speed V_{no} is retained.

"CAR 3.48 Susceptibility of materials to fire. Where necessary for the purpose of determining compliance with any of the definitions in this section, the Administrator shall prescribe the heat conditions and testing procedures which any specific material or individual part must meet.

"(a) Fireproof. 'Fireproof' material means a material which will withstand heat equally well or better than steel in dimensions appropriate for the purpose for which it is to be used. When applied to material and parts used to confine fires in designated fire zones 'fireproof' means that the material or part will perform this function under the most severe conditions of fire and duration likely to occur in such zones.

"(b) Fire-resistant. When applied to sheet or structural members, 'fire-resistant' material shall mean a material which will withstand heat equally well or better than aluminum alloy in dimensions appropriate for the purpose for which it is to be used. When applied to fluid-carrying lines, this term refers to a line and fitting assembly which will perform its intended protective functions under the heat and other conditions likely to occur at the particular location.

"(c) Flame-resistant. 'Flame-resistant' material means material which will not support combustion to the point of propagating, beyond safe limits, a flame after removal of the ignition source.

"(d) Flash-resistant. 'Flash-resistant' material means material which will not burn violently when ignited.

"(e) Inflammable. 'Inflammable' fluids or gases means those which will ignite readily or explode."

3.48-1 FIRE-RESISTANT AIRCRAFT MATERIAL. (CAA rules which apply to section 3.48 (b), previously 3.075 (b)).

(a) The minimum safety requirements for fire-resistant material which is intended for use in civil aircraft have been established by the Administrator in Technical Standard Order No. TSO-C17, effective September 1, 1948, "Fire Resistant Aircraft Material."

"WEIGHT RANGE AND CENTER OF GRAVITY"

"CAR 3.71 Weight and balance. (a) There shall be established, as a part of the type inspection, ranges of weight and center of gravity within which the airplane may be safely operated.

"(b) When low fuel adversely affects balance or stability, the airplane shall be so tested as to simulate the condition existing when the amount of usable fuel on board does not exceed one gallon for every 12 maximum continuous horsepower of the engine or engines installed."

3.71-1 WEIGHING PROCEDURE FOR NEW PRODUCTION AIRCRAFT NOT FALLING WITHIN THE TRANSPORT CATEGORY. (CAA policies which apply to section 3.71 (a), previously 3.11).

(a) The manufacturer may weigh the first five aircraft and compute an average empty weight from which the empty weight of none of the aircraft should vary by more than one half of one percent, the average empty weight thus determined may then be used for the next four production aircraft. The effects of variable equipment may be computed.

(b) Following the above, each fifth aircraft should be weighed and its empty weight determined.

(1) If the empty weight of each fifth aircraft recurrently falls within the specified weight tolerance defined above, the continued use of the average empty weight for each succeeding group of four production aircraft is acceptable.

(2) If the empty weight of a fifth aircraft falls outside of the specified weight tolerance, the following five aircraft should be weighed and a new average empty weight determined. The procedure described in the foregoing paragraphs is then repeated.

(c) Sub-paragraphs (a) and (b) apply only to those manufacturers producing aircraft under a currently effective Production Certificate, and only at the discretion of the Chief, Aircraft Division, in the Region in which the manufacturer is located.

3.71-2 WEIGHT AND BALANCE LIMITATIONS FOR FLIGHT TESTS. (CAA policies which apply to section 3.71 (a), previously 3.11).

(a) Flight tests should be conducted at the maximum weight for which the airplane is to be certificated and at no time during the test should the weight exceed the following tolerances from the maximum weight:

Item	Tolerance
General	+ 5%; - 10%
Flight characteristics general	+ 5%; - 10%
Flight characteristics, critical items affected by weight	+ 5%; - 1%

(b) The forward and rearward center of gravity during flight test loading should be within a tolerance of 7% of the total travel for which the airplane is to be certificated.

(c) When the maximum weight at maximum center of gravity limits cannot be obtained practically during type tests, aircraft specifications center of gravity limits information should be referred to the Chief, Aircraft Division, Civil Aeronautics Administration, Washington, D. C. for ruling.

(d) The airplane certificated weight and center of gravity range should not exceed the authorized structural limits.

"CAR 3.72 Use of ballast. Removable ballast may be used to enable airplanes to comply with the flight requirements in accordance with the following provisions:

"(a) The place or places for carrying ballast shall be properly designed, installed, and plainly marked as specified in section 3.766.

"(b) The Airplane Flight Manual shall include instructions regarding the proper disposition of the removable ballast under all loading conditions for which such ballast is necessary, as specified in sections 3.755-3.770."

3.72-1 USE OF BALLAST. (CAA policies which apply to section 3.72, previously 3.110).

(a) Removable ballast may be used in accordance with CAR 3.72 provided compliance is demonstrated with CAR 3.72 (a) and (b) as related items. If the airplane does not have an Airplane Flight Manual, the instructions regarding use of the ballast should be included on the placard prescribed in CAR 3.766.

(b) If misuse of ballast would result in a particularly dangerous situation, such as spin recovery difficulties, a warning note should be included in the instructions.

(c) Because of the operational difficulties likely to occur in using removable ballast, it should be used only as a last resort when it is found that fixed ballast cannot accomplish the purpose without seriously limiting the utility of the airplane. On new designs manufacturers should make every effort to arrange or modify the designs to avoid the use of removable ballast.

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"CAR 3.73 Empty weight. The empty weight and corresponding center of gravity location shall include all fixed ballast, the unusable fuel supply (see section 3.437), undrainable oil, full engine coolant, and hydraulic fluid. The weight and location of items of equipment installed when the airplane is weighed shall be noted in the Airplane Flight Manual."

3.73-2 EMPTY WEIGHT ITEMS. (CAA interpretations which apply to section 3.73, previously 3.112).

(a) The empty weight must at least include the items covered in CAR 3.73. Any additional items such as de-icer fluid, wash water and toilet chemical, if carried, should be included in the empty weight, or so handled that they will be included in the useful load and take-off weight.

(b) In any case, of course, the equipment list should clearly reflect which items are included in the empty weight. If this is done, it is not believed that confusion will result at some later date as to what is or is not added into the empty weight.

3.73-3 UNUSABLE FUEL SUPPLY AND UNDRAINABLE OIL. (CAA interpretations which apply to section 3.73, previously 3.112).

(a) Unusable fuel is determined by the provisions of CAR 3.437. The unusable fuel, whether or not greater than 5% of the fuel tank capacity or one gallon (see CAR 3.440) should be included in the empty weight. If the unusable fuel supply is greater than 5% or one gallon, the fuel quantity indicator should be marked in accordance with the provisions of CAR 3.761.

(b) Undrainable oil is defined as that oil which remains in the system after draining oil from all aircraft components including the engine by means of the oil drains provided, with the aircraft in ground attitude.

(c) All fuel and oil weight in the airplane that is not measurable by the gauges provided should be accounted for, preferably in inclusion in the empty weight.

"CAR 3.76 Center of gravity position. If the center of gravity position under any possible loading condition between the maximum weight as specified in section 3.74 and the minimum weight as specified in section 3.75 lies beyond (a) the extremes selected by the applicant, or (b) the extremes for which the structure has been proven, or (c) the extremes for which compliance with all functional requirements were demonstrated, loading instructions shall be provided in the Airplane Flight Manual as specified in sections 3.777-3.780."

3.76-1 CENTER OF GRAVITY POSITION. (CAA policies which apply to section 3.76, previously 3.115).

(a) It is suggested that as wide a range of c.g. as practicable be investigated (using ballast if necessary) in the flight tests to provide for future changes in empty weight c.g. without rerunning tests or structural analysis.

(b) Where practicable, the extreme c.g. positions should be investigated, both in structural design and flight tests in combination with maximum weight (using ballast if necessary) to make loading instructions as simple as possible, and also provide for future changes in empty weight c.g. and useful load.

(c) In cases where the permissible c.g. positions vary with maximum weight, it is suggested that a note be included in the loading instruction portion of the Airplane Flight Manual advising owners to contact the airplane manufacturer for new loading instructions when any change is made to the airplane which would appreciably affect the location of the empty weight c.g. or the useful load.

"CAR 3.82 Definition of stalling speeds. (a) V_{s_o} denotes the true indicated stalling speed, if obtainable, or the minimum steady flight speed at which the airplane is controllable, in miles per hour, with:

"(1) Engines idling, throttles closed (or not more than sufficient power for zero thrust),

"(2) Propellers in position normally used for take-off,

"(3) Landing gear extended,

"(4) Wing flaps in the landing position,

"(5) Cowl flaps closed,

"(6) Center of gravity in the most unfavorable position within the allowable landing range,

"(7) The weight of the airplane equal to the weight in connection with which V_{s_o} is being used as a factor to determine a required performance.

"(b) V_{s_1} denotes the true indicated stalling speed, if obtainable, otherwise the calculated value in miles per hour, with:

"(1) Engines idling, throttles closed (or not more than sufficient power for zero thrust),

"(2) Propellers in position normally used for take-off, the airplane in all other respects (flaps, landing gear, etc.) in the particular condition existing in the particular test in connection with which V_{s_1} is being used.

"(3) The weight of the airplane equal to the weight in connection with which V_{s_1} is being used as a factor to determine a required performance.

"(c) These speeds shall be determined by flight tests using the procedure outlined in section 3.120."

3.82-1 ZERO THRUST. <u>(CAA interpretation which applies to section 3.82, previously 3.121)</u>.

As used in CAR 3.82 (a) (1) and (b) (1), the term "zero thrust" contained in the phrase "engines idling, throttles closed (or not more than sufficient power for zero thrust)" is interpreted to permit "zero thrust at a speed not greater than 110% of the stalling speed."

"TAKE-OFF"

"CAR 3.84 Take-off. (a) The distance required to take off and climb over a 50-foot obstacle shall be determined under the following conditions:

"(1) Most unfavorable combination of weight and center of gravity location,

"(2) Engines operating within the approved limitations,

"(3) Cowl flaps in the position normally used for take-off.

"(b) Upon obtaining a height of 50 feet above the level take-off surface, the airplane shall have attained a speed of not less than 1.3 V_{s_1} unless a lower speed of not less than V_x plus five can be shown to be safe under all conditions, including turbulence and complete engine failure.

"(c) The distance so obtained, the type of surface from which made, and the pertinent information with respect to the cowl flap position, the use of flight-path control devices and landing gear retraction system shall be entered in the Airplane Flight Manual. The take-off shall be made in such a manner that its reproduction shall not require an exceptional degree of skill on the part of the pilot or exceptionally favorable conditions."

3.84-1 TAKE-OFF PERFORMANCE. (CAA policies which apply to section 3.84, previously 3.122).

To meet the requirements of CAR 3.84 pertaining to certification of take-off performance and to provide the Airplane Flight Manual performance data required in CAR 3.780 (a) (3) and (4), the following procedure may be used during official type tests:

The ground and climb distances may be determined separately and the corrected data pieced together (as is now done in the transport category). Thus, for the simplest procedure, the airplane would be accelerated on (or near) the ground with gear extended to a speed not less than 1.3 V_{s_1}, and a climb segment to the 50 ft. height point with gear extended would be determined by saw-tooth climb data. If it is desired to assume retraction of the landing gear at an earlier point, such point should be assumed to occur not earlier than that which would be used in normal take-offs. The acceleration to 1.3 V_{s_1} should then be measured as above, with gear retraction being initiated at the selected speed. If gear retraction is completed before reaching 1.3 V_{s_1}, only one climb segment, with gear retracted, need be determined. If retraction is not completed during acceleration to 1.3 V_{s_1}, two climb segments should be determined; one with gear extended for the time period necessary to complete retraction; the second with gear retracted. The acceleration segment should be determined photographically, and a minimum of three trials should be made up to speeds equal to or greater than 1.3 V_{s_1}. Note: (CAA camera equipment may be obtained on a loan basis.)

Based upon the CAA's experience to date, the test method outlined above has given the desired accuracy of results. It also provides suitable means for showing the approximate calculated effect of temperature and altitude upon climb (up to 7,000 ft.).

> Note: It is permissible for other methods to be used in accomplishing these tests, providing that any method used is one which the average pilot may be reasonably expected to duplicate without use of unusual skill or experience, and one which produces equivalent accuracy. The operating procedure which must be followed to achieve the measured performance should in all cases be described in the Airplane Flight Manual.

The take-off and climb requirements of CAR 3.84 and CAR 3.85 were written to assure the airplane's ability to clear obstacles in the vicinity of the airport. Consequently, the wing flap used for the air-borne portion of the take-off to the 50 foot height should not exceed that used for the "normal climb condition" of CAR 3.85 (a). However, if the applicant so desires, he may enter additional take-off data in the Airplane Flight Manual in which the flap setting specified in CAR 3.84 or CAR 3.85 (a) has been exceeded, provided the portion of the flight path beyond the 50 foot point which will cover the transition to normal climb configuration of CAR 3.85 (a), <u>is also included</u>.

3.84-2 MEASUREMENT OF SEAPLANE TAKE-OFF DISTANCES. <u>(CAA interpretation which applies to section 3.84 (a), previously 3.122)</u>.

The standard starting point for the measurement of seaplane take-off distances may be assumed to be the point at which the seaplane has attained an initial speed of three miles per hour during take-off.

3.84-3 TAKE-OFF SPEED. (CAA interpretation which applies to section 3.84 (b), previously 3.122).

$1.3 \times V_{s_1}$ or $V_x + 5$ speed should be used for take-off even if throttling back is necessary to prevent exceeding r.p.m. limits.

"CLIMB"

"CAR 3.85 Climb. (a) Normal climb condition. The steady rate of climb at sea level shall be at least 300 feet per minute, and the steady angle of climb at least 1:12 for landplanes or 1:15 for seaplanes with:

"(1) Not more than maximum continuous power on all engines,

"(2) Landing gear fully retracted,

"(3) Wing flaps in take-off position,

"(4) Cowl flaps in the position used in cooling tests specified in sections 3.581-3.596.

"(b) Climb with inoperative engine. All multiengine airplanes having a stalling speed V_{s_o} greater than 70 miles per hour or a maximum weight greater than 6,000 pounds shall have a steady rate of climb of at least $0.02\ V_{s_o}^{2}$ in feet per minute at an altitude of 5,000 feet with the critical engine inoperative and:

"(1) The remaining engines operating at not more than maximum continuous power,

"(2) The inoperative propeller in the minimum drag position,

"(3) Landing gear retracted,

"(4) Wing flaps in the most favorable position,

"(5) Cowl flaps in the position used in cooling tests specified in sections 3.581-3.596.

"(c) Balked landing conditions. The steady angle of climb at sea level shall be at least 1:30 with:

"(1) Take-off power on all engines,

"(2) Landing gear extended,

"(3) Wing flaps in landing position.

"If rapid retraction is possible with safety without loss of altitude and without requiring sudden changes of angle of attack or exceptional skill on the part of the pilot, wing flaps may be retracted."

3.85-1 RATE OF CLIMB. (CAA policies which apply to section 3.85, previously 3.123).

To meet the requirements of CAR 3.85 a suitable method such as outlined below, should be employed for the purpose of determining the rates of climb.

This method of obtaining rates of climb is through the derivation of a polar curve obtained from a series of saw-tooth climbs at various speeds. When saw-tooth climbs are employed, a minimum of five different speeds is required. However, demonstration climbs to prove the article meets the minimum climb requirement may be made at one given airspeed. In such cases, the minimum number of climbs at one airspeed shall be not less than three. This may not be interpreted to mean the best three of a number of climbs. In the event additional climbs are made the average of the total should be the value to be accepted. It should be permissible, however, to discard any climbs which are obviously in error due to such factors as turbulent air.

3.85-2 NORMAL CLIMB AND COOLING TEST PROCEDURE FOR SINGLE-ENGINE AIRPLANES. (CAA interpretations which apply to section 3.85, previously 3.123).

In connection with any application to have an aircraft certified for airworthiness under a combination of the requirements of CAR 3 and CAR 4a as authorized by the provisions of CAR 3.2, the items of "normal climb" (CAR 3.85 (a)) and "cooling test procedure for single-engine airplanes" (CAR 3.586), shall be construed by the Administrator as "related items."

3.85-3 RAPID RETRACTION. (CAA interpretations which apply to section 3.85, previously 3.123).

"Rapid retraction" of flaps as that phrase is used in CAR 3.85 (c) for flaps is considered two seconds or less.

3.85-4 WEIGHT FOR ITEMS OF PERFORMANCE AND FLIGHT CHARACTERISTICS. CAA interpretations which apply to section 3.85, previously 3.123).

For multi-engine airplanes in which the design landing weight (CAR 3.242) is less than the maximum take-off weight (CAR 3.74) for which certification is desired, the weight for items of performance and flight characteristics should be taken as the maximum weight defined in CAR 3.74. Items of performance and flight characteristics should consist of balked landing (climb) conditions (CAR 3.85 (c)), landing over 50 foot obstacles (CAR 3.86) and all flight characteristics tests in the landing configuration. The design weight covered in CAR 3.242 is intended for use for structural design purposes only.

3.85-5 LOW-PITCH PROPELLER SETTING IN NORMAL CLIMB POSITION. (CAA interpretations which apply to section 3.85 (a), previously 3.123).

(a) In the event an airplane has:

(1) an engine for which the take-off and maximum continuous power ratings are identical, and

(2) a fixed-pitch, two-position or similar type propeller,

then the regulations provide that the best rate of climb speed specified in CAR 3.85 (a) for normal climb should be determined with the low-pitch propeller setting which would restrain the engine to an r.p.m. at full throttle not exceeding its permissible, take-off r.p.m. (see CAR 3.419 (a)).

(b) A relaxation of the propeller pitch setting requirement stipulated by CAR 3.419 (a) may be granted, however, for an airplane falling into the foregoing classification, when it shows a marginal item of performance as, for example, when it can meet the rate of climb requirement of CAR 3.85 (a) for normal climb, but may have difficulty in meeting the angle of climb requirements of CAR 3.85 (a) for normal climb and/or CAR 3.85 (c) for balked landing. In this case, it will be permissible to use a lower propeller pitch setting than specified in CAR 3.419 (a), in order to obtain rated engine r.p.m. at the best angle of climb speed: Provided acceptable engine cooling can be demonstrated at the lower speed associated with the best angle of climb. In employing this procedure, consideration should also be given to the following:

(1) That the best angle of climb speed for the balked landing condition may be considerably lower than the best angle of climb speed for the normal climb condition.

(2) That as a result of sub-paragraph (1), the engine would normally have to be part throttled to avoid exceeding rated r.p.m. at the higher speeds, and would therefore develop less than rated power for showing compliance with the normal climb and take-off requirements of CAR 3.85 (a) and 3.84, respectively.

"LANDING"

"CAR 3.86 Landing. (a) The horizontal distance required to land and to come to a complete stop (to a speed of approximately 3 miles per hour for seaplanes or float planes) from a point at a height of 50 feet above the landing surface shall be determined as follows:

"(1) Immediately prior to reaching the 50-foot altitude, a steady gliding approach shall have been maintained, with a true indicated air speed of at least 1.3 V_{s_o}.

"(2) The landing shall be made in such a manner that there is no excessive vertical acceleration, no tendency to bounce, nose over, ground loop, porpoise, or water loop, and in such a manner that its reproduction shall not require any exceptional degree of skill on the part of the pilot or exceptionally favorable conditions.

"(b) The distance so obtained, the type of landing surface on which made and the pertinent information with respect to cowl flap position, and the use of flight path control devices shall be entered in the Airplane Flight Manual."

3.86-1 USE OF CAMERA EQUIPMENT. (CAA policy which applies to section 3.86, previously 3.124).

The landing distance should be determined photographically. CAA camera equipment is available on a loan basis.

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"TRIM"

"CAR 3.112 Requirements. (a) The means used for trimming the airplane shall be such that, after being trimmed and without further pressure upon or movement of either the primary control or its corresponding trim control by the pilot or the automatic pilot, the airplane will maintain:

"(1) Lateral and directional trim in level flight at a speed of 0.9 V_h or at V_c, if lower, with the landing gear and wing flaps retracted;

"(2) Longitudinal trim under the following conditions:

"(i) During a climb with maximum continuous power at a speed between V_x and 1.4 V_{s_1},

"(a) With landing gear retracted and wing flaps retracted,

"(b) With landing gear retracted and wing flaps in the take-off position.

"(ii) During a glide with power off at a speed not in excess of 1.4 V_{s_1},

"(a) With landing gear extended and wing flaps retracted,

"(b) With landing gear extended and wing flaps extended under the forward center of gravity position approved with the maximum authorized weight.

"(c) With landing gear extended and wing flaps extended under the most forward center of gravity position approved, regardless of weight.

"(iii) During level flight at any speed from 0.9 V_h to V_x or 1.4 V_{s_1} with landing gear and wing flaps retracted.

"(b) In addition to the above, multiengine airplanes shall maintain longitudinal and directional trim at a speed between V_y and 1.4 V_{s_1} during climbing flight with the critical of two or more engines inoperative, with:

"(1) The other engine(s) operating at maximum continuous power,

"(2) The landing gear retracted,

"(3) Wing flaps retracted,

"(4) Bank not in excess of 5 degrees."

3.112-1 TRIM DURING A GLIDE. (CAA policies which apply to section 3.112 (a) (2) (ii), previously 3.132 (b) (2)).

The following performance standards may be used for the purposes of administering CAR 3.112 (a) (2) (ii):

(a) In the case of new airplane designs which, due to their being equipped with high lift devices, cannot meet the required trim at 1.4 times stall speed with the landing gear and flaps extended, the Administrator, as authorized in CAR 3.1, may accept, as being of equivalent safety, performance with the flaps extended based on the following standards:

(1) The flap down, power off, stalling speed should not exceed 90% of the flap retracted, power off stalling speed.

(2) The minimum trim speed with power off, flaps and landing gear extended, under the forward center of gravity position approved with the maximum authorized weight, and under the most forward center of gravity position approved, regardless of weight, should not exceed 1.5 times the stall speed for that configuration.

(3) The force required to maintain steady flight in this configuration at 1.4 V_{s_1}, should not exceed 10 pounds.

(4) It should be possible trimmed in this configuration to execute a normal power off landing without exceeding a stick force of 40 pounds.

(5) It should be possible with the stick free, to reduce the rate of descent to zero and simultaneously bring the airplane to an attitude suitable for landing, using not more than maximum continuous power. During this demonstration the flaps extended speed should not be exceeded.

(b) When the standards set forth above are relied upon to determine compliance with this section of the Civil Air Regulations, the Administrator may accept as equivalent safety a demonstration of the following items at 1.5 times stall speed instead of 1.4 times stall speed: Longitudinal control (CAR 3.109 (a) and (b) (2) (5) and (6). Specific conditions (CAR 3.115 (a)).

(c) Either the requirement of CAR 3.112 (a) (2) (ii) or that of the alternate method outlined in sub-paragraphs (a) and (b) should be met in full; no interpolation between the 1.4 V_{s_1} and 1.5 V_{s_1} (for cases where the 90% factor cannot be met) may be permitted. For example, an airplane whose flaps-down stall speed is 95% of flaps-up stall speed is not to be permitted to demonstrate minimum trim at 1.45 V_{s_1}, but should comply with the original requirement in CAR 3.112 (a) (2) (ii).

"CAR 3.118 Directional and lateral stability. (a) Three-control airplanes.

"(1) The static directional stability, as shown by the tendency to recover from a skid with rudder free, shall be positive for all flap positions and symmetrical power conditions, and for all speeds from 1.2 V_{s_1} up to the maximum permissible speed.

"(2) The static lateral stability as shown by the tendency to raise the low wing in a sideslip, for all flap positions and symmetrical power conditions, shall:

"(i) Be positive at the maximum permissible speed.

"(ii) Not be negative at a speed equal to 1.2 V_{s_1}.

"(3) In straight steady sideslips (unaccelerated forward slips), the aileron and rudder control movements and forces shall increase steadily, but not necessarily in constant proportion, as the angle of sideslip is increased; the rate of increase of the movements and forces shall lie between satisfactory limits up to sideslip angles considered appropriate to the operation of the type. At greater angles, up to that at which the full rudder control is employed or a rudder pedal force of 150 pounds is obtained, the rudder pedal forces shall not reverse and increased rudder deflection shall produce increased angles of sideslip. Sufficient bank shall accompany sideslipping to indicate adequately any departure from steady unyawed flight.

"(4) Any short-period oscillation occurring between stalling speed and maximum permissible speed shall be heavily damped with the primary controls (i) free and (ii) in a fixed position.

"(b) Two-control (or simplified) airplanes. (1) The directional stability shall be shown to be adequate by demonstrating that the airplane in all configurations can be rapidly rolled from a 45-degree bank to a 45-degree bank in the opposite direction without exhibiting dangerous skidding characteristics.

"(2) Lateral stability shall be shown to be adequate by demonstrating that the airplane will not assume a dangerous attitude or speed when all the controls are abandoned for a period of 2 minutes. This demonstration shall be made in moderately smooth air with the airplane trimmed for straight level flight at 0.9 V_h (or at V_c, if lower), flaps and gear retracted, and with rearward center of gravity loading.

"(3) Any short period oscillation occurring between the stalling speed and the maximum permissible speed shall be heavily damped with the primary controls (i) free and (ii) in a fixed position."

3.118-1 TEST CONDITIONS. (CAA policies which apply to section 3.118 (a) (3), previously 3.13330 (c)).

The tests made necessary in CAR 3.118 (a) (3) may be conducted at speeds up to 1.2 times stall speed, flaps up and down, and with power up to 75% of maximum continuous rating.

3.118-2 LARGE DISPLACEMENTS OF FLIGHT CONTROLS IN DIRECTIONAL AND LATERAL STABILITY TESTS. (CAA policies which apply to section 3.118, previously 3.1333).

(a) In performing flight tests to determine compliance with CAR 3.118, it should be borne in mind that the airplane structural requirements do not provide for large displacements of the flight controls at high speeds. Full application of rudder and aileron controls should be confined to speeds below the design maneuvering speed, V_p. The following rules (approximations) will serve as a guide for the maximum permissible control surface deflections at speeds above V_p. (This does not imply that these maximum deflections must be used in the tests at high speeds).

(1) The permissible rudder angle decreases approximately according to the ratio $(V_p/V)^2$, where V is the speed of the test.

(2) The permissible aileron deflection decreases approximately at the ratio (V_p/V), up to the design cruising speed, V_c. Above V_c, the permissible aileron deflection decreases at a faster rate.

(b) Thus, in a typical case, assuming V_p is 141 mph, V_c is 200 mph, and V_{NE} is 250 mph:

	V_c	V_{NE}
Permissible rudder deflection	50%	32%
Permissible aileron deflection	70%	32%

where 100% is the deflection obtainable at V_p.

(c) Control movements should be made smoothly and sudden reversals avoided.

3.118-3 FLIGHT TESTS FOR ADVERSE CONTROL FORCE REVERSAL OR CONTROL LOCKING. (CAA policies which apply to section 3.118 (a) (3), previously 3.13330 (c)).

(a) Tests should be conducted in all critical configurations, weights and c.g. positions from power off to 75% M.C.P. for the following speeds and any higher speeds if considered more critical:

(1) NORMAL CATEGORY

(i) Over 4,000 lbs.: 1.2 V_{s_1}

(ii) Under 4,000 lbs.: All speeds from 1.2 V_{s_1} down to the lowest speed attainable in steady unstalled flight.

(2) UTILITY AND ACROBATIC CATEGORIES (REGARDLESS OF WEIGHT)

Same as sub-paragraph (ii).

(b) V_{s_1} is the stalling speed in the critical configuration as defined in CAR 3.82 (b).

(c) The rear c.g. is usually critical for these tests.

"STALLS"

"CAR 3.120 Stalling demonstration. (a) Stalls shall be demonstrated under two conditions:

"(1) With power off.

"(2) With the power setting not less than that required to show compliance with section 3.85 (a).

"(b) In either condition it shall be possible, with flaps and landing gear in any position, with center of gravity in the position least favorable for recovery, and with appropriate airplane weights for: (1) Airplanes having independently controlled rolling and directional controls to produce and to correct roll by unreversed use of the rolling control and to produce and to correct yaw by unreversed use of the directional control during the maneuvers described below up to the time when the airplane pitches, (2) two-control airplanes having either interconnected lateral and directional controls or providing only one of these controls to produce and to correct roll by unreversed use of the rolling control without producing excessive yaw during the maneuvers described below up to the time the airplane pitches.

"(c) During the recovery portions of the maneuver, pitch shall not exceed 30 degrees below level, there shall be no loss of altitude in excess of 100 feet, and not more than 15 degrees roll or yaw shall occur when controls are not used for 1 second after pitch starts and are used thereafter only in a normal manner.

"(d) Where clear and distinctive stall warning is apparent to the pilot at a speed at least 5 percent above the stalling speed with flaps and landing gear in any position, both in straight and turning flight, these requirements are modified as follows:

"(1) It shall be possible to prevent more than 15 degrees roll or yaw by the normal use of controls.

"(2) Any loss of altitude in excess of 100 feet or any pitch in excess of 30 degrees below level shall be entered in the Airplane Flight Manual.

"(e) In demonstrating the qualities set forth in paragraph (d) of this section, the order of events shall be:

"(1) With trim controls adjusted for straight flight at a speed of approximately 1.4 V_{s_1}, reduce speed by means of the elevator control until the speed is steady at slightly above stalling speed, then

"(2) Pull elevator control back at a rate such that the airplane speed reduction does not exceed 1 mile per hour per second until a stall is produced as evidenced by an uncontrollable downward pitching motion of the airplane, or until the control reaches the stop. Normal use of the elevator control for recovery may be made after such pitching motion is unmistakably developed."

3.120-1 MEASURING LOSS OF ALTITUDE DURING STALL. (CAA policies which apply to section 3.120, previously 3.134).

To meet the requirements of CAR 3.120 pertaining to the maximum loss of altitude permitted during the stall, it is necessary that a suitable method be used for the purpose of measuring such loss during the investigation of stalls. Unless special features of an individual type being investigated render the following instructions inapplicable, the procedure described should be used for this purpose:

(a) The standard procedure for approaching a stall should be used as specified in CAR 3.120.

(b) The loss of altitude encountered in the stall (power on or power off) should be the distance as observed on the sensitive altimeter testing installation from the moment the airplane pitches to the observed altitude reading at which horizontal flight has been regained.

(c) Power used during the recovery portions of a stall maneuver may be that which, at the discretion of the inspector, would be likely to be used by a pilot under normal operating conditions when executing this particular maneuver. However, the power used to regain level flight should not be applied until the airplane has regained flying control at a speed of approximately 1.2 V_{s_1}. This means that in the investigation of stalls with the critical engine inoperative, the power may be reduced on the operating engine(s) before re-applying power on the operating engine or engines for the purpose of regaining level flight.

3.120-2 INDICATIONS OF STALL WARNINGS. (CAA policies which apply to section 3.120, previously 3.134).

(a) No precise and complete description of the various warnings that would comply with CAR 3.120 can be given at this time, but the following lists of items may be used as a guide:

(1) Satisfactory items include:

(i) Buffeting, which may be defined as general shaking or vibration of the airplane, elevator nibble, aileron nibble, rudder nibble, audible indications such as oil canning of structural members or covering, roughness in riding qualities of the airplane due to aerodynamic disturbances, etc.

(ii) Stall warning instrument - either visual or aural. A visual instrument could be either a light or a dial.

(iii) Stick force - defined as heavy.

(iv) Stick travel to hold attitude.

(v) Stick position.

(2) Unsatisfactory items include:

(i) Airplane attitude.

(ii) Inability to hold heading.

(iii) Inability to hold wing level.

"CAR 3.121 Climbing stalls. When stalled from an excessive climb attitude it shall be possible to recover from this maneuver without exceeding the limiting air speed or the allowable acceleration limit."

3.121-1 CLIMBING STALL FLIGHT TESTS FOR LIMITED CONTROL AIRPLANES. (CAA interpretations which apply to section 3.121, previously 3.1340).

(a) This requirement is intended to draw particular attention to any stall recovery characteristics that might be encountered when a limited control airplane is completely stalled from an extremely nose high attitude, either intentionally or inadvertently. In practice it is possible that the elevator control travel could be limited to such an extent that stalls could not be obtained at the normal rate of deceleration used in testing. However, if the airplane was pulled up into a very steep climbing attitude from reasonably high speed flight either power on or power off, and held in this attitude, excessive pitching may occur. At the same time, the limited elevator travel may retard recovery from the pitched attitude until excessively high speeds are obtained. These characteristics would normally be considered under CAR 3.106; however, it appears wise to call particular attention to the control characteristics that might result from these flight configurations on limited control airplanes.

(b) Although Form ACA-283-03, item A, (3), (a), indicates that take-off power should be used for these tests, this is not a mandatory requirement. In this regard it is to be noted that although CAR 3.121 is entitled "Climbing Stalls", it specifically states: ". . . when stalled from an excessive climb attitude", thus a specified application of power is not required. For example, flight tests recently conducted on several aircraft have indicated that the power-off configuration was critical since the stall resulted in greater pitch and less elevator control. The technique used for inducing such stalls consisted of stalling the airplane(power off) in as steep a climbing attitude as possible without falling into a whip stall, or other flight maneuver that might overstress the structure. (Form ACA-283-03 will be revised at the next printing, so that the power found to be critical can be recorded in a space that will be provided for this purpose.)

"SPINNING"

"CAR 3.124 Spinning. (a) Category N. All airplanes of 4,000 pounds or less maximum weight shall recover from a one-turn spin with controls assisted to the extent necessary to overcome friction in not more than one and one-half additional turns and without exceeding either the limiting air speed or the limit positive maneuvering load factor for the airplane. It shall not be possible to obtain uncontrollable spins by means of any possible use of the controls. Compliance with the above shall be demonstrated at any permissible combination of weight and center of gravity positions obtainable with all or part of the design useful load. All airplanes in this category, regardless of weight, shall be placarded against spins or demonstrated to be 'characteristically incapable of spinning' in which case they shall be so designated. (See paragraph (d) of this section.)

"(b) Category U. Airplanes in this category shall comply with either the entire requirements of paragraph (a) of this section or the entire requirements of paragraph (c) of this section.

"(c) Category A. All airplanes in this category must be capable of spinning and shall comply with the following:

"(1) At any permissible combination of weight and center of gravity position obtainable with all or part of the design useful load, the airplane shall recover from a six-turn spin with controls free in not more than four additional turns after releasing the controls. If the airplane will not recover as prescribed with controls free but will recover with the controls assisted to the extent necessary to overcome friction, the airplane may be certificated with the rearmost center of gravity position 2 percent forward of the position used in the test.

"(2) It shall be possible to recover at any point in the spinning described above by using the controls in a normal manner for that purpose in not more than one and one-half additional turns, and without exceeding either the limiting air speed or the limit positive maneuvering load factor for the airplane. It shall not be possible to obtain uncontrollable spins by means of any possible use of the controls.

"(d) Category NU. When it is desired to designate an airplane as a type 'characteristically incapable of spinning,' the flight tests to demonstrate this characteristic shall also be conducted with:

"(1) A maximum weight 5 percent in excess of the weight for which approval is desired,

"(2) A center of gravity at least 3 percent aft of the rearmost position for which approval is desired, "(3) An available up-elevator travel 4 degrees in excess of that to which the elevator travel is to be limited by appropriate stops.

"(4) An available rudder travel 7 degrees, in both directions, in excess of that to which the rudder travel is to be limited by appropriate stops."

3.124-1 SPIN TESTS FOR CATEGORY N AIRPLANES. (CAA interpretation which applies to section 3.124 (a), previously 3.135-N).

If during recovery from a one-turn flaps-down spin the airplane exceeds the placard flap speed or limit load factor, it is permissible to retract the flaps during recovery to avoid exceeding these limits.

3.124-2 SPIN TESTS FOR CATEGORY A AIRPLANES. (CAA interpretation which applies to section 3.124 (c), previously 3.135-A).

If during recovery from a one-turn flaps-down spin the airplane exceeds the placard flap speed or limit load factor, it is permissible to retract the flaps during recovery to avoid exceeding these limits. In addition the airplane is to be placarded "Intentional spins with flaps down prohibited."

"CAR 3.173 Strength and deformations. The structure shall be capable of supporting limit loads without suffering detrimental permanent deformations. At all loads up to limit loads, the deformation shall be such as not to interfere with safe operation of the airplane. The structure shall be capable of supporting ultimate loads without failure for at least 3 seconds, except that when proof of strength is demonstrated by dynamic tests simulating actual conditions of load application, the 3-second limit does not apply."

3.173-1 DYNAMIC TESTS. (CAA policies which apply to section 3.173, previously 3.202).

(a) CAR 3.173 permits dynamic testing in lieu of stress analysis or static testing in the proof of compliance of the structure with strength and deformation requirements. In demonstrating, by dynamic tests, proof of strength of landing gears for the stipulated landing conditions contained in CAR 3.245, 3.246, and 3.247, a procedure should be employed which would not result in the accepting of landing gears weaker than those qualified for acceptance under present procedures, i.e., stress analysis or static testing, since repeated tests have indicated that a landing gear of given static strength can usually develop higher strength under dynamic conditions.

(b) The following dynamic tests would be considered adequate:

The structure should be dropped a minimum of ten times from the limit drop height, and at least one time from the ultimate drop height, for each basic design condition for which proof of strength is being made by drop tests.

(c) With regard to the extent to which the structure can be proved by dynamic tests, such dynamic tests should be accepted as proof of strength for only those elements of the structure for which it can be shown that the critical limit and ultimate loads have been reproduced.

"CAR 3.174 Proof of structure. Proof of compliance of the structure with the strength and deformation requirements of section 3.173 shall be made for all critical loading conditions. Proof of compliance by means of structural analysis will be accepted only when the structure conforms with types for which experience has shown such methods to be reliable. In all other cases substantiating load tests are required. In all cases certain portions of the structure must be subjected to tests as specified in Subpart D."

3.174-1 MATERIAL CORRECTION FACTORS. (CAA policies which apply to section 3.174, previously 3.203).

(a) In tests conducted for the purpose of establishing allowable strengths of structural elements such as sheet, sheet stringer combinations, riveted joints, etc., test results should be reduced to values which would be met by elements of the structure if constructed of materials having properties equal to design allowable values. Material correction factors in this case may be omitted, however, if sufficient test data are obtained to permit a probability analysis showing that 90% or more of the elements will either equal or exceed in strength the selected design allowable values. The number of individual test specimens needed to form a basis of "probability values" cannot be definitely stated but should be decided on the basis of consistency of results; i.e. "spread of results," deviations from mean value, and range of sizes, dimensions of specimens, etc. to be covered. This item should therefore be a matter for decision between the manufacturer and the CAA. (sections 1.654 and 1.655 of ANC-5a 1949 edition outline two means of accomplishing material corrections in element tests; these methods, however, are by no means considered the only methods available.)

(b) In cases of static or dynamic tests of structural components, no material correction factor is required. The manufacturer, however, should use care to see that the strength of the component tested conservatively represents the strength of subsequent similar components to be used on aircraft to be presented for certification. The manufacturer should, in addition, include in his report of tests of major structural components, a statement substantially as follows:

"The strength properties of materials and dimensions of parts used in the structural component(s) tested are such that subsequent components of these types used in aircraft presented for certification will have strengths substantially equal to or exceeding the strengths of the components tested."

3.174-2 STRUCTURAL TESTING OF NEW PROJECTS. (CAA policies which apply to section 3.174, previously 3.203).

(a) The following is a general procedure that may be followed for determining the extent of required structural testing of a new project:

(1) As the initial step to determine the structural testing of a new project, a meeting between representatives of the manufacturer, the Civil Aeronautics Administration project engineer, and (if practicable) the pertinent Branch Chief of the Aircraft Division should be arranged. The question of minimum tests should be reviewed first. This will include generally such tests as proof and operation tests of control surfaces and systems, drop tests of landing gear, vibration tests, and wing torsional stiffness tests.

(2) If the structure is of a type on which the manufacturer has a thorough background of experience, analysis and proof tests can usually be considered acceptable. If, in addition, the analysis has a high degree of conservatism, proof tests other than those specifically required by Regulation may be omitted at the discretion of the CAA.

(b) If the structure or parts thereof are definitely outside the manufacturer's previous experience, the manufacturer may be requested to establish a strength test program. In the case of a wing, this will usually involve a 100% ultimate load test for PHAA. In cases of this type, it should be suggested to the manufacturer that he carry the PHAA test to destruction. If a comparison of the effects of inverted and normal types of loading can be carried out, some of the above tests, such as ILAA test, can be omitted and a test made for one condition only.

(c) When ultimate load static tests are made, the limit load need not be removed provided that continuous readings of deflections of the structure are measured at an adequate number of points, and also provided that a close examination of the structure is maintained throughout the tests with particular emphasis being placed upon close observation of the structure at limit load for any indications of local distress, yielding buckles, etc.

(d) In the case of small airplanes of other than two spar and steel tube construction, the manufacturer should be encouraged to strength test his product and reduce formal analysis to a minimum.

3.174-3 ALLOWABLE BENDING MOMENTS OF STABLE SECTIONS IN THE PLASTIC RANGE. (CAA policies which apply to section 3.174, previously 3.203).

(a) The analytical method for determining allowable bending moments of stable sections in the plastic range as outlined in "Bending Strength in the Plastic Range" by F. P. Cozzone, Journal of Aeronautical Sciences, May 1948, is satisfactory for general use; however, the following should be considered in the application of this method of analysis to particular problems:

(1) The above method may be unconservative and should not be used for sections subject to local failure unless verified by suitable tests.

For example, ANC-5a should be used for round tubing.

(2) The method may be unconservative and should be verified by testing representative cross sections for materials having stress-strain curves differing materially from those discussed in the reference article, or for materials whose stress strain properties in compression differ materially from those in tension.

3.174-4 ACCEPTABILITY OF STATIC AND/OR DYNAMIC TESTS IN LIEU OF STRESS ANALYSES. (CAA policies which apply to section 3.174, previously 3.203).

Static testing to ultimate load is considered an adequate substitute for and in some cases superior to formal stress analysis where static loads are critical in the design of the component. In cases where a dynamic loading is critical dynamic load tests are equivalent to formal stress analysis. An example of components on which dynamic loading is usually critical is the landing gear and landing gear structure of an aircraft. (See CAM 3.174-2). The same yield criteria apply to dynamic tests as to static tests.

3.174-5 OPERATION TESTS. (CAA policies which apply to section 3.174, previously 3.203).

Operation tests of structural components are required for mechanisms and linkages in several of the Civil Air Regulations. For CAR 3 these are: CAR 3.343 "Control System" and CAR 3.358 "Landing Gear Retracting Mechanisms."

3.174-6 MATERIAL CORRECTION FACTORS, FITTING FACTORS, AND OTHER FACTORS; THEIR EFFECT ON TEST LOADS. (CAA policies which apply to section 3.174, previously 3.203).

(a) CAR 3 specifies certain factors which must be taken into account in establishing design and test loads for structural components. These factors are to be found in the following sections of CAR 3 and are discussed in sub-paragraphs (b) through (g):

(1) 3.172 Factor of Safety
(2) 3.301 Material Strength Properties and Design Values
(3) 3.304 Castings
(4) 3.305 Bearing Factors
(5) 3.318 Ribs
(6) 3.329 Hinges
(7) 3.346 Joints

(b) FACTOR OF SAFETY OF 1.50. In all cases of ultimate load testing the factor of safety of 1.50 should be included in the test load.

(c) MATERIAL CORRECTION FACTORS. (See CAM 3.174-1)

(d) FITTING FACTOR. The additional multiplying factor of safety of 1.15 specified in CAR 3.306 need not be included in test loads in which the actual stress conditions are simulated in the fitting and the surrounding structure. Also, these factors are considered to be included in and covered by the other special factors specified in CAR 3.302.

(e) CASTING FACTORS. Casting factors should be included in all tests in the substantiation of castings. (See CAM 3.304-1).

(f) HINGE AND BEARING FACTORS. Hinge and bearing factors specified shall be included in tests unless the appropriate portions of the parts are substantiated otherwise.

(g) OTHER FACTORS. Test factors for rib, wing, and wing-covering are as follows:

(1) No additional factors of safety need be applied when rational chordwise upper and lower surface pressure distribution is used, provided that the test includes a complete wing or a section of a wing with end conditions and loadings applied in a manner closely simulating the actual wing conditions.

(2) When a rib alone, a section of wing, or small section of the airplane covering is tested without employing a completely rational load analysis and distribution, a factor of 1.25 should be included in the test loads. In an intermediate case, a factor between 1.0 and 1.25 may be employed in wing section tests if it is suitably established that a reduction from 1.25 is warranted by the particular conditions of the test.

3.174-7 ESTABLISHMENT OF MATERIAL STRENGTH PROPERTIES AND DESIGN VALUES BY STATIC TEST. (CAA policies which apply to section 3.174, previously 3.203).

(a) There are several types of material design allowables, all of which are derived from test data. These are:

(1) Minimum acceptable values based on a minimum value already in an applicable materials procurement specification.

(2) Minimum non-specification values derived from tests of a series of standard specimens.

(3) Ninety percent probability values which are the lowest strength

values expected in 90% of the specimens tested.

(4) Values based on "premium selection" of the material.

(b) Where testing is used to determine any of these types of allowables, procedures outlined in existing Government or industry specifications, e.g. QQ-M-151, ASTM's, etc., should be used although other procedures if approved by the CAA, may be used. No clear-cut rules as to the extent of testing to be done can be established herein, as this usually varies with the case. It is therefore a matter for joint discussion between the manufacturer and the CAA. The results, however, should be based on a sufficiently large number of tests of the material to establish minimum acceptable or probability values on a statistical basis.

(c) Design values pertinent to the items in sub-paragraphs (a) (1), (2) and (3) are presented in ANC-5a and ANC-18 for commonly used materials.

(d) With reference to sub-paragraph (a) (4), some manufacturers have indicated a desire to use values greater than the established minimum acceptable values even in cases where only the use of minimum acceptable values is indicated. Such increases will be acceptable provided that specimens of each individual item of basic material as obtained are tested prior to use, to ascertain that the strength properties of that particular item will equal or exceed the properties to be used in design.

3.174-8 UNUSUAL TEST SITUATIONS. <u>(CAA policy which applies to section 3.174, previously 3.203)</u>.

It should be borne in mind that in any unusual or different situations a conference between the CAA and the manufacturer should be held to determine if the testing program as proposed by the manufacturer is sufficient to substantiate the structural strength of the aircraft or its component.

"CAR 3.188 Gust load factors. In applying the gust requirements, the gust load factors shall be computed by the following formula:

$$n = 1 + \frac{KUVm}{575\ (W/S)}$$

where: $K = \frac{1}{2}(W/S)^{1/4}$ (for $W/S < 16$ p. s. f.)

$= 1.33 - \frac{2.67}{(W/S)^{3/4}}$ (for $W/S > 16$ p. s. f.)

U = nominal gust velocity, f. p. s. (Note that the 'effective sharp-edged gust' equals KU.)

V = airplane speed, m. p. h.

m = slope of lift curve, C_L per radian, corrected for aspect ratio.

W/S = wing loading, p. s. f.

3.188-1 SLOPE OF LIFT CURVE. (CAA interpretation which applies to section 3.188, previously 3.21120).

For purposes of gust load computations as required in CAR 3.188, the slope of the lift curve may be assumed equal to that of the wing alone.

"FLAPS EXTENDED FLIGHT CONDITIONS"

"CAR 3.190 Flaps extended flight conditions. (a) When flaps or similar high lift devices intended for use at the relatively low air speeds of approach, landing, and take-off are installed, the airplane shall be assumed to be subjected to symmetrical maneuvers and gusts with the flaps fully deflected at the design flap speed V_f resulting in limit load factors within the range determined by the following conditions:

"(1) Maneuvering, to a positive limit load factor of 2.0.

"(2) Positive and negative 15-feet-per-second gusts acting normal to the flight path in level flight. The gust load factors shall be computed by the formula of section 3.188.

"V_f shall be assumed not less than 1.4 V_s or 1.8 V_{sf}, whichever is greater, where

V_s = the computed stalling speed with flaps fully retracted at the design weight

V_{sf} = the computed stalling speed with flaps fully extended at the design weight

except that when an automatic flap load limiting device is employed, the airplane may be designed for critical combinations of air speed and flap position permitted by the device. (See also section 3.338.)

"(b) In designing the flaps and supporting structure, slipstream effects shall be taken into account as specified in section 3.223.

"Note: In determining the external loads on the airplane as a whole, the thrust, slipstream, and pitching acceleration may be assumed equal to zero."

3.190-1 DESIGN FLAP SPEED V_f. (CAA interpretations which apply to section 3.190 (a), previously 3.212).

(a) The minimum permissible speed of 1.8 V_{sf} is specified in order to cover power-off flight tests as required by CAR 3.315 (a). CAR 3.223 requires that slipstream effects be considered in the design of the flaps and operating mechanism up to a speed of at least 1.4 V_s in order to cover the power on flight tests of CAR 3.109 (b) (5).

(b) The designer may treat the foregoing conditions as two separate cases, or he may combine them if he so desires.

"UNSYMMETRICAL FLIGHT CONDITIONS"

"CAR 3.191 Unsymmetrical flight conditions. The airplane shall be assumed to be subjected to rolling and yawing maneuvers as described in the following conditions. Unbalanced aerodynamic moments about the center of gravity shall be reacted in a rational or conservative manner considering the principal masses furnishing the reacting inertia forces.

"(a) Rolling conditions. The airplane shall be designed for (1) unsymmetrical wing loads appropriate to the category, and (2) the loads resulting from the aileron deflections and speeds specified in section 3.222, in combination with an airplane load factor of at least two-thirds of the positive maneuvering factor used in the design of the airplane. Only the wing and wing bracing need be investigated for this condition.

"(b) Yawing conditions. The airplane shall be designed for the yawing loads resulting from the vertical surface loads specified in sections 3.219 to 3.221.

"Note: These conditions may be covered as noted below:

"(a) Rolling accelerations may be obtained by modifying the symmetrical flight conditions shown in Figure 3-1 as follows:

"(1) Acrobatic category. In conditions A and F assume 100 percent of the wing air load acting on one side of the plane of symmetry and 60 percent on the other.

"(2) Normal and utility categories. In condition A, assume 100 percent of the wing air load acting on one side of the airplane and 70 percent on the other. For airplanes over 1,000 pounds design weight, the latter percentage may be increased linearly with weight up to 80 percent at 25,000 pounds.

"(b) The effect of aileron displacement on wing torsion may be accounted for by adding the following increment to the basic airfoil moment coefficient over the aileron portion of the span in the critical condition as determined by the note under section 3.222:

$$\Delta_{cm} = -.01\,\delta$$

where:

Δ_{cm} = moment coefficient increment

δ = down aileron deflection in degrees in critical condition"

3.191-1 AILERON ROLLING CONDITIONS. (CAA policies which apply to section 3.191 (a), previously 3.2131).

In determining whether airplanes of small to medium size and speed comply with CAR 3.191 (a), the Administrator will accept the following simplified procedure may be used:

(a) STEADY ROLL. Determine the C_n value, corresponding to 2/3 the symmetrical maneuvering load factor. The C_n distribution over the span may be assumed the same as that for the symmetrical flight conditions. Modify the wing moment coefficient over the aileron portions of the span, as described in the "Note" under CAR 3.191 (a), corresponding to the required aileron deflections. The wing may be critical in torsion on the up, as well as on the down aileron side, depending upon airfoil section, elastic axis location, aileron differential, etc. (For the up aileron, the moment coefficient increment will be positive.)

The above assumption concerning C_n distribution implies that the aerodynamic damping forces have exactly the same distribution as the rolling forces, which is not strictly correct. However, since the load factor in the rolling conditions is only 2/3 of that in the symmetrical conditions, the errors involved in this assumption are not likely to be significant.

(b) MAXIMUM ANGULAR ACCELERATION. This condition need be investigated only for wings carrying large mass items outboard. In such cases instantaneous aileron deflection (zero rolling velocity) may be assumed and the local value of C_n and C_m over the aileron portions of the span modified accordingly to obtain the spanwise airload distribution. The average C_n of the entire wing should correspond to 2/3 of the symmetrical maneuvering load factor. The resulting rolling moment should be resisted by the rolling inertia of the entire airplane. This procedure is, in general, conservative, and a more rational investigation based on the time history of the control movement and response of the airplane may be used if desired.

"CONTROL SURFACE LOADS"

"CAR 3.211 General. The control surface loads specified in the following sections shall be assumed to occur in the symmetrical and unsymmetrical flight conditions as described in sections 3.189-3.191. See Figures 3-3 to 3-10 for acceptable values of control surface loadings which are considered as conforming to the following detailed rational requirements."

3.211-1 CONTROL SURFACE LOADS FOR DESIGN OF "VEE" TYPE TAIL ASSEMBLIES. (CAA policies which apply to section 3.211, previously 3.220).

(a) "Vee" type tail assemblies require special design criteria in order to show "the same level of safety" under CAR 3.1. Thus, for "Vee" type tail assemblies, all the tail load requirements as set forth in CAR 3 are considered acceptable to this type tail design. It will be necessary, however, to increase the unit loads on each side of the tail surface to account for the tail surface dihedral, since air loads act normal to the surface only. Thus the unit loads, based on the projected area, on each side of the tail surface due to vertical loads on the tail assembly should be increased by a factor equal to $1/\cos \theta$, while the unit horizontal loads on the tail assembly should be increased by a factor equal to $1/\sin \theta$, where θ is the dihedral angle, or the angle between each side of the tail surface and the horizontal.

(b) The following supplementary conditions should also be investigated:

(1) A ± 30 fps gust, acting normal to the chord plane of one side of the tail surface at V_c, should be combined with a one "g" balancing tail load. Reduction for downwash is acceptable. It is evident that this condition will be unsymmetrical, since one side of the "Vee" tail will not be highly loaded by the gust.

(2) COMBINED RUDDER AND ELEVATOR MANEUVERING CONDITION.

(i) In order to obtain the full one way travel of the ruddervator, it is desirable to have full elevator travel in conjunction with full rudder travel. The limiting factor for this configuration is 2/3 elevator load for one pilot, and 2/3 rudder load for one pilot applied simultaneously.

(ii) When it can be shown that the lateral gust condition (reference: CAR 3.220) is less critical than the condition in sub-paragraph (b) (1), no analysis for the lateral gust need be made.

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"CAR 3.212 Pilot effort. In the control surface loading conditions described, the airloads on the movable surfaces and the corresponding deflections need not exceed those which could be obtained in flight by employing the maximum pilot control forces specified in Figure 3-11. In applying this criterion, proper consideration shall be given to the effects of control system boost and servo mechanisms, tabs, and automatic pilot systems in assisting the pilot."

3.212-1 AUTOMATIC PILOT SYSTEMS. (CAA policies which apply to section 3.212, previously 3.2201).

The Administrator will accept the following as giving proper consideration of automatic pilot systems in assisting the pilot under CAR 3.212: The autopilot effort need not be added to human pilot effort, but the autopilot effort should be used for design if it alone can produce greater control surface loads than the human pilot.

"CAR 3.216 <u>Maneuvering loads</u>. (a) At maneuvering speed V_p assume a sudden deflection of the elevator control to the maximum upward deflection as limited by the control stops or pilot effort, whichever is critical.

"Note: The average loading of Figure 3-3 and the distribution of Figure 3-8 may be used. In determining the resultant normal force coefficient for the tail under these conditions, it will be permissible to assume that the angle of attack of the stabilizer with respect to the resultant direction of air flow is equal to that which occurs when the airplane is in steady unaccelerated flight at a flight speed equal to V_p.

The maximum elevator deflection can then be determined from the above criteria and the tail normal force coefficient can be obtained from the data given in NACA Report No. 688, 'Aerodynamic Characteristics of Horizontal Tail Surfaces,' or other applicable NACA reports.

"(b) Same as case (a) except that the elevator deflection is downward.

"Note: The average loading of Figure 3-3 and the distribution of Figure 3-8 may be used.

"(c) At all speeds above V_p the horizontal tail shall be designed for the maneuvering loads resulting from a sudden upward deflection of the elevator, followed by a downward deflection of the elevator such that the following combinations of normal acceleration and angular acceleration are obtained:

Condition	Airplane normal accelera-tion n	Angular accleration radian/sec.
Down load	1.0	$+ \frac{45}{V} n_m (n_m - 1.5)$
Up load	n_m	$- \frac{45}{V} n_m (n_m - 1.5)$

where:

n_m = positive limit maneuvering load factor used in the design of the airplane.

V = initial speed in miles per hour.

"(d) The total tail load for the conditions specified in (c) shall be the sum of: (1) The balancing tail load corresponding with the condition at speed V and the specified value of the normal load factor n, plus (2) the maneuvering load increment due to the specified value of the angular acceleration.

"Note: The maneuvering load increment of Figure 3-4 and the distributions of Figure 3-8 (for downloads) and Figure 3-9 (for uploads) may be used. These distributions apply to the total tail load."

3.216-1 TIME HISTORIES OF PULL-UP MANEUVERS. <u>(CAA policies which apply to section 3.216, previously 3.2212)</u>.

See Figure 1 on next page.

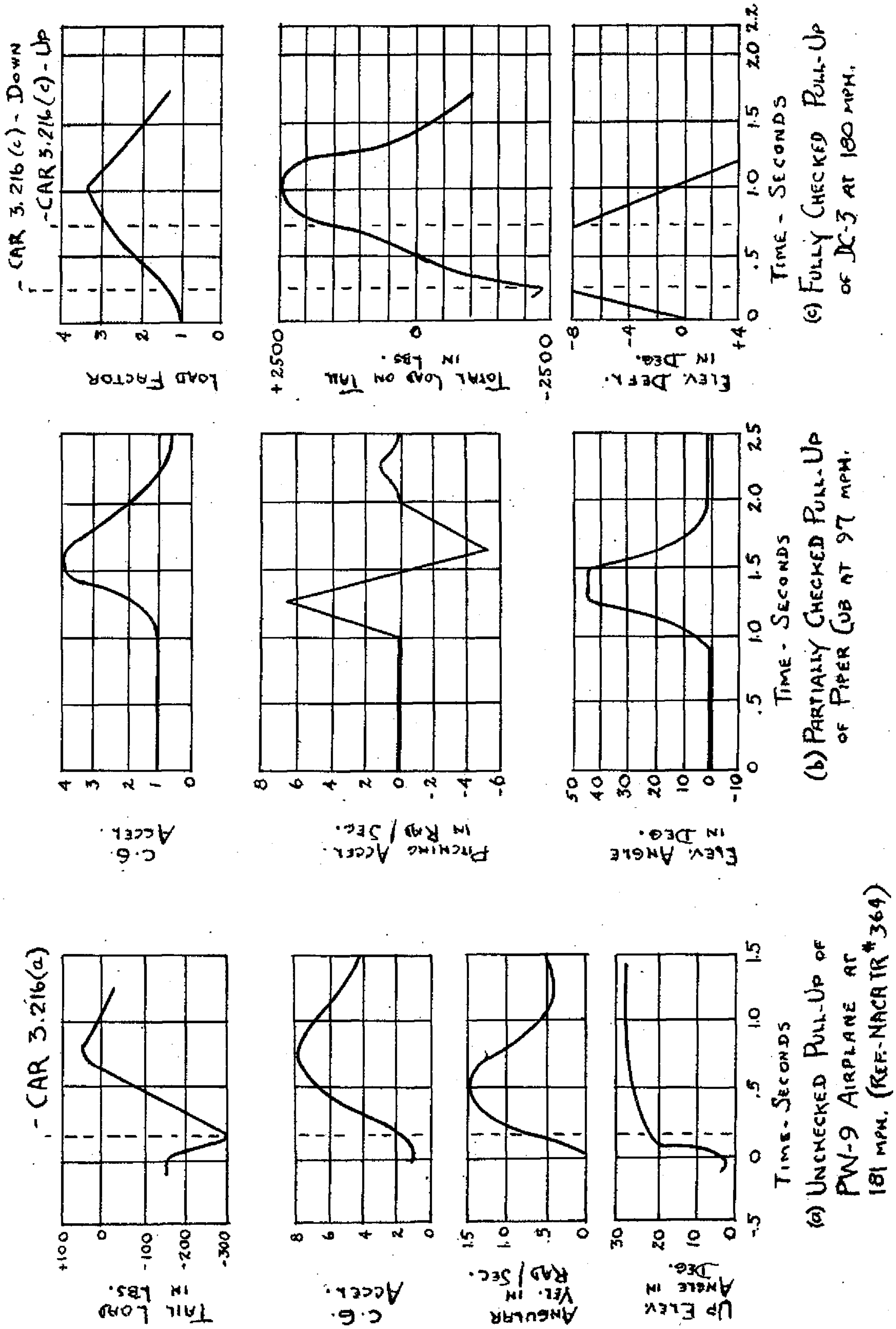

FIG. 1- TIME HISTORIES OF PULL-UP MANEUVERS

3.216-2 UNCHECKED PULL-UP MANEUVER. <u>(CAA policies which apply to section 3.216 (a), previously 3.2212 (a))</u>.

(a) The condition given in CAR 3.216 (a) represents what may occur in an "unchecked" pull-up maneuver. The basic assumption is that while the airplane is flying in steady level flight at the speed V_p, the pilot suddenly pulls the elevator control back and holds it in the full back position.

(1) An example of the time history of a typical case of an uncheck pull-up maneuver is shown in Figure 1 (a) (see CAM 3.216-1). It will be noted from this figure that approximately full elevator deflection was applied in roughly 0.1 second and that the elevator was held in the full up position until after the peak c.g. acceleration was obtained. It will also be noted that the <u>maximum down tail load</u> was attained before the airplane had a chance to pitch appreciably since the c.g. acceleration corresponding to maximum down tail load was approximately 1.5.

(2) This condition is intended to represent the condition obtained at the <u>instant</u> of maximum down tail load in an unchecked pull-up as shown on the Figure 1 (a) (see CAM 3.216-1) at the time of approximately 0.15 seconds.

(b) For purposes of simplifying analysis procedure the download applied to the horizontal tail surface may be carried forward to the wing attachment points, assuming that the fuselage load factor is equal to zero. The moment at the wing due to the above described loads need not be balanced out as a couple at the wing attachment points. However, the linear and angular inertia forces may be taken into account if desired.

.3.216-3 UNCHECKED PUSH-DOWN MANEUVERING LOAD. <u>(CAA policy which applies to section 3.216 (b), previously 3.2212 (b))</u>.

The condition given in CAR 3.216 (b) represents an "unchecked" push-down and is identical to CAR 3.216 (a) in principle, except that sudden application of full forward stick is assumed. To simplify the analysis the up load applied to the horizontal tail surfaces may be carried through the attachment of the horizontal tail surfaces to the fuselage, and local fuselage members. No other structure need be investigated for this condition.

3.216-4 CHECKED MANEUVERING LOAD CONDITION. <u>(CAA policies which apply to section 3.216 (c), previously 3.2212 (c))</u>.

(a) The condition given in CAR 3.216 (c) involves a down load and upload corresponding to what may occur in a "checked maneuver."

(b) A "checked maneuver" is defined as one in which the pitching control is suddenly displaced in one direction and then suddenly moved in the opposite direction, the deflections and timing being such as to avoid exceeding the limit maneuvering load factor.

(c) A typical case of a fully checked pull-up maneuver is shown for the DC-3 airplane in Figure 1 (c) (see CAM 3.216-1). This figure will be briefly reviewed as it contains all of the information essential to explaining the down load and up load cases required by CAR 3.216 (c).

(1) It will be noted that 8 degrees of up elevator was obtained in approximately .2 second. This .2 second time is the time at which the critical down load case occurs. It will be noted that a maximum down tail load of approximately 2500 pounds is obtained at this point; further, that the airplane load factor is only slightly over 1 g. (The requirements specify a load factor of 1.0 for simplicity.) As time increases, it will be noted that the load factor begins to build up but that, when the load factor had been built up to approximately 2.7 g, the pilot started to push forward rapidly on the elevator control. This pushing forward is called "checking" and at speeds above the maneuvering speed such "checking" is required in order to prevent the airplane from exceeding the limit maneuvering factor. It will be noted that at the end of one second, the elevator has been completely "checked" back to zero deflection and that the maximum up tail load was obtained at this point concurrent with the maximum load factor of 3.2 g. The condition occurring at this time (1.0 second) represents the critical up tail load condition of CAR 3.216 (c).

3.216-5 PRINCIPLES APPLICABLE TO DETAILED ANALYSIS OF CONDITIONS GIVEN IN CAR 3.216. (CAA policies which apply to section 3.216, previously 3.2212).

(a) The basic principles underlying detailed analysis for the conditions covered in CAR 3.216 (a), (b) and (c) are described below:

(1) For the down load case, a normal acceleration of 1.0 is specified, concurrent with a specified positive value of angular acceleration. The forces acting on the airplane should therefore satisfy the following conditions:

(i) The algebraic sum of the upload on the wing and down load on the tail should equal the weight of the airplane. (For analysis purposes, a reasonable approximation to this condition is satisfactory.)

(ii) The summation of wing, fuselage and tail moments about the center of gravity of the airplane should be equal to the pitching moment of inertia of the airplane multiplied by the specified angular acceleration.

(2) The analysis of the upload condition may be carried out in the same manner, except that "n_m" times the weight of the airplane is used in paragraph (a) (1) (i).

(b) In all of the conditions covered in CAR 3.216 (c), the thrust may be assumed zero for simplicity. There are many computation procedures by which these conditions can be satisfied. An example of a typical method is that given in Navy Specification SS-1A. In Figure 3-4 of CAR 3, the maneuvering tail load increment has been based on average values of the ratio of airplane pitching inertia to overall length.

(c) Conditions specified by this requirement are likely to be critical only at speeds V_p and V_d. Investigation has shown that at V_p the specified down load condition is adequately taken care of by CAR 3.216 (a) and that the specified upload condition is adequately taken care of by CAR 3.216 (b). For these reasons, the conditions of CAR 3.216 (c) need not be investigated at the speed V_p.

3.216-6 MANEUVERING CONTROL SURFACE LOADING FIGURE 3-3 (b) IN PART 3. (CAA policies which apply to section 3.216, previously 3.2212).

(a) The curves on Figure 3-3 (b) in CAR 3 were derived as follows:

(1) The three curves A, B and C of Figure 3-3 (b) of CAR 3 giving control surfaces loading vs. W/S correspond to normal force coefficients of 0.80, 0.70 and 0.55 respectively. These curves represent psf loading obtained with the above normal force coefficients acting at a design speed of V_p based on the assumption of $C_{L_{max}}$ equals 1.5.

(2) The basic computations for these curves were as follows:

$$V_p = V_s \sqrt{n}$$

$$q_p = .00256\ V_p^2 = .00256\ n\ V_s^2$$

$$V_s^2 = \frac{W/S}{.00256\ C_{L_{max}}}$$

$$q_p = \frac{n\ (W/S)}{C_{L_{max}}} = \frac{n(W/S)}{1.5}$$

$$\bar{w} = C_n\ q_p = \frac{C_n}{1.5}\ n(W/S)$$

$$4.4\ \bar{w} = \frac{4.4.\ C_n}{1.5}\ (W/S)$$

(3) These curves are all straight line curves and can be extended as straight lines to give the correct pounds per square foot loadings on the surface on the same basis as given above.

"CAR 3.217 Gust loads. The horizontal tail surfaces shall be designed for loads occurring in the following conditions:

"(a) Positive and negative gusts of 30 feet per second nominal intensity at speed V_c, corresponding to flight condition section 3.187 (a) with flaps retracted.

"Note: The average loadings of Figures 3-5 (a) and 3-5 (b) and the distribution of Figure 3-9 may be used for the total tail loading in this condition.

"(b) Positive and negative gusts of 15 feet per second nominal intensity at speed V_t, corresponding to flight condition section 3.190 (b) with flaps extended. In determining the total load on the horizontal tail for these conditions, the initial balancing tail loads shall first be determined for steady unaccelerated flight at the pertinent design speeds V_c and V_t. The incremental tail load resulting from the gust shall then be added to the initial balancing tail load to obtain the total tail load.

"Note: The incremental tail load due to the gust may be computed by the following formula:

$$\Delta t = 0.1\ KUVS_t a_t \left[1 - \frac{36a_w}{R_w}\right]$$

where:

Δt = the limit gust load increment on the tail in pounds,

K = gust coefficient K in section 3.188,

U = nominal gust intensity in feet per second,

V = airplane speed in miles per hour,

S_t = tail surface area in square feet,

a_t = slope of lift curve of tail surface, C_L per degree, corrected for aspect ratio,

a_w = slope of lift curve of wing, C_L per degree,

R_w = aspect ratio of the wing."

"VERTICAL TAIL SURFACES"

"CAR 3.219 Maneuvering loads. At all speeds up to V_p:

"(a) With the airplane in unaccelerated flight at zero yaw, a sudden displacement of the rudder control to the maximum deflection as limited by the control stops or pilot effort, whichever is critical, shall be assumed.

"Note: The average loading of Figure 3-3 and the distribution of Figure 3-8 may be used.

"(b) The airplane shall be assumed to be yawed to a sideslip angle of 15 degrees while the rudder control is maintained at full deflection (except as limited by pilot effort) in the direction tending to increase the sideslip.

"Note: The average loading of Figure 3-3 and the distribution of Figure 3-7 may be used.

"(c) The airplane shall be assumed to be yawed to a sideslip angle of 15 degrees while the rudder control is maintained in the neutral position (except as limited by pilot effort). The assumed sideslip angles may be reduced if it is shown that the value chosen for a particular speed cannot be exceeded in the cases of steady slips, uncoordinated rolls from a steep bank, and sudden failure of the critical engine with delayed corrective action.

"Note: The average loading of Figure 3-3 and the distribution of Figure 3-9 may be used."

3.219-1 VERTICAL SURFACE MANEUVERING LOADS. (CAA policy which applies to section 3.219, previously 3.2221).

The specified maneuvering loads may be applied to the vertical surfaces and carried through the fuselage structure to the wing attachment points, assuming the lateral inertia load factor along the fuselage structure as zero. The wing drag bracing through the fuselage should be analyzed for this condition since the wings will furnish a large part of the resisting angular inertia. Angular inertia forces on the fuselage may be included if desired.

"CAR 3.220 Gust loads. (a) The airplane shall be assumed to encounter a gust of 30 feet per second nominal intensity, normal to the plane of symmetry while in unaccelerated flight at speed V_c.

"(b) The gust loading shall be computed by the following formula:

$$\bar{w} = \frac{KUVm}{575}$$

where:

$\bar{w}$ = average limit unit pressure in pounds per square foot,

$K = 1.33 - \frac{4.5}{(W/S_v)^{3/4}}$, except that K shall not be less than 1.0. A value of K obtained by rational determination may be used.

U = nominal gust intensity in feet per second,

V = airplane speed in miles per hour,

m = slope of lift curve of vertical surface, C_L per radian, corrected for aspect ratio,

W = design weight in pounds,

S_v = vertical surface area in square feet.

"(c) This loading applies only to that portion of the vertical surfaces having a well-defined leading edge.

"Note: The average loading of Figure 3-6 and the distribution of Figure 3-9 may be used."

3.220-1 GUST LOADS - VERTICAL TAIL SURFACES (CAA policies which apply to section 3.220, previously 3.2222).

The K factor specified in CAR 3.220 was derived from the K factor for vertical gusts (CAR 3.188) on the assumption that the effective area of the airplane for lateral gusts is twice the vertical surface area. Substituting $2S_v$ in place of S in the formula of CAR 3.188, we obtain:

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$$K = 1.33 - \frac{2.67}{\left(\frac{W}{2S_v}\right)^{3/4}}$$

$$= 1.33 - \frac{4.50}{\left(\frac{W}{S_v}\right)^{3/4}}$$

(b) The specified gust loads may be applied to the vertical surfaces and carried through the fuselage structure to the wing attachment points as described in CAM 3.219-1.

"CAR 3.223 Wing flaps. Wing flaps, their operating mechanism, and supporting structure shall be designed for critical loads occurring in the flap-extended flight conditions (see section 3.190) with the flaps extended to any position from fully retracted to fully extended; except that when an automatic flap load limiting device is employed these parts may be designed for critical combinations of air speed and flap position permitted by the device. (Also see sections 3.338 and 3.339.) The effects of propeller slipstream corresponding to take-off power shall be taken into account at an airplane speed of not less than 1.4 V_s where V_s is the computed stalling speed with flaps fully retracted at the design weight. For investigation of the slipstream condition, the airplane load factor may be assumed to be 1.0."

3.223-1 WING FLAP LOAD DISTRIBUTION. (CAA policies which apply to section 3.223, previously 3.224).

A trapezoidal chord load distribution with the leading edge twice the trailing edge loading is acceptable. (Note that these loadings apply in the up direction only; however, it is recommended that the supporting structure also be designed to withstand a down load equal to 25% of the up load.)

"CAR 3.224 Tabs. Control surface tabs shall be designed for the most severe combination of air speed and tab deflection likely to be obtained within the limit V-n diagram (Fig. 3-1) for any usable loading condition of the airplane."

3.224-1 TRIM TAB DESIGN. (CAA policies which apply to section 3.224, previously 3.225).

(a) To provide ruggedness and for emergency use of tabs, it is recommended that trim tabs, their attachments and actuating mechanism be designed for loads corresponding to full tab deflection at speed V_c with main surface neutral; except that the tab deflection need not exceed that which would produce a hinge moment on the main surface corresponding to maximum pilot effort.

(b) A trapezoidal chord load distribution with the loading of the leading edge twice that of the trailing edge is acceptable.

"CONTROL SYSTEM LOADS"

"CAR 3.231 Primary flight controls and systems. (a) Flight control systems and supporting structures shall be designed for loads corresponding to 125 percent of the computed hinge moments of the movable control surface in the conditions prescribed in sections 3.211 to 3.225, subject to the following maxima and minima:

"(1) The system limit loads need not exceed those which can be produced by the pilot and automatic devices operating the controls.

"(2) The loads shall in any case be sufficient to provide a rugged system for service use, including consideration of jamming, ground gusts, taxiing tail to wind, control inertia, and friction.

"(b) Acceptable maximum and minimum pilot loads for elevator, aileron, and rudder controls are shown in Figure 3-11. These pilot loads shall be assumed to act at the appropriate control grips or pads in a manner simulating flight conditions and to be reacted at the attachments of the control system to the control surface horn."

3.231-1 HINGE MOMENTS. (CAA policies which apply to section 3.231 (a), previously 3.230 (a)).

The 125% factor on computed hinge moments provided in CAR 3.231 (a) need be applied only to elevator, aileron and rudder systems. A factor as low as 1.0 may be used when hinge moments are based on test data; however, the exact reduction will depend to an extent upon the accuracy and reliability of the data. Small scale wind tunnel data are generally not reliable enough to warrant elimination of the factor. If accurate flight test data are used, the factor may be reduced to 1.0.

3.231-2 SYSTEM LIMIT LOADS. (CAA policies which apply to section 3.231 (a) (1), previously 3.230 (a)).

(a) When the autopilot is acting in conjunction with the human pilot, the autopilot effort need not be added to human pilot effort, but the autopilot effort should be used for design if it alone can produce greater control system loads than the human pilot.

(b) When the human pilot acts in opposition to the autopilot, that portion of the system between them should be designed for the maximum effort of human pilot or autopilot, whichever is the lesser.

3.231-3 INTERCONNECTED CONTROL SYSTEMS ON TWO CONTROL AIRPLANES. (CAA policies which apply to section 3.231, previously 3.230).

(a) With respect to interconnected control systems such as in two control airplanes, the following is recommended in showing the "same level of safety" specified in CAR 3.1.

(1) If, in the case of two or more interconnected control systems, the control wheel or stick forces due to combined control system loads resulting from air loads on the control surfaces are less than the minimum prescribed in Figure 3-11 of CAR 3, each control system from the interconnection to the control surface should be designed for minimum pilot effort on the control wheel or stick in order that sufficient ruggedness be incorporated into the system.

(2) If the control wheel or stick forces due to combined control system loads resulting from air loads on the control surfaces are in excess of the maximum forces prescribed in Figure 3-11 of CAR 3, it is considered permissible to divide the maximum pilot effort loads in the control systems from the point of interconnection to the control surfaces in proportion to the control surface air loads. However, the load in each such control system should be increased 25% to allow for any error in the determination of the control surface loads, but in no case need the resulting loads in any one system exceed the total pilot effort, if the pilot effort were applied to that system alone. In any case, the minimum load in any one system should be no less than that specified in paragraph (1).

"CAR 3.233 Ground gust conditions. (a) The following ground gust conditions shall be investigated in cases where a deviation from the specific values for minimum control forces listed in Figure 3-11 is applicable. The following conditions are intended to simulate the loadings on control surfaces due to ground gusts and when taxiing with the wind.

"(b) The limit hinge moment H shall be obtained from the following formula:

$$H = KcSq$$

where:

H = limit hinge moment (foot-pounds).

c = mean chord of the control surface aft of the hinge line (feet).

S = area of control surface aft of the hinge line (square feet).

q = dynamic pressure (pounds) per square foot) to be based on a design speed not less than $10\sqrt{W/S}$ +10 miles per hour, except that the design speed need not exceed 60 miles per hour.

K = factor as specified below:

(a) Aileron	0.75
Control column locked or lashed in mid-position.	
(b) Aileron	0.50
Ailerons at full throw; +moment on one aileron, - moment on the other.	
(c) (d) Elevator	0.75
Elevator (c) full up (-), and (d) full down (+).	
(e) (f) Rudder	0.75
Rudder (e) in neutral, and (f) at full throw.	

"(c) As used in paragraph (b) in connection with ailerons and elevators, a positive value of K indicates a moment tending to depress the surface while a negative value of K indicates a moment tending to raise the surface."

3.233-1 GROUND GUST LOADS. (CAA policies which apply to section 3.233, previously 3.231).

CAR 3.233 requires ground gust loads to be investigated when a reduction in minimum pilot effort loads is desired. In such cases the entire system should be investigated for ground gust loads. However, in instances where the designer desires to investigate ground gust loads without intending to reduce pilot effort loads, the ground gust load need be carried only from the control surface horn to the nearest stops or gust locks, including the stops or locks and their supporting structures.

"GROUND LOADS"

"CAR 3.241 Ground loads. The loads specified in the following conditions shall be considered as the external loads and inertia forces which would occur in an airplane structure if it were acting as a rigid body. In each of the ground load conditions specified the external reactions shall be placed in equilibrium with the linear and angular inertia forces in a rational or conservative manner."

3.241-1 FOUR WHEEL TYPE ALIGHTING GEARS. (CAA policies which apply to section 3.241, previously 3.24).

At present, little operational data or other information are available on which to base requirements for airplanes equipped with four wheel type alighting gears. The following is suggested for applying the requirements of CAR 3 to aircraft equipped with four wheel type alighting gears.

(a) The provisions of CAR 3.241 through 3.256, except for the following, should be considered applicable: CAR 3.245 (a), CAR 3.246 (a), and CAR 3.250 through 3.252.

(b) The conditions as specified in CAR 3.245 (b) (2), CAR 3.246 (b), CAR 3.247 and CAR 3.249 should be considered applicable to four wheel type gear without modification, the rear wheels being considered the main gear.

(c) The landing conditions specified in CAR 3.245 (b) (1) should be modified by dividing the total required load on the forward gear between the two wheels, 60% to one wheel and 40% to the other.

(d) The requirements of CAR 3.253 should be modified by applying the required loads simultaneously to the two front wheels, 120% to one wheel and 80% to the other. (Note that this gives a 80% - 40% distribution of the total load on the front gear.)

(e) It is believed that the method of applying CAR 3 requirements for single nose wheel type alighting gear to four wheel type alighting gear should result in a satisfactory design. It is suggested, however, that sufficient landing and taxiing tests be conducted to determine the suitability of the landing gear design and configuration. Since higher speed turns should be possible with a four wheel aircraft than with one having a conventional tricycle gear, it is believed that provision should be made to include high speed turns in the taxiing test programs of all four wheel aircraft.

(f) If an aircraft with four wheel type alighting gear is also designed for roadibility, i.e. for use as an automobile, which is usually the case, the design of the alighting gear in accordance with applicable motor vehicle design requirements is acceptable, provided it can be shown that these requirements fully cover the airworthiness requirements of the Civil Air Regulations.

"LANDING CASES AND ATTITUDES"

"CAR 3.244 Landing cases and attitudes. For conventional arrangements of main and nose, or main and tail wheels, the airplane shall be assumed to contact the ground at the specified limit vertical velocity in the attitudes described in sections 3.245-3.247. (See Figs. 3-12 (a) and 3-12 (b) for acceptable landing conditions which are considered to conform with sections 3.245-3.247.)"

3.244-1 LANDING CASES AND ATTITUDES. (CAA policy which applies to section 3.244, previously 3.242).

The supporting structure as well as the landing gear itself should be capable of withstanding the loads occurring at the critical extension of the shock struts in accordance with Note (2) of Figure 3-12 (a).

"CAR 3.245 Level landing. (a) Tail wheel type. Normal level flight attitude.

"(b) Nose wheel type. Two cases shall be considered:

"(1) Nose and main wheels contacting the ground simultaneously,

"(2) Main wheels contacting the ground, nose wheel just clear of the ground. (The angular attitude may be assumed the same as in subparagraph (1) of this paragraph for purposes of analysis.)

"(c) Drag components. In this condition, drag components simulating the forces required to accelerate the tires and wheels up to the landing speed shall be properly combined with the corresponding instantaneous vertical ground reactions. The wheel spin-up drag loads may be based on vertical ground reactions, assuming wing lift and a tire-sliding coefficient of friction of 0.8, but in any case the drag loads shall not be less than 25 percent of the maximum vertical ground reactions neglecting wing lift."

3.245-1 WHEEL SPIN-UP LOADS. (CAA policies which apply to section 3.245, previously 3.2421).

(a) CAR 3.245 requires that spin-up loads be taken into account in structural designs. CAR 3.244 permits the use of arbitrary drag loads for this purpose.

(b) If it is desired to use a method more rational than the arbitrary drag components referred to in CAR 3.244 in determining the wheel spin-up loads for landing conditions, the following method from NACA T.N. 863 may be employed. However, the minimum drag component of 0.25 times the vertical component should still apply.

$$F_{H_{max}} = \frac{1}{r_e}\sqrt{\frac{2I_w \ (V_H - V_c)\mu F_{V_{max}}}{t_z}}$$

where:

$F_{H_{max}}$ = maximum rearward horizontal force acting on the wheel (pounds).

r_e = effective rolling radius of wheel (feet) under impact, based on recommended operating tire pressure (may be assumed equal to the rolling radius under a static load of $n_j W_e$).

I_w = rotational mass moment of inertia of rolling assembly (slug-feet squared).

V_H = linear velocity of airplane parallel to ground at instant of contact, assumed 1.2 V_{s_o}, in feet per second.

V_c = peripheral speed of tire if pre-rotation is used (feet per second). A positive means of pre-rotation should be provided before pre-rotation can be considered.

μ = effective coefficient of friction; 0.80 is acceptable.

$F_{V_{max}}$ = maximum vertical force on wheel (pounds) = $n_j W_e$, where W_e and n_j are defined in CAR 3.353 and 3.354.

t_z = time interval between ground contact and attainment of maximum vertical force on wheel (seconds).

If the value of $F_{H_{max}}$ from the above equation exceeds 0.8 $F_{V_{max}}$, the latter value should be used for $F_{H_{max}}$.

Note: This equation assumes a linear variation of load factor with time until the peak load is reached and under this assumption determines the drag force at the time that the wheel peripheral velocity at radius r_e equals the airplane velocity. Most shock absorbers do not exactly follow a linear variation of load factor with time. Hence, rational or conservative allowances should be made to compensate for these variations. On most landing gears the time for wheel spin-up will be less than the time required to develop maximum vertical load factor for the specified rate of descent and forward velocity. However, for exceptionally large wheels, a wheel peripheral velocity equal to the ground speed may not have been attained at time of maximum vertical gear load. This case is covered by the statement above that the drag spin-up load need not exceed 0.8 of the maximum vertical load.

(c) Dynamic spring back of the landing gear and adjacent structure at the instant just after the wheels come up to speed may result in dynamic forward acting loads of considerable magnitude. This effect may be simulated in the level landing condition by assuming that the wheel spin-up loads are reversed. Dynamic spring back is likely to be critical only for landing gear units having wheels of large mass supported by relatively flexible cantilever struts.

(d) The arbitrary drag loads referred to in CAR 3.244 (Fig. 3-12) are usually sufficient to provide for wheel spin-up except for airplanes having large diameter wheels or high stalling speeds. For the latter, it is recommended that a more rational investigation, such as that described above, be made.

3.245-2 LEVEL LANDING INCLINED REACTION RESULTANT. (CAA policy which applies to section 3.245, previously 3.2421).

In Figure 3-12 (b) the level landing inclined reaction resultant for both tail wheel and nose wheel type landing gears is assumed to pass through the wheel axles.

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"SKIPLANES"

"CAR 3.257 Supplementary conditions for skiplanes. The airplane shall be assumed resting on the ground with one main ski frozen in the snow and the other main ski and the tail ski free to slide. A limit side force equal to P/3 shall be applied at the most convenient point near the tail assembly, where P is the static ground reaction on the tail ski. For this condition the factor of safety shall be assumed equal to 1.0."

3.257-1 TYPE CERTIFICATION OF SKIS. (CAA policy which applies to section 3.257, previously 3.246).

Type certification of skis is not contingent upon compliance with CAR 3.257 which applies to skiplanes only.

3.257-2 SUPPLEMENTARY CONDITIONS FOR SKIPLANES. (CAA policies which apply to section 3.257, previously 3.246).

(a) The following material outlines acceptable supplementary structural conditions for skiplanes with a tricycle type gear, in order to show "the same level of safety" under CAR 3.1.

(1) To provide adequate strength for normal landing, taxiing and ground handling conditions for skiplanes equipped with a tricycle gear, a limit torque equal to 0.667 W foot pounds should be separately applied about the vertical axis through the centerline of each main pedestal bearing of each main gear, W being the maximum design weight of the airplane in pounds.

(2) For the nose gear, a limit torque equal to 1.333 WK foot pounds should be separately applied about the vertical axis through the centerline of the nose gear pedestal bearing, where K is the ratio of the nose gear ground reaction (total of both sides), as determined from CAR 3.245 (b) (1), proper account being taken of the increase of load on the nose gear due to pitching of the airplane.

(3) In the case of a steerable nose gear, the limit torque on the nose gear need not exceed the pilot effort.

(b) An ultimate factor of safety of 1.5 should be applied to the limit torques specified in paragraphs (a) (1), (2) and (3).

3.257-3 FACTOR OF SAFETY OF 1.0. (CAA policy which applies to section 3.257, previously 3.246).

(a) The load P/3 in CAR 3.257 is considered an ultimate loading. Therefore the factor of 1.0 is considered an ultimate factor.

"WATER LOADS"

"CAR 3.265 General. The requirements set forth in sections 3.266-3.282 shall apply to the entire airplane, but have particular reference to hull structure, wing, nacelles, and float supporting structure."

3.265-1 FLOAT LOADS. (CAA policies which apply to section 3.265, previously 3.25).

(a) Floats which are presently certificated on the basis of CAR 4a in effect prior to November 9, 1945, are considered satisfactory structurally for installation on airplanes which are designed in accordance with CAR 3.

(b) New float designs which are submitted for approval should be investigated for the structural design requirements of CAR 3. In this connection, it is pointed out that CAR 15 refers to CAR 4a for design requirements, whereas the latest structural requirements in CAR 3 should be used. CAR 15 is to be revised accordingly.

"STRUCTURAL PARTS"

"CAR 3.301 Material strength properties and design values. Material strength properties shall be based on a sufficient number of tests of material conforming to specifications to establish design values on a statistical basis. The design values shall be so chosen that the probability of any structure being understrength because of material variations is extremely remote. Values contained in ANC-5 and ANC-18 shall be used unless shown to be inapplicable in a particular case.

"Note: ANC-5, 'Strength of Aircraft Elements' and ANC-18, 'Design of Wood Aircraft Structures' are published by the Army-Navy-Civil Committee on Aircraft Design Criteria and may be obtained from the Government Printing Office, Washington 25, D.C."

3.301-1 DESIGN PROPERTIES. (CAA policies which apply to section 3.301, previously 3.310).

(a) With reference to section 3.111 of ANC-5a (1949 edition), it should be noted that the design mechanical properties listed in the A column for the various aluminum alloys have been derived from test data and are the minimum values expected but are not necessarily covered by procurement specifications. All values in the B column have been derived from test data and are the lowest expected in 90% of the material.

(1) In the case of structures constructed of aluminum alloys where the applied loads are eventually distributed through single members within an assembly, the failure of which would result in the loss of the structural integrity of the component involved, the design mechanical properties listed in column A in ANC-5a (Tables 3.111) should be used.

Note: Typical examples of such items are:

Wing lift struts.
Spars in two-spar wings.
Sparcaps in regions such as wing cut-outs and wing center sections where loads are transmitted through caps only.
Primary attachment fittings dependent on single bolts for load transfer.

(2) Redundant structures wherein partial failure of individual elements would result in the applied load being safely distributed to other load carrying members may be designed on the basis of the "90% probability" allowable or B values.

Note: Typical examples of such items are:

Sheet-stiffener combinations.
Multi-rivet or multiple bolt connections.

(b) Certain manufacturers have indicated a desire to use design values greater than the guaranteed minimums even in applications where only guaranteed minimum values would be permitted under sub-paragraph (1) above, and have advocated that such allowables be based on "premium selection" of the material. Such increased design allowables are acceptable: provided, that a specimen or specimens of each individual item are tested prior to its use, to determine that the actual strength properties of that particular item will equal or exceed the properties used in design. This, in effect, results in the airplane or materials manufacturer guaranteeing higher minimum properties than those given in the basic procurement specifications.

(c) See CAM 3.174-1 (a).

3.301-2 SUBSTITUTION OF SEAM WELDED FOR SEAMLESS STELL TUBING. (CAA policies which apply to section 3.301, previously 3.310).

Seam welded tubing may be substituted for seamless steel tubing as follows:

(a) SAE 4130 welded tubing as per Specification AN-T-3, may be substituted for SAE 4130 seamless tubing conforming to Specification AN-WW-T-850a, and vice versa.

(b) SAE 1025 welded tubing as per Specification AN-T-4, may be substituted for SAE 1025 seamless tubing conforming to Specification AN-WW-T-846, and vice versa.

(c) SAE 8630 welded tubing conforming to Specification AN-T-33a may be substituted for SAE 8630 seamless tubing conforming to Specification AN-T-15 and vice versa.

"CAR 3.304 Castings. (a) Where visual inspection only is to be employed, the variability factor shall be 2.0.

"(b) The variability factor may be reduced to 1.25 for ultimate loads and 1.15 for limit loads when at least three sample castings are tested to show compliance with these factors, and all sample and production castings are visually and radiographically inspected in accordance with an approved inspection specification.

"(c) Other inspection procedures and variability factors may be used if found satisfactory by the Administrator."

3.304-1 LOWER CASTING FACTORS. (CAA policies which apply to section 3.304, previously 3.31100).

With reference to sub-paragraphs (b) and (c) of CAR 3.304, the use of lower casting factors as specified in (b) will be acceptable, with 100% radiographic inspection on initial runs. Such radiographic inspection may be gradually reduced on production lots as it becomes evident that adequate quality control has been established. All such procedures require the submittal and execution of a satisfactory process specification and statistical proof that adequate quality control has been achieved.

"CAR 3.318 Ribs. (a) The strength of ribs in other than stressed-skin wings shall be proved by test to at least 125 percent of the ultimate loads for the most severe loading conditions, unless a rational load analysis and test procedure is employed and the tests cover the variability of the particular type of construction.

"(b) The effects of ailerons and high lift devices shall be properly accounted for. Rib tests shall simulate conditions in the airplane with respect to torsional rigidity of spars, fixity conditions, lateral support, and attachment to spars."

3.318-1 RIB TESTS. (CAA policies which apply to section 3.318 (a), previously 3.3300).

See CAM 3.174-6 (g).

"CAR 3.320 Covering. Strength tests of fabric covering shall be required unless approved grades of cloth, methods of support, attachment, and finishing are employed. Special tests shall be required when it appears necessary to account for the effects of unusually high design air speeds, slipstream velocities, or other unusual conditions."

3.320-1 AIRCRAFT FABRIC. (CAA rules which apply to section 3.320, previously 3.332).

(a) The minimum safety requirements for "Intermediate" grade fabric which is intended for use as external covering material on civil aircraft, have been established by the Administrator in Technical Standard Order No. TSO-C14, effective September 1, 1948, "Aircraft Fabric, 'Intermediate' Grade, External Covering Material."

(b) The minimum safety requirements for Grade "A" fabric which is intended for use as external covering material on civil aircraft, have been established by the Administrator in Technical Standard Order No. TSO-C15, effective September 1, 1948, "Aircraft Fabric, Grade 'A', External Covering Material."

3.320-2 WING, RIB, AND WING COVERING TEST FACTORS. (CAA interpretations which apply to section 3.320, previously 3.332).

See CAM 3.174-6 (g).

"CAR 3.328 Installation. Movable tail surfaces shall be so installed that there is no interference between the surfaces or their bracing when each is held in its extreme position and all others are operated through their full angular movement. When an adjustable stabilizer is used, stops shall be provided which, in the event of failure of the adjusting mechanism, will limit its travel to a range permitting safe flight and landing."

3.328-1 BONDING OF CONTROL SURFACES. (CAA policy which applies to section 3.328, previously 3.342).

In order to avoid possible "freezing" of control surface bearings caused by electrical discharges (as for example when flying through thunderstorms), it is recommended that all control surfaces be bonded to the airframe.

"CAR 3.336 Primary flight controls. (a) Primary flight controls are defined as those used by the pilot for the immediate control of the pitching, rolling, and yawing of the airplane.

"(b) For two-control airplanes the design shall be such as to minimize the likelihood of complete loss of the lateral directional control in the event of failure of any connecting or transmitting element in the control system."

3.336-1 AILERON CONTROLS FOR TWO-CONTROL AIRPLANES. (CAA interpretation which applies to section 3.336 (b), previously 3.351).

In the case of two-control airplanes having side by side control wheels, the aileron controls in the right wing should be independent of those in the left wing; however, they may be connected to a common bell-crank or lever in the fuselage. From the point of common connection to the control wheels, the margins of safety should be large and the detail design adequate to minimize possibility of failure of any part.

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"CAR 3.337 Trimming controls. Proper precautions shall be taken against the possibility of inadvertent, improper, or abrupt tab operations. Means shall be provided to indicate to the pilot the direction of control movement relative to airplane motion and the position of the trim device with respect to the range of adjustment. The means used to indicate the direction of the control movement shall be adjacent to the control, and the means used to indicate the position of the trim device shall be easily visible to the pilot and so located and operated as to preclude the possibility of confusion. Trimming devices shall be capable of continued normal operation notwithstanding the failure of any one connecting or transmitting element in the primary flight control system. Tab controls shall be irreversible unless the tab is properly balanced and possesses no unsafe flutter characteristics. Irreversible tab systems shall provide adequate rigidity and reliability in the portion of the system from the tab to the attachment of the irreversible unit to the airplane structure."

3.337-1 INDEPENDENT MEANS OF CONTROL OF CONTROL SYSTEM. (CAA interpretations which apply to section 3.337, previously 3.352).

The intent of CAR 3.337 is to provide an independent means of control from the cockpit in case of the failure of the primary control system. The installation of a bungee system to trim an airplane by actuating a primary control surface is, for example, not acceptable. In such a case, even the provision of large margins of safety would not preclude the possibility of failure of the primary control system caused by loosening bolts, wear and tear, etc. On the other hand, an equivalent degree of safety can be incorporated into a tab control system by some other means as, for example, by attaching a bungee directly to the control surface horn. Such an arrangement could be shown to meet the intent of CAR 3.337; however, each design will be reviewed on the basis of its individual merits.

"CAR 3.345 Cable systems. Cables, cable fittings, turnbuckles, splices, and pulleys shall be in accordance with approved specifications. Cables smaller than 1/8-inch diameter shall not be used in primary control systems. The design of cable systems shall be such that there will not be hazardous change in cable tension throughout the range of travel under operating conditions and temperature variations. Pulley types and sizes shall correspond to the cables with which they are used, as specified on the pulley specification. All pulleys shall be provided with satisfactory guards which shall be closely fitted to prevent the cables becoming misplaced or fouling, even when slack. The pulleys shall lie in the plane passing through the cable within such limits that the cable does not rub against the pulley flange. Fairleads shall be so installed that they are not required to cause a change in cable direction of more than 3 degrees. Clevis pins (excluding those not subject to load or motion) retained only by cotter pins shall not be employed in the control system. Turnbuckles shall be attached to parts having angular motion in such a manner as to prevent positively binding throughout the range of travel. Provisions for visual inspection shall be made at all fairleads, pulleys, terminals, and turnbuckles."

3.345-1 CABLES IN PRIMARY CONTROL SYSTEMS. (CAA interpretations which apply to section 3.345, previously 3.3571).

CAR 3.345 provides that "cables smaller than 1/8-inch diameter shall not be used in primary control systems." Primary control systems are normally considered to be the aileron, rudder, and elevator control systems. Hence, this minimum of 1/8-inch need not be applied to tab control cables having high strength margins. However, in cases where the airplane would not be safely controllable in flight and landing, with tabs in the most adverse positions required for the various critical trim, weight and center of gravity conditions, tab systems should be designed to provide reliability equivalent to that required for primary systems, as for example, with respect to pulley sizes, guards, use of fairleads, inspection provisions, etc.

3.345-2 SPECIAL AIRCRAFT TURNBUCKLE ASSEMBLIES AND/OR TURNBUCKLE SAFETYING DEVICES. (CAA rules which apply to 3.345, previously 3.3571).

The minimum safety requirements for special aircraft turnbuckle assemblies and/or turnbuckle safetying devices which are intended for use in civil aircraft have been established by the Administrator in Technical Standard Order No. TSO-C21 effective October 1, 1949, "Special Aircraft Turnbuckle Assemblies and/or Turnbuckle Safetying Devices."

"CAR 3.352 Shock absorption tests. (a) It shall be demonstrated by energy absorption tests that the limit load factors selected for design in accordance with section 3.243 will not be exceeded in landings with the limit descent velocity specified in that section.

"(b) In addition, a reserve of energy absorption shall be demonstrated by a test in which the descent velocity is at least 1.2 times the limit descent velocity. In this test there shall be no failure of the shock absorbing unit, although yielding of the unit will be permitted. Wing lift equal to the weight of the airplane may be assumed for purposes of this test."

3.352-1 LANDING GEAR DROP TESTS. (CAA policies which apply to section 3.352, previously 3.3610).

(a) The following method has been approved for determining the effective mass to be used in drop tests of nose wheel landing gear assemblies pursuant to CAR 3.352 (a): For aircraft with nose wheel type gear, the effective mass to be used in free drop test of the nose wheel should be determined from the formula for W_e (CAR 3.353 and 3.355) using $W = W_n$, where W_n is equal to the vertical component of the resultant force acting on the nose wheel, computed under the following assumptions: (1) the mass of the airplane concentrated at the c.g. and exerting a force of 1.0 g downward and 0.33 g forward, (2) the nose and the main gears and tires in static position, and (3) the resultant reactions at the main and nose gears acting through the axles and parallel to the resultant force at the airplane c.g.

> Note: By way of explanation, the use of an inclined reactions condition as the basis for determining the mass to be dropped with a nose wheel unit is based on rational dynamic investigation of the landing condition, assuming the landing is made with simultaneous three point contact, zero pitching velocity, and a drag component representing the average wheel spin-up reactions during the landing impact. Although spin-up loads on small airplanes may be less than the value implied by the formula, such airplanes are more likely to be landed with a nose dropping pitching velocity, or in soft ground. The vertical component of the ground reaction is specified above because the method of defining the direction of the inertia force at the c.g. gives a resultant effective mass greater than that of the airplane.

(b) The following procedure is acceptabe for determining the attitude in which the landing gear unit should be dropped pursuant to CAR 3.352 (a): The attitude in which a landing gear unit is dropped shall be that which simulates the airplane landing condition which is critical from the standpoint of energy to be absorbed by the particular unit, thus: (1) For nose wheel type landing gear, the nose wheel gear should be drop tested in an attitude which simulates the three point landing inclined reaction condition. (2) The attitude selected for main gear drop tests should be that which simulates the two-wheel level landing with inclined reactions condition.

Note: In addition, it is recommended that the main gear be dropped in an attitude simulating the tail down landing with vertical reactions condition if the geometry of the gear is such that this condition is likely to result in shock strut action appreciably different from that obtained in level attitude drop tests; for example, when a cantilever shock strut has a large inclination with respect to the direction of the ground reaction.

(3) Tail wheel units should be tested in such a manner as to simulate the tail down landing condition (three point contact). Drag components may be covered separately by the tail wheel "obstruction" condition.

(c) The following procedure may be used for determining slopes of inclined platforms when such are used in drop tests: When the arbitrary drag components given on Fig. 3-12(a) of CAR 3 are used for the design of the landing gear in the level landing conditions, the drag loads in the drop tests for these conditions may be simulated by dropping the units onto inclined platforms, so arranged as to obtain the proper direction of the resultant ground reactions in relation to the landing gear. (If wheel spin-up loads for these conditions are determined by rational methods and found to be more severe than the arbitrary drag loads, it is suggested that the spin-up loads be simulated by dropping the gear onto a level platform with wheels spinning.) In at least one limit drop test the platform should simulate the friction characteristics of paved runways, and the rotational speed of the wheel just prior to contact should correspond to an airplane ground speed of 1.2 V_{s_o}. (It is suggested that additional limit drops be made onto surfaces of lower friction coefficient and at several wheel rotational speeds; for example, corresponding to .6, .8, and 1.0 V_{s_o}.) The direction of wheel rotation in the drop test should be opposite to that which would occur in the landing of the airplane. Spin-up loads which are slightly greater than the arbitrary drag loads can probably be simulated satisfactorily by inclined platforms, but platforms having greater inclinations may not simulate spin-up loads correctly and are not recommended.

"RETRACTING MECHANISM"

"CAR 3.356 General. The landing gear retracting mechanism and supporting structure shall be designed for the maximum load factors in the flight conditions when the gear is in the retracted position. It shall also be designed for the combination of friction, inertia, brake torque, and air loads occurring during retraction at any air speed up to 1.6 V_{s_1}, flaps retracted and any load factors up to those specified for the flaps extended condition, section 3.190. The landing gear and retracting mechanism, including the wheel well doors, shall withstand flight loads with the landing gear extended at any speed up to at least 1.6 V_{s_1} flaps retracted. Positive means shall be provided for the purpose of maintaining the wheels in the extended position."

3.356-1 RETRACTING MECHANISM. (CAA policies which apply to section 3.356, previously 3.362).

(a) In order to provide for adequate strength of the landing gear doors, landing gear, etc., in yawed attitude, it will be satisfactory to show compliance with CAR 3.356 at the maximum yaw angle as determined by the flight characteristic requirements of CAR 3.105 and at speeds up to 1.6 V_{s_1} flaps retracted.

(b) To meet the requirement that a positive means be provided for maintaining wheels in the extended position, a positive mechanized lock or latch should be provided that can be released directly or sequentially only by some specific manual actuation by the pilot. In this regard, the use of hydraulic pressure is not considered a positive means of down lock.

"CAR 3.359 <u>Position indicator and warning device</u>. When retractable landing wheels are used, means shall be provided for indicating to the pilot when the wheels are secured in the extreme positions. In addition, landplanes shall be provided with an aural or equally effective warning device which shall function continuously after the throttle is closed until the gear is down and locked."

3.359-1 WHEEL POSITION INDICATORS. <u>(CAA policies which apply to section 3.359, previously 3.3622)</u>.

(a) The means to be provided for in CAR 3.359 to indicate to the pilot when the wheels are secured in the extreme positions may consist of lights. For example, a green light for the gear down and locked position is considered satisfactory, provided a placard indicates that this is the down position. "All lights out" is considered satisfactory for intermediate gear positions. However, there should then be another light indicating gear up and locked. "All lights out" is not considered desirable for either extreme gear locked position, since such a system would not "fail safe" if a lamp burned out.

(b) The regulations do not require an aural warning device for amphibian aircraft. A two-light warning system similar to the following would be considered sufficient and satisfactory:

Gear Up-------- Light #1 --------- Water

Gear Down------ Light #2 --------- Land

When light #1 is on, the gear would be in the extreme up position and locked and when light #2 is on, the gear would be in the extreme down position and locked.

3.359-2 POSITION INDICATOR AND WARNING DEVICE. <u>(CAA policy which applies to section 3.359, previously 3.3622)</u>.

A throttle stop is not considered an acceptable alternative to an aural landing gear warning device.

"CAR 3.362 Tires. A landing gear wheel may be equipped with any make or type of tire, provided that the tire is a proper fit on the rim of the wheel and provided that the approved tire rating is not exceeded under the following conditions:

"(a) Load on main wheel tires equal to the airplane weight divided by the number of wheels,

"(b) Load on nose wheel tires (to be compared with the dynamic rating established for such tires) equal to the reaction obtained at the nose wheel, assuming the mass of the airplane concentrated at the center of gravity and exerting a force of 1.0g downward and 0.31g forward, the reactions being distributed to the nose and main wheels by the principle of statics with the drag reaction at the ground applied only at those wheels having brakes. When specially constructed tires are used to support an airplane, the wheels shall be plainly and conspicuously marked to that effect. Such markings shall include the make, size, number of plies, and identification marking of the proper tire.

"Note: Approved ratings are those assigned by the Tire and Rim Association or by the Administrator."

3.362-1 TIRE AND RIM ASSOCIATION (TRA) RATINGS. (CAA interpretation which applies to section 3.362, previously 3.364).

Experimental ratings assigned by the TRA are considered fully adequate for determining that a tire is satisfactory for use on commercial aircraft.

"SKIS"

"CAR 3.364 Skis. Skis shall be of an approved type. The approved rating of the skis shall not be less than the maximum weight of the airplane on which they are installed."

3.364-1 TAIL SKIS. (CAA interpretation which applies to section 3.364, previously 3.366).

Type certification of tail skis is not required under the Civil Air Regulations. Such skis should therefore be approved as a part of the airplane.

"CAR 3.382 Vision. The pilot compartment shall be arranged to afford the pilot a sufficiently extensive, clear, and undistorted view for the safe operation of the airplane. During flight in a moderate rain condition, the pilot shall have an adequate view of the flight path in normal flight and landing, and have sufficient protection from the elements so that his vision is not unduly impaired. This may be accomplished by providing an openable window or by a means for maintaining a portion of the windshield in a clear condition without continuous attention by the pilot. The pilot compartment shall be free of glare and reflections which would interfere with the pilot's vision. For airplanes intended for night operation, the demonstration of these qualities shall include night flight tests."

3.382-1 OPENABLE WINDOW OR OPENABLE PORTION OF THE WINDSHIELD. (CAA interpretations which apply to section 3.382, previously 3.3801).

(a) The third sentence of CAR 3.382 is interpreted to mean that an openable window, or an openable portion of the windshield is required only when the windshield does not remain, or is not maintained (by means of windshield wipers or other devices) in a clean condition during a moderate rain.

(b) If deflectors or other means are provided, so that the elements do not fully impair the pilot's ability to see when an openable window, or a movable portion of the windshield is open, then the pilot should have an adequate view during the rain condition of the flight path in normal flight and landing with these deflectors or other devices installed (and, if applicable, in any position within the limits of adjustability).

3.382-2 PILOT VISION IN RAIN CONDITIONS. (CAA interpretation which applies to section 3.382, previously 3.3801).

The means for providing vision during flight in rain conditions should permit the pilot to view both the normal flight path and the instrument panel without difficulty or excessive head movement.

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"CAR 3.383 Pilot windshield and windows. All glass panes shall be of a nonsplintering safety type."

3.383-1 PLEXIGLAS WINDSHIELDS AND WINDOWS. (CAA policy which applies to section 3.383, previously 3.38010).

A plastic material such as plexiglas is considered to be a nonsplintering material and can be used in windshields and windows.

"EMERGENCY PROVISIONS"

"CAR 3.386 Protection. The fuselage shall be designed to give reasonable assurance that each occupant, if he makes proper use of belts or harness for which provisions are made in the design, will not suffer serious injury during minor crash conditions as a result of contact of any vulnerable part of his body with any penetrating or relatively solid object, although it is accepted that parts of the airplane may be damaged.

"(a) The ultimate accelerations to which occupants are assumed to be subjected shall be as follows:

	N,U	A
Upward----------------------	3.0g	4.5g
Forward---------------------	9.0g	9.0g
Sideward--------------------	1.5g	1.5g

"(b) For airplanes having retractable landing gear, the fuselage in combination with other portions of the structure shall be designed to afford protection of the occupants in a wheels-up landing with moderate descent velocity.

"(c) If the characteristics of an airplane are such as to make a turn-over reasonably probable, the fuselage of such an airplane in combination with other portions of the structure shall be designed to afford protection of the occupants in a complete turn-over.

"Note: In section 3.386 (b) and (c), a vertical ultimate acceleration of 3g and a friction coefficient of 0.5 at the ground may be assumed."

3.386-1 CRASH PROTECTION. (CAA interpretations which apply to section 3.386, previously 3.3811).

(a) Cockpit arrangement and collapse of cabin structure have been found to cause excessive injuries in crashes. Close study of crash results shows that the human body, when properly supported, can tolerate crash forces which exceed those necessary to demolish contemporary aircraft structure.

(b) The following points are of general significance:

(1) Many survivable accidents are "fatal" because of insufficient design consideration when mocking up the cabin and its installation.

(2) The torso is rarely exposed to dangerous injury when the safety belts hold and control wheels provide reasonable support for the chest.

(3) Fractures of the extremities occur in severe crashes but are not normally regarded as dangerous injuries.

(4) Head injuries are the principal cause of crash fatalities. Increased protection for the head can be provided by elimination, shielding, or redesigning of elements of the cabin which permit solid head blows in a crack-up, such as turn-overs during a bad landing.

(c) In view of the fact that injuries and fatalities in many moderate and severe accidents are purely mechanical results of poor cockpit design, the following guide rules for design are suggested:

(1) Typical injurious objects, from the standpoint of crash injury, are listed as follows:

(i) Those which present a hard surface and are so attached or have sufficient mass to produce a severe impact when struck by the head or other vulnerable part of the body as it swings forward under the specified inertia forces.

(ii) Those which present corners, knobs, or similar projections which are likely to penetrate a vulnerable part of the body, even when the impact forces are not as high as in case (a).

(2) A flat or curved sheet metal panel which will dent upon impact by the head is not considered dangerous, whereas a magnetic compass case having appreciable mass and a rigid mounting might cause fatal head injuries.

(3) Heavy transverse braces or other structures immediately behind a light instrument panel have changed many accident reports from "Instrument panel depressed six inches by pilot's head" to "Fatal head injury; depressed fracture of the skull." Pilot's chances can be greatly improved by spacing solid braces several inches behind the ductile skirt of an instrument panel.

(4) The solid tubing used as a backrest of the front seats of tandem aircraft is a set-up for excessive head injury. The suggestion has been made that backs of forward seats be allowed to pivot forward so that the head of the occupant of the rearward seat would not contact the solid members when the body pivots about the belt.

(5) Panels should be smooth, with top edge curved in a substantial radius.

(6) Apertures for instruments should preferably have bevelled instead of sharp edges.

(7) In personal aircraft, every consideration should be given to holding the body by adequate safety belt installations, and by the support which can be provided in control wheels and instrument panels. The present "1000 pound" safety belts have failed in a high percentage of accidents without causing internal injuries or bruising of the hips. In failing, they have exposed the pilot to excessive injuries.

(8) Control wheels should be designed to provide broad areas of support for the chest. Wheels which break under heavy loads from the hands or deform to permit contact between the chest and a small hub, localize force and set up chances of unnecessary chest injury.

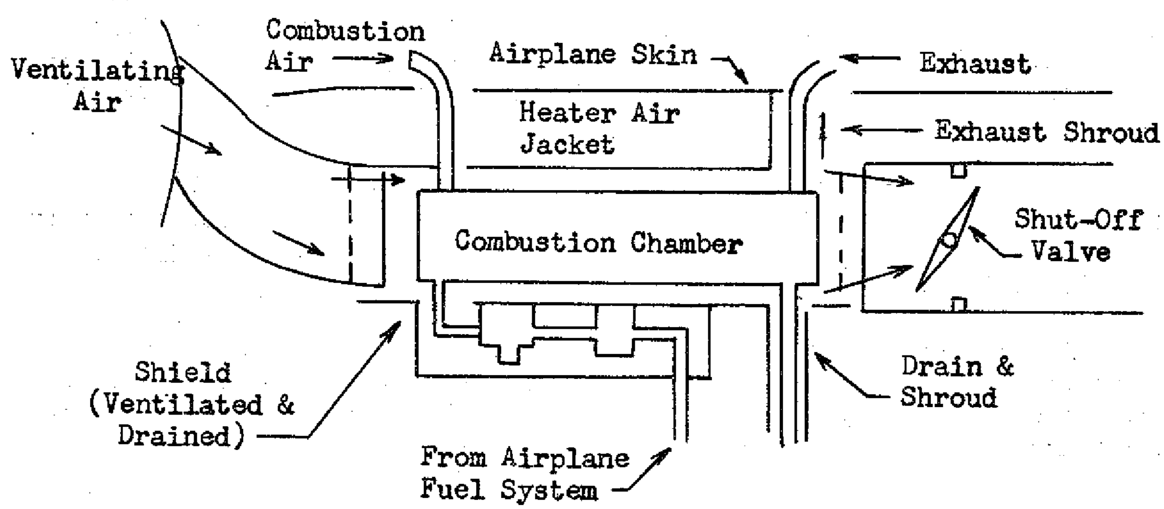
"CAR 3.388 Fire precautions. (a) Cabin interiors. Only materials which are flash-resistant shall be used. In compartments where smoking is to be permitted, the materials of the cabin lining, floors, upholstery, and furnishings shall be flame-resistant. Such compartments shall be equipped with an adequate number of self-contained ash trays. All other compartments shall be placarded against smoking.

"(b) Combustion heaters. Gasoline operated combustion heater installations shall comply with applicable parts of the power-plant installation requirements covering fire hazards and precautions. All applicable requirements concerning fuel tanks, lines, and exhaust systems shall be considered."

3.388-1 HEATER ISOLATION. (CAA policies which apply to section 3.388 (b), previously 3.38132).

(a) Under CAR 3.388 (b) and 3.623, heaters should be isolated from the remainder of the airplane by means of a fireproof shield. However, this need not necessarily mean a complete shield around the entire heater unit (although this would be satisfactory) since in many heater designs, a fireproof air jacket largely surrounds the flame chamber. Thus, the heater design itself practically provides a steel shield between the combustion unit and the remainder of the airplane. In such cases, it should suffice to provide isolation for the fuel system components mounted on the heater and for the heater exhaust and combustion chamber drains.

(b) The following schematic sketch shows an example of an installation which should be satisfactory:



(e) Detectors may be dispensed with as an alternative to fireproof isolation, only when the heater is so located that the occurrence of fire would immediately be noted by the crew.

3.388-3 HEATER FUEL SYSTEM. (CAA policies which apply to section 3.388 (b), previously 3.38132).

(a) The heater fuel system should comply with airworthiness standards for the engine fuel system as regards fuel lines, fittings and accessories.

(b) Valves should be provided for shutting off in flight the flow of fuel at its source, unless equivalent provisions in the form of a separate heater fuel pump are available.

(c) All pressure lines should comply with the provisions of CAR 3.432 regarding pressure cross feed arrangements.

3.388-4 COMBUSTION HEATERS. (CAA rules which apply to section 3.388 (b), previously 3.38132).

The minimum safety requirements for combustion heaters which are intended for use in civil aircraft have been established by the Administrator in Technical Standard Order No. TSO-C20, effective June 15, 1949, "Combustion Heaters."

"CAR 3.390 Seats and berths. (a) Passenger seats and berths. All seats and berths and supporting structure shall be designed for a passenger weight of 170 pounds (190 pounds with parachute for the acrobatic and utility categories) and the maximum load factors corresponding to all specified flight and ground load conditions including the emergency conditions of section 3.386.

"(b) Pilot seats. Pilot seats shall be designed for the reactions resulting from the application of the pilot forces to the primary flight controls as specified in section 3.231.

"(c) Categories U and A. All seats designed to be occupied in the U and A categories under section 3.74 (c) (4) shall be designed to accommodate passengers wearing parachutes."

3.390-1 APPROVAL OF SEATS AND BERTHS, AND THEIR INSTALLATIONS. (CAA policies which apply to section 3.390, previously 3.3822).

(a) Seats and berths and their installations, as well as related aircraft components, can be approved by any one of the three following procedures:

(1) Proof of compliance with the strength and deformation requirements of the regulations may be obtained on the basis of structural analysis alone when the structure conforms with conventional types for which the existing methods of analysis are known to be reliable.

(2) Proof of such compliance may be obtained by a combination of analysis and load tests to limit loads.

(3) Proof of such compliance may be obtained by static load tests alone, when such tests are carried to design ultimate loads.

(b) All seats shall be designed for the weights stipulated in this section (170 pounds for normal category; 190 pounds for utility and acrobatic category). When designed for a lower weight than those referred to above, the seat should be placarded to indicate the permissible, maximum weight of the occupant (see CAR 3.766).

"CAR 3.391 Safety belt or harness provisions. Provisions shall be made at all seats and berths for the installation of belts or harness of sufficient strength to comply with the emergency conditions of section 3.386."

3.391-1 SAFETY BELT ATTACHMENT LOADS. (CAA interpretations which apply to section 3.391, previously 3.38221).

All airplanes to which CAR 3.391 is applicable under CAR 3.2, should have structural provisions and attachments adequate for the safety belt loads corresponding to the requirements of CAR 3.386, even though certificated safety belts meeting these requirements may not yet be available.

"CAR 3.392 Cargo compartments. Each cargo compartment shall be designed for the placarded maximum weight of contents and critical load distributions at the appropriate maximum load factors corresponding to all specified flight and ground load conditions. Suitable provisions shall be made to prevent the contents of cargo compartments from becoming a hazard by shifting. Such provisions shall be adequate to protect the passengers from injury by the contents of any cargo compartment when the ultimate forward acting accelerating force is 4.5g."

3.392-1 LOAD FACTORS FOR DESIGN OF CARGO COMPARTMENTS LOCATED IN THE FUSELAGE. (CAA interpretations which apply to section 3.392, previously 3.3823).

(a) It would seem on examination of CAR 3.392 and CAR 3.386 that there is a conflict between the load factors required for the design of cargo compartments which are located in the fuselage. The following explanation should clarify this possible misconception:

(1) CAR 3.392 was specially promulgated to overcome objections to the excessively heavy cargo compartment structure that would be required to meet the crash conditions of CAR 3.386. In past cases of crashes, injuries to passengers caused by shifting cargo or baggage have not been prevalent despite the fact that in many cases the lower design factors of Bulletin 7a and CAR 4a were in effect. Because of this, CAR 3.392 was incorporated in the requirements, to apply specifically to cargo compartments. It should therefore not be necessary to consider the strength requirements of CAR 3.386 in their design.

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"CAR 3.419 Speed limitations for fixed-pitch propellers, ground adjustable pitch propellers, and automatically varying pitch propellers which cannot be controlled in flight. (a) During take-off and initial climb at best rate-of-climb speed, the propeller, in the case of fixed pitch or ground adjustable types, shall restrain the engine to a speed not exceeding its maximum permissible take-off speed and, in the case of automatic variable-pitch types, shall limit the maximum governed engine revolutions per minute to a speed not exceeding the maximum permissible take-off speed. In demonstrating compliance with this provision the engine shall be operated at full throttle or the throttle setting corresponding to the maximum permissible take-off manifold pressure.

"(b) During a closed throttle glide at the placard, 'never-exceed speed' (see section 3.739), the propeller shall not cause the engine to rotate at a speed in excess of 110 percent of its maximum allowable continuous speed."

3.419-1 PROPELLER PITCH AND SPEED LIMITATIONS. (CAA interpretations which apply to section 3.419, previously 3.41110).

(a) The low pitch setting should comply with CAR 3.419 (a) which states that the propeller shall not exceed the rated engine take-off r.p.m. with take-off power (full throttle unless limited by manifold pressure) during take-off and initial climb at best rate of climb speed. It is not permissible to use a lower pitch setting than that specified above in order to obtain take-off r.p.m. at the best angle of climb speed for the purpose of showing compliance with CAR 3.85 (c), Balked Landing Climb. An exception to the above may be granted in the specific case covered by CAM 3.85-5, when satisfactory engine cooling can be demonstrated at the best angle of climb speed in the balked landing configuration (CAR 3.85 (c)). However, in cases where the interpretation of CAR 3.85 does not govern, it will be necessary to conduct the balked landing climb with whatever r.p.m. is possible without exceeding the engine take-off limitations with the low pitch setting determined in accordance with CAR 3.419 (a).

(b) In cases where the airplane is to be operated using either the water injection or dry take-off power ratings of the engines, the low pitch stop setting shall be determined on the basis of whichever rating will result in the lower pitch. This will generally be the "dry" rating. In instances where the airplane is intended to be operated only at the water injection take-off power ratings of the engines, the low pitch stop for the propellers should be determined on that basis. These settings are to be determined in the usual manner with the airplane static unless there are unconventional features in the propeller installation requiring this determination by some other means.

(c) In cases where dual engines drive a single propeller through free wheeling clutches, the setting of the low pitch stop should be such that the propeller will not overspeed when take-off power is applied to one engine at an airplane speed of V_2.

"CAR 3.422 Propeller clearance. With the airplane loaded to the maximum weight and most adverse center of gravity position and the propeller in the most adverse pitch position, propeller clearances shall not be less than the following, unless smaller clearances are properly substantiated for the particular design involved:

"(a) Ground clearance. (1) Seven inches (for airplanes equipped with nose wheel type landing gears) or 9 inches (for airplanes equipped with tail wheel type landing gears) with the landing gear statically deflected and the airplane in the level, normal take-off, or taxiing attitude, whichever is most critical.

"(2) In addition to subparagraph (1) of this paragraph, there shall be positive clearance between the propeller and the ground when, with the airplane in the level take-off attitude, the critical tire is completely deflated and the corresponding landing gear strut is completely bottomed.

"(b) Water clearance. A minimum clearance of 18 inches shall be provided unless compliance with section 3.147 can be demonstrated with lesser clearance.

"(c) Structural clearance. (1) One inch radial clearance between the blade tips and the airplane structure, or whatever additional radial clearance is necessary to preclude harmful vibration of the propeller or airplane.

"(2) One-half inch longitudinal clearance between the propeller blades or cuffs and stationary portions of the airplane. Adequate positive clearance shall be provided between other rotating portions of the propeller or spinner and stationary portions of the airplane."

3.422-1 PROPELLER CLEARANCE ON TRICYCLE GEAR AIRPLANES. (CAA interpretation which applies to section 3.422 (a) (1), previously 3.4112 (a) (1)).

In determining minimum propeller clearance for aircraft equipped with tricycle gear, dynamic effects need not be considered.

3.422-2 PROPELLER CLEARANCE ON AIRCRAFT WITH LEAF SPRING TYPE SHOCK STRUTS. (CAA interpretation which applies to section 3.422 (a) (2), previously 3.4112 (a) (2)).

CAR 3.422 (a) (2) applies only to conventional landing gear struts employing fluid and for mechanical means for absorbing landing shocks. Aircraft employing struts of the leaf spring type need only be loaded to one load factor to determine whether positive clearance exists.

"CAR 3.442 Fuel tank installation. (a) The method of support for tanks shall not be such as to concentrate the loads resulting from the weight of the fluid in the tanks. Pads shall be provided to prevent chafing between the tank and its supports. Materials employed for padding shall be nonabsorbent or shall be treated to prevent the absorption of fluids. If flexible tank liners are employed, they shall be so supported that the liner is not required to withstand fluid loads. Interior surfaces of compartments for such liners shall be smooth and free of projections which are apt to cause wear of the liner, unless provisions are made for protection of the liner at such points or unless the construction of the liner itself provides such protection.

"(b) Tank compartments shall be ventilated and drained to prevent the accumulation of inflammable fluids or vapors. Compartments adjacent to tanks which are an integral part of the airplane structure shall also be ventilated and drained.

"(c) Fuel tanks shall not be located on the engine side of the fire wall. Not less than one-half inch of clear air space shall be provided between the fuel tank and the fire wall. No portion of engine nacelle skin which lies immediately behind a major air egress opening from the engine compartment shall act as the wall of an integral tank. Fuel tanks shall not be located in personnel compartments, except in the case of single-engine airplanes. In such cases fuel tanks the capacity of which does not exceed 25 gallons may be located in personnel compartments, if adequate ventilation and drainage are provided. In all other cases, fuel tanks shall be isolated from personnel compartments by means of fume and fuel proof enclosures."

3.442-1 BLADDER TYPE FUEL CELLS LOCATED IN A PERSONNEL COMPARTMENT. (CAA interpretations which apply to section 3.442, previously 3.4231).

In the case where a bladder type fuel cell having a fuel capacity in excess of 25 gallons is located in a personnel compartment, a separate fume and fuel proof enclosure for the fuel cell and its retaining shell is not deemed necessary provided the retaining shell is at least equivalent to a conventional metal fuel tank in structural integrity and fume and fuel tightness. The shell surrounding the tank should be adequately drained to the exterior of the airplane.

"OIL SYSTEM"

"CAR 3.561 Oil system. Each engine shall be provided with an independent oil system capable of supplying the engine with an ample quantity of oil at a temperature not exceeding the maximum which has been established as safe for continuous operation. The oil capacity of the system shall not be less than 1 gallon for every 25 gallons of fuel capacity. However, in no case shall the oil capacity be less than 1 gallon for each 75 maximum continuous horsepower of the engine(s) involved unless lower quantities can be substantiated."

3.561-1 CAPACITY. (CAA interpretations which apply to section 3.356, previously 3.43).

The word "capacity" as used in CAR 3.561 is interpreted by the Administrator as follows:

(a) Only the usable fuel system capacity need be considered.

(b) In a conventional oil system (no transfer system provided) only the usable oil tank capacity should be considered. The quantity of oil in the engine oil lines, the oil radiator, or in the feathering reserve should not be included. When an oil transfer system is installed, and the transfer pump is so located that it can pump some of the oil in the transfer lines into the main engine oil tanks, the quantity of oil in these lines which can be pumped by the transfer pump may be added to the oil capacity.

"TESTS"

"CAR 3.582 Cooling tests. Compliance with the provisions of section 3.581 shall be demonstrated under critical ground, water, and flight operating conditions. If the tests are conducted under conditions which deviate from the highest anticipated summer air temperature (see section 3.583), the recorded power-plant temperatures shall be corrected in accordance with the provisions of sections 3.584 and 3.585. The corrected temperatures determined in this manner shall not exceed the maximum established safe values. The fuel used during the cooling tests shall be of the minimum octane number approved for the engines involved, and the mixture settings shall be those appropriate to the operating conditions. The test procedures shall be as outlined in sections 3.586 and 3.587."

3.582-1 WATER TAXIING TESTS. (CAA interpretation which applies to section 3.582, previously 3.440).

No water taxiing tests need be conducted on aircraft certificated under CAR 3, except in the case of flying boats which may reasonably be expected to be taxied for extended periods.

"CAR 3.583 Maximum anticipated summer air temperatures. The maximum anticipated summer air temperature shall be considered to be 100° F. at sea level and to decrease from this value at the rate of 3.6° F. per thousand feet of altitude above sea level."

3.583-1 POWERPLANT WINTERIZATION EQUIPMENT. (CAA interpretations which apply to section 3.583, previously 3.4400).

(a) Cooling test results for winterization installations may be corrected to any temperature desired by the manufacturer rather than the conventional 100° F. hot day. For example, if a manufacturer chooses to demonstrate cooling to comply with requirements for a 50 or 60° F. day with winterization equipment installed, he may do so. In such a case the sea level temperature for correction purposes should be considered to be the value elected by the manufacturer with a rate of temperature drop of 3.6° F. per thousand feet above sea level.

(b) Cooling tests and temperature correction methods should be the same as for conventional cooling tests.

(c) The airplane flight manual should clearly indicate that winterization equipment must be removed whenever the temperature reaches the limit for which adequate cooling has been demonstrated. The cockpit should also be placarded accordingly. In addition, the airplane should be equipped with an ambient air temperature gauge or, alternatively, a cylinder head, barrel, or oil inlet temperature gauge (depending upon which is critical).

(d) If practical, winterization equipment such as baffles for oil radiators or for engine cooling air openings should be marked clearly to indicate the limiting temperature at which this equipment should be removed.

(e) Since winterization equipment is often supplied in kit form, accompanied by instructions for its installation, suitable information regarding temperature limitations should be included in the installation instructions for such kits.

"CAR 3.587 Cooling test procedure for multiengine airplanes. (a) Airplanes which meet the minimum one-engine-inoperative climb performance specified in section 3.85 (b). The engine cooling test for these airplanes shall be conducted with the airplane in the configuration specified in section 3.85 (b), except that the operating engine(s) shall be operated at maximum continuous power or at full throttle when above the critical altitude. After stabilizing temperatures in flight, the climb shall be started at the lower of the two following altitudes and shall be continued until at least 5 minutes after the highest temperature has been recorded:

"(1) 1,000 feet below the engine critical altitude or at the lowest practicable altitude (when applicable).

"(2) 1,000 feet below the altitude at which the single-engine-inoperative rate of climb is $0.02\ V_{s_o}{}^2$.

"The climb shall be conducted at a speed not in excess of the highest speed at which compliance with the climb requirement of section 3.85 (b) can be shown. However, if the speed used exceeds the speed for best rate of climb with one engine inoperative, a cylinder head temperature indicator shall be provided as specified in section 3.675.

"(b) Airplanes which cannot meet the minimum one-engine-inoperative climb performance specified in section 3.85 (b). The engine cooling test for these airplanes shall be the same as in paragraph (a) of this section, except that after stabilizing temperatures in flight, the climb (or descent, in the case of airplanes with zero or negative one-engine-inoperative rate of climb) shall be commenced at as near sea level as practicable and shall be conducted at the best rate-of-climb speed (or the speed of minimum rate of descent, in the case of airplanes with zero or negative one-engine-inoperative rate of climb)."

3.587-1 COOLING TEST PROCEDURE FOR TWIN ENGINE AIRCRAFT WHICH DO NOT MEET THE MINIMUM ONE-ENGINE-INOPERATIVE CLIMB PERFORMANCE. (CAA interpretation which applies to section 3.587 (b), previously 3.4404 (b)).

In order to provide a practicable test procedure for compliance with this requirement, the engine temperatures should be stabilized in flight at the lowest practicable altitude above the ground, with maximum continuous power from the engine on which cooling is being investigated, and with just sufficient power on the other engine to maintain level flight at the speed for minimum rate of descent.

"CAR 3.606 Induction system de-icing and anti-icing provisions. The engine air induction system shall incorporate means for the prevention and elimination of ice accumulations in accordance with the provisions in this section. It shall be demonstrated that compliance with the provisions outlined in the following paragraphs can be accomplished when the airplane is operating in air at a temperature of 30° F. when the air is free of visible moisture.

"(a) Airplanes equipped with sea level engines employing conventional venturi carburetors shall be provided with a preheater capable of providing a heat rise of 90° F. when the engine is operating at 75 percent of its maximum continuous power.

"(b) Airplanes equipped with altitude engines employing conventional venturi carburetors shall be provided with a preheater capable of providing a heat rise of 120° F. when the engine is operating at 75 percent of its maximum continuous power.

"(c) Airplanes equipped with altitude engines employing carburetors which embody features tending to reduce the possibility of ice formation shall be provided with a preheater capable of providing a heat rise of 100° F. when the engine is operating at 60 percent of its maximum continuous power. However, the preheater need not provide a heat rise in excess of 40° F. if a fluid de-icing system complying with the provisions of sections 3.607-3.609 is also installed."

3.606-1 INDUCTION SYSTEM DE-ICING PROVISIONS. (CAA policies which apply to section 3.606, previously 3.450).

(a) A series of pressure type carburetors for small engines has been developed which incorporate the feature of injecting fuel into the intake air at a point downstream from the throttle and carburetor venturi. This feature tends to greatly reduce the possibility of ice formation in the engine induction system and the results of extensive tests have demonstrated the carburetors to be relatively free of icing hazards.

(b) In order to outline the limitations of our approval for the elimination of preheat on the carburetors, and to provide what are considered equivalent safety margins the following is stipulated:

(1) This approval applies only to sea level engines of the general power class with which the largest of these pressure carburetors has been tested. No tests have as yet been conducted on any altitude engines. The largest of these carburetors which has been tested at present is a model which is intended for use on engines in the general range of approximately 220 horsepower.

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(2) Unless the main carburetor air intake is located in a sheltered position where it is free from impact icing possibilities, a sheltered alternate air intake should be provided even though there is no preheater.

(c) During tests of the non-icing qualities of these carburetors, it was found that in some cases poor idling of the engine was encountered and this was attributed to a possible ice formation in the internal carburetor passage which acts as the air bleed for the main discharge nozzle. As a result, it is necessary to provide a small intensifier tube to supply hot air to the air bleed side of the main discharge nozzle on installation in which the carburetor and a portion of the induction system are exposed to the exterior of the airplane. When the installation is completely cowled, the hot air bleed will not be necessary.

"FIRE WALL AND COWLING"

"CAR 3.623 Fire walls. All engines, auxiliary power units, fuel burning heaters, and other combustion equipment which are intended for operation in flight shall be isolated from the remainder of the airplane by means of fire walls, or shrouds, or other equivalent means."

3.623-1 FIRE-PROOF MATERIALS FOR FIREWALLS. (CAA rules which apply to section 3.623, previously 3.470).

(a) The test for demonstrating compliance with criteria for fire-proof material or components shall subject the material or unit to a $2000 \pm 50^{\circ}$ F. flame. Sheet materials shall be tested by subjecting a sample approximately 10 inches square to a flame from a suitable burner. The flame shall be large enough to maintain the required test temperature over an area approximately five inches square.

(b) Firewall materials and fittings shall resist flame penetration for 15 minutes.

(c) The following materials are considered satisfactory for use in firewalls or shrouds without being tested as outlined in sub-paragraphs (a) and (b):

(1) Stainless steel sheet, .015 inches thick.
(2) Mild steel sheet coated with aluminum or otherwise protected against corrosion, .018 inches thick.
(3) Terne plate, .018 inches thick.
(4) Monel metal, .018 inches thick.
(5) Steel or copper base alloy firewall fittings.

"CAR 3.672 Fuel quantity indicator. Means shall be provided to indicate to the flight personnel the quantity of fuel in each tank during flight. Tanks, the outlets and air spaces of which are interconnected, may be considered as one tank and need not be provided with separate indicators. Exposed sight gauges shall be so installed and guarded as to preclude the possibility of breakage or damage. Fuel quantity indicators shall be calibrated to read zero during level flight when the quantity of fuel remaining in the tank is equal to the unusable fuel supply as defined by section 3.437."

3.672-1 MEANS TO INDICATE FUEL QUANTITY. (CAA policies which apply to section 3.672, previously 3.5222)

The Administrator will accept, as a "means to indicate to the flight personnel the quantity of fuel in each tank during flight," a fuel tank calibrated to read in either gallons or pounds, providing the gauge is clearly marked to indicate which scale is being used.

"ELECTRICAL SYSTEMS AND EQUIPMENT"

"CAR 3.681 Installation. (a) Electrical systems in airplanes shall be free from hazards in themselves, in their method of operation, and in their effects on other parts of the airplane. Electrical equipment shall be of a type and design adequate for the use intended. Electrical systems shall be installed in such a manner that they are suitably protected from fuel, oil, water, other detrimental substances, and mechanical damage.

"(b) Items of electrical equipment required for a specific type of operation are listed in other pertinent parts of the Civil Air Regulations."

3.681-1 SHIELDING OF FLARE CIRCUITS. (CAA policy which applies to section 3.681, previously 3.53).

Flare circuits should be shielded or separated from other circuits far enough to preclude induction of other current into flare circuit.

"MASTER SWITCH"

"CAR 3.688 Arrangement. If electrical equipment is installed, a master switch arrangement shall be provided which will disconnect all sources of electrical power from the main distribution system at a point adjacent to the power sources.

3.688-1 STALL WARNING INDICATOR CIRCUITS. (CAA policies which apply to section 3.688, previously 3.532).

(a) WIRING OF CIRCUIT BY THE MASTER SWITCH. Airplanes on which the indicators are required for type certification as a result of the particular stall characteristics of the airplane, should have the indicator circuit by-pass the master switch. A circuit protector should be installed for the protection of the indicator wiring and this protector should be located as near as is practicable to the source of electric power.

(b) WIRING OF CIRCUIT THROUGH THE MASTER SWITCH. Where the indicator is installed as an accessory but not as required equipment, it is permissible to wire the indicator through the master switch or direct to the source of power. A circuit protector should be installed for the protection of the indicator wiring and this protector should be located as near as is practicable to the source of the electric power.

"INSTRUMENT LIGHTS"

"CAR 3.696 Instrument lights. If instrument lights are required, they shall be of such construction that there is sufficient distance or insulating material between current-carrying parts and the housing so that vibration in flight will not cause shorting. They shall provide sufficient illumination to make all instruments and controls easily readable and discernible, respectively.

3.696-1 INSTRUMENT LIGHTS. (CAA interpretation which applies to section 3.696, previously 3.536).

The use of the cabin dome light is not considered adequate to comply with the provision of CAR 3.696.

"CAR 3.702 Rear position light installation. The rear position light shall be mounted as far aft as practicable and so installed that unbroken light is directed symmetrically aft in such a manner that the axis of the maximum cone of illumination is parallel to the flight path. In addition, the intersection of the two planes forming dihedral angle A given in Part 15 of this chapter shall be vertical."

3.702-1 REAR POSITION LIGHT INSTALLATION. (CAA interpretation which applies to section 3.702, previously 3.5381).

A single rear position light may be installed in a position displaced laterally from the plane of symmetry of an airplane if the axis of the maximum cone of illumination is parallel to the flight path in level flight, and if there is no obstruction aft of the light and between planes 70° to the right and left of the axis of maximum illumination.

"EMERGENCY FLOTATION AND SIGNALING EQUIPMENT"

"CAR 3.716 Rafts and life preservers. An approved life raft or approved life preserver, when required by other parts of the Civil Air Regulations, is one approved by either the Administrator, the Bureau of Marine Inspection and Navigation, the United States Army Air Forces, or the Bureau of Aeronautics, Navy Department."

3.716-1 LIFE RAFTS AND LIFE PRESERVERS. (CAA rules which apply to section 3.716, previously 3.5440).

(a) The minimum safety requirements for life preservers and life rafts which are intended for use in certificated civil aircraft engaged in over-water operations have been established by the Administrator in the following Technical Standard Orders:

(1) No. TSO-C12, "Life Rafts," effective August 1, 1948.

(2) No. TSO-C13, "Life Preservers," effective August 1, 1948.

"RADIO EQUIPMENT; INSTALLATION"

"CAR 3.721 General. Radio equipment and installations in the airplane shall be free from hazards in themselves, in their method of operation, and in their effects on other components of the airplane."

3.721-1 RADIO EQUIPMENT INSTALLATION. (CAA interpretation which applies to section 3.721, previously 3.550).

Engineering flight tests are not required for equipment installations unless a particular installation could conceivably interfere with flight operation of airplane or change the airplane configuration so that performance or flight characteristics became adversely affected.

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"MARKINGS AND PLACARDS"

"CAR 3.755 Markings and placards. (a) The markings and placards specified are required for all airplanes. Placards shall be displayed in a conspicuous place and both shall be such that they cannot be easily erased, disfigured, or obscured. Additional informational placards and instrument markings having a direct and important bearing on safe operation may be required by the Administrator when unusual design, operating, or handling characteristics so warrant.

"(b) When an airplane is certificated in more than one category, the applicant shall select one category on which all placards and markings on the airplane shall be based. The placard and marking information for the other categories in which the airplane is certificated shall be entered in the Airplane Flight Manual. A reference to this information shall be included on a placard which shall also indicate the category on which the airplane placards and markings are based."

3.755-1 MARKINGS AND PLACARDS FOR AN AIRPLANE CERTIFICATED IN MORE THAN ONE CATEGORY. (CAA policies which apply to section 3.755 (b), previously 3.62).

(a) The following suggestions are given to assist in making placards and markings as simple and straightforward as possible:

(1) The applicant (who may be the manufacturer or an individual operator) should select a "basic" category on which all markings and placards will be based and installed on a particular airplane. However, this does not prevent the selection of some other category as "basic" for the placarding and marking of other airplanes of the same model.

(2) Placards of markings pertaining to other categories should be installed only when this can be done without confusing the placards or markings for the "basic" category. For example, previous attempts to put dual sets of markings on airspeed indicators have proven unsatisfactory. On the other hand, it may be desirable to install baggage capacity and number of persons placards which cover both normal and utility categories.

(3) A statement on the placard, required by CAR 3.769 and CAR 3.770, should refer the operator to the "Approved Airplane Flight Manual" for information on the placards and markings appropriate to the other categories in which the airplane is certificated.

(4) All placards should be arranged to present the necessary information to the pilot in as simple and practical a manner as possible. In many cases, it may be convenient to consolidate various placards.

(5) The following is an example of a possible (but not necessarily complete) form for a consolidated placard for an airplane certificated in Normal and Utility Categories, using the Normal Category as the "basic" category for purposes of placarding and marking:

THIS AIRPLANE MUST BE OPERATED AS A NORMAL OR UTILITY CATEGORY AIRPLANE IN COMPLIANCE WITH THE APPROVED AIRPLANE FLIGHT MANUAL
All markings and placards on this airplane apply to its operation as a Normal Category Airplane. For Utility Category operations, refer to the Airplane Flight Manual
NO ACROBATIC MANEUVERS (INCLUDING SPINS) ARE APPROVED FOR NORMAL CATEGORY OPERATIONS.

(6) When the category selected for marking and placarding is the Utility Category, the appropriate placards for limiting the weight to the approved utility value should, of course, be posted. This may, for example, require placards on some of the seats, "Not to be occupied during Utility operations," and "Maximum baggage capacity during Utility Category operations, _____ pounds."

When the number of occupants permitted for the Utility Category is less than the number of seats, but the seating arrangement makes no difference, it may be more convenient to omit the seat placards and substitute a statement such as the following on the consolidated placard, "Maximum number of persons for Utility Category Operations, ______ ."

(7) For Utility Category maneuvering limitations, see CAM 3.6-1.

3.755-2 MARKINGS AND PLACARDS FOR FLAP SETTINGS. <u>(CAA policies which apply to section 3.755 (a), previously 3.62)</u>.

(a) FLAP SETTINGS AS RELATED TO PERFORMANCE. Instructions on flap settings relating to airplane performance should be included in the "performance information" section of the Manual, and should be identified with the corresponding performance data given in CAM 3.777-1 (g). If the applicant has demonstrated compliance with the pertinent performance requirements for a range of flap settings, the range may be given instead of a single setting. In this case, performance data should be shown for both extremes of the range, or for the critical setting within the range, plus explanation of the qualitative effect on performance of using other settings within the range.

(b) FLAP SETTINGS RESULTING IN UNSAFE CHARACTERISTICS. If improper setting of the flaps can result in dangerous characteristics, a suitable item should be included in the "operating limitations" section of the Flight Manual, and on a placard in view of the pilot.

Typical examples of "dangerous characteristics" would be cases in which a flap take-off setting less than that marked on the flap indicator would cause unusual difficulty in take-off by greatly extending the take-off distance, or affecting controllability (e.g. porpoising, or inability to raise nose wheel). Reasonable and gradual variations in performance with change in flap setting would not be considered dangerous. Cases of obvious pilot error need not be considered such as take-off with flaps in landing setting, provided the pertinent settings are adequately marked on the flap indicator.

"CAR 3.757 <u>Air-speed indicator</u>. (a) True indicated air speed shall be used:

"(1) The never-exceed speed, V_{ne}—a radial red line (see section 3.739).

"(2) The caution range—a yellow arc extending from the red line in (1) above to the upper limit of the green arc specified in (3) below.

"(3) The normal operating range--a green arc with the lower limit at V_{s_1}, as determined in section 3.82 with maximum weight, landing gear and wing flaps retracted, and the upper limit at the maximum structural cruising speed established in section 3.740.

"(4) The flap operating range—a white arc with the lower limit at V_{s_o} as determined in section 3.82 at the maximum weight, and the upper limit at the flaps-extended speed in section 3.742.

"(b) When the never-exceed and maximum structural cruising speeds vary with altitude, means shall be provided which will indicate the appropriate limitations to the pilot throughout the operating altitude range."

3.757-1 WHITE ARC ON AIR-SPEED INDICATOR. <u>(CAA interpretations which apply to section 3.757 (a) (4), previously 3.6200 (d))</u>.

The white arc on the air-speed indicator should extend to the "basic" flaps extended speed specified in CAR 3.742. Additional combinations of flap setting, airspeed and power established in accordance with CAR 3.742 should be listed in the airplane flight manual and may be listed on a placard if the manufacturer desires.

"CAR 3.759 Power-plant instruments. All required power-plant instruments shall be marked with a red radial line at the maximum and minimum (if applicable) indications for safe operation. The normal operating ranges shall be marked with a green arc which shall not extend beyond the maximum and minimum limits for continuous operation. Take-off and precautionary ranges shall be marked with a yellow arc."

3.759-1 POWER-PLANT INSTRUMENT MARKINGS. (CAA interpretations which apply to section 3.759, previously 3.6202).

(a) Where the propeller is restricted against operation in a definite r.p.m. range, because of vibrating stress considerations, such restrictions should be indicated by a red arc on the tachometer extending from the low to the high engine r.p.m. speeds corresponding to the restricted propeller speed r.p.m. ranges. This policy follows the general practice of the regulations in prescribing the use of red markings instead of yellow markings in indicating restrictions that are more than precautionary.

(b) Tachometer dial should not be marked to indicate restricted operating range due to propeller vibratory stress considerations when this consideration applies only under certain conditions such as when landing gear is extended. It is considered satisfactory for a placard covering such restricted ranges to be provided.

"CONTROL MARKINGS"

"CAR 3.762 General. All cockpit controls, with the exception of the primary flight controls, shall be plainly marked as to their function and method of operation."

3.762-1 MARKING OF BUTTON-TYPE STARTER SWITCHES. (CAA interpretation which applies to section 3.762, previously 3.621).

Simple push-button type starter switches need not be marked to indicate method of operation.

"AIRPLANE FLIGHT MANUAL"

"CAR 3.777 Airplane Flight Manual. An Airplane Flight Manual shall be furnished with each airplane. The portions of this document listed below shall be verified and approved by the Administrator, and shall be segregated, identified, and clearly distinguished from portions not so approved. Additional items of information having a direct and important bearing on safe operation may be required by the Administrator when unusual design, operating, or handling characteristics so warrant."

3.777-1 PREPARATION OF AIRPLANE FLIGHT MANUALS FOR AIRPLANES IN THE NORMAL, UTILITY, AND ACROBATIC CATEGORIES. (CAA policies which apply to section 3.777, previously 3.63).

(a) This section outlines an acceptable arrangement for the Airplane Flight Manual as required by CAR 3.777. It should be noted that the items outlined below for inclusion in the document will not all be necessary for a given airplane, and the Civil Aeronautics Administration is desirous of holding the document to the smallest practicable amount of material. Only the material required by CAR 3 should be included in the Civil Aeronautics Administration approved portion of the manual. However, if desired, the manufacturer may add other data in a distinctly separate section in the same cover. The portion of the material that is to be approved by the Civil Aeronautics Administration must be so marked and clearly separated from any other material so that no one could easily err in regard to the part that is approved.

(b) The page size for the Airplane Flight Manual will be left to the decision of the manufacturer. Some sort of a cover should be provided where more than one page is involved and should indicate the nature of the contents with the following title: "Airplane Flight Manual." Each page of the approved portion should bear the notation "CAA Approved" and the date of issuance. The material should be bound in some semipermanent fashion so that pages will not easily be lost, but should be so bound that revised pages can be inserted. In the case of small airplanes where the document consists of only one or two pages, superseding the entire document would be preferable to issuing revised pages. The aircraft specification will identify the manual by the approval date, and when different versions of the airplane (skiplanes, seaplanes, etc.) are covered in separate manuals, each will be listed. Also, the latest approved revisions will be shown.

(1) When an aircraft has tentative approval only, the following statement should appear on the inside of the front covering page of the manual:

> "The certificate of airworthiness issued to the aircraft described hereon, subject to the final issuance of a covering type certificate, is based upon tentative approval of aircraft of this model. Upon issuance of a covering type certificate, it may become necessary to make certain modifications or adjustments to the subject aircraft in order that the certificate of airworthiness may remain effective."

(c) The Airplane Flight Manual should contain as much of the material in sub-paragraphs (d) through (h) as is applicable to the individual model. It is suggested that the document be divided into sections as indicated in sub-paragraphs (d) through (h). The sequence of sections and of items within sections should follow the outline in so far as is practicable. This will facilitate revising the document when an airplane is altered in the field.

(d) ADMINISTRATIVE SECTION. (This section will be unnecessary in the case of small uncomplicated airplanes where the limitations consist of only one or two pages. In such cases the data noted for inclusion on the title page can be placed at the top of the first page.)

(1) TITLE PAGE. This page should include the manufacturer's name, airplane model and the registration number.

(2) TABLE OF CONTENTS. This page will not be necessary where the document consists of only a few pages.

(3) LOG OF REVISIONS. Should provide spaces in which to record revised pages and the date inserted. This page will not be necessary where the document is short and will be superseded completely if changes are necessary.

(e) LIMITATIONS SECTION:

(1) ENGINE POWER AND SPEED LIMITS. Should also list engine and propeller manufacturer and model.

(2) TEMPERATURE AND MANIFOLD PRESSURE LIMITS. Include, if applicable, minimum climbing airspeeds for hot weather operation.

(3) FUEL GRADE. This item as well as (1) and (2) above may, in the case of most airplanes, be covered together.

(4) PROPELLER. Should list propeller manufacturer and model.

(5) POWER-PLANT DOOR AND FLAP SETTINGS. Pertains only when cowl flaps, cooler doors or other similar devices are installed.

(6) PLACARDS (POWER-PLANT ONLY). Should list all power-plant operating placards and explain their significance, where pertinent.

(7) INSTRUMENT MARKINGS (POWER-PLANT INSTRUMENTS). Should list all power-plant instrument markings.

(8) AIRSPEED LIMITATIONS. Should include "never exceed speed," "maximum structural cruising speed," "maneuvering speed," "flaps extended speed," and "landing gear extended speed" where applicable.

(9) FLIGHT LOAD FACTORS. The pertinent load factors should be given in terms of accelerations.

(10) MAXIMUM WEIGHT. This should list maximum weights.

(11) C.G. RANGE. The approved c.g. limits and datum should be listed in inches.

(12) MANEUVERS. This should list the approved maneuvers with recommended entry speeds.

(13) PLACARDS (EXCEPT POWER-PLANT PLACARDS). Should list all flight placards and explain their significance where pertinent.

(14) INSTRUMENT MARKINGS (EXCEPT POWER-PLANT INSTRUMENTS). Should list all flight instrument markings, and explain their significance. (In most cases this will involve only the airspeed indicator.)

(15) MINIMUM CREW. This section should be used only when the minimum crew is more than one. Where used, the section should explain the basic duties of each crew member.

(f) PROCEDURES SECTION:

(1) NORMAL OPERATING PROCEDURES. For the small conventional airplane where all procedures are conventional, this section will not be necessary. Only unconventional features and peculiarities of the particular airplane should be covered here, and, in the case of more complex airplanes, the following should be covered where pertinent.

(i) One engine inoperative. Applies only to multiengine types and should contain all necessary procedures for such operation.

(ii) Propeller feathering. Applies only to multiengine types equipped with feathering propellers. Should contain full instructions on feathering and unfeathering.

(iii) Circuit breakers. Should contain full information on the location and method of resetting all circuit breakers installed.

(iv) Fire procedures. Pertains only to airplanes equipped with a built-in fire extinguishing system. Should contain full instructions on the operation of such systems as well as associated fire protection equipment and procedures.

(v) Emergency procedures for flaps, landing gear, fuel dumping, etc.

(vi) Other special operating procedures (if any).

(g) PERFORMANCE INFORMATION SECTION:

(1) TAKE-OFF DATA. Should include distance to clear 50 ft. obstacle, etc. at various altitudes and temperatures.

(2) CLIMB DATA. Should give normal rate of climb, balked landing climb (landing gear extended and wing flaps in landing position) and one-engine inoperative climb (for multiengine types) at various altitudes and temperatures.

(3) LANDING DATA. Should give distance to complete landing over 50 ft. obstacle and approach speed for various altitudes and temperatures.

(4) STALLING DATA. Should give stall speeds, stall warning indications and other pertinent data including stalling speeds at various angles of bank.

(v) WEIGHT AND BALANCE DATA SECTION. This section will not be included in the approved portion of the Airplane Flight Manual. It is the intention of the Civil Aeronautics Administration to place the responsibility for the control of weight and balance with the manufacturer and operator. The manufacturer will furnish a weight and balance report for each new airplane. The Civil Aeronautics Administration representative will not approve each individual report but will make only occasional spot checks to ascertain that the manufacturer's weight control procedure is adequate. The manufacturer will be expected to furnish complete information with the airplane, not only regarding its actual weight and balance, but also to include sketches, samples and other data that will assist the operator in checking the balance after alterations. The Repair and Alteration Form (ACA-337) has been revised to include space for recording the new empty weight, empty weight C.G. and useful load on the form after each change. A copy of this form will be given to the owner and his file of such forms, together with the manufacturer's original data will afford the owner with a complete and up-to-date file. In cases where the permissible C.G. positions vary with gross weight, it is suggested that a note be included in the weight and balance report advising owners to contact the airplane manufacturer when any change is made to the airplane which would appreciably affect the location of the empty C.G. or location of useful load items. The manufacturer is asked to cooperate in an educational program to inform the owner of his responsibility and the means whereby he can discharge it. To this end, a statement substantially as follows should be prominently displayed in the weight and balance section:

> "Note: It is the responsibility of the airplane owner and the pilot to insure that the airplane is loaded properly. The empty weight, empty weight C.G. and useful load are noted below for this airplane as delivered from the factory. If the airplane has been altered, refer to the latest approved Repair and Alteration Form (ACA-337) for this information."

(1) WEIGHT LIMITS. Should list and explain (where necessary) the various weight limits. In the case of a small airplane, only the maximum (gross) weight would be applicable.

(2) C.G. LIMITS. Approved operating C.G. range.

(3) EMPTY WEIGHT C.G. LIMITS WHERE PRACTICABLE. This applies to the empty weight C.G. range which will automatically assure compliance with the operating C.G. limits under the most adverse loading conditions.

(4) EMPTY WEIGHT AND EMPTY WEIGHT C.G. LOCATION.

(5) EQUIPMENT LIST. All equipment included in the empty weight. Equipment items should normally be identified by the item number and name used in the Aircraft Specification.

(6) WEIGHT COMPUTATIONS. The computations necessary to determine the empty weight C.G. location and the check of forward and aft C.G. locations where applicable.

(7) LOADING SCHEDULE. Supply where necessary.

(8) LOADING SCHEDULE INSTRUCTIONS. Complete instructions in the use of the loading schedule.

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(9) UNCONVENTIONAL AIRPLANES. The material in sub-paragraph (h) is believed to be complete and adequate for a conventional airplane. In the case of unconventional airplanes or airplanes with special features, the foregoing should be modified or amplified as necessary to cover the case.

(i) NUMBER OF COPIES. Three copies of the above material, less the Weight and Balance Data Section, should be submitted to the appropriate Civil Aeronautics Administration regional office by the manufacturer for an original approval. One copy will be signed by the Chief, Aircraft Division, and returned to the manufacturer. Revisions to the manual will be approved in the regional office. One copy of the Weight and Balance Data Section should be included in the manual by the manufacturer for each airplane at the time of certification.

(j) SAMPLE OF AIRPLANE FLIGHT MANUAL. A sample of an Airplane Flight Manual that fulfills the requirements in the case of a small uncomplicated airplane is given on the attached sheet, and is identified by number as CAM 3.777-1 (k).

3.777-2 CALCULATED EFFECTS OF TEMPERATURE AND ALTITUDE VARIATIONS. CAA policies which apply to section 3.777, previously 3.63).

See CAM 3.780-1.

3.777-3 PERFORMANCE DATA FOR ALTERED PART 3 AIRPLANES. (CAA policies which apply to section 3.777, previously 3.63).

See CAM 3.780-2.

3.777-4 PERFORMANCE DATA AND FLIGHT TESTS FOR SKI INSTALLATIONS ON PART 3 AIRPLANES. (CAA policies which apply to section 3.777, previously 3.63).

See CAM 3.780-3.

SAMPLE SHEET

THIS DOCUMENT MUST BE KEPT IN AIRPLANE AT ALL TIMES

C.A.A. Approved
January 1, 1947

RONSON AIRCRAFT CO.
LOS ANGELES
MAINE

RONSON 98
NORMAL AND
UTILITY CATEGORIES

CAA Identification No. _____

AIRPLANE FLIGHT MANUAL

1. LIMITATIONS

The following limitations must be observed in the operation of this airplane:

Engine	Motors model 150A		
Engine limits	For all operations - 2500 rpm, 150 hp		
Fuel	73 minimum octane aviation gasoline		
Propeller	Hamilton Standard constant speed, hub 2D30, blades 6167A-15. Pitch settings, high 29°, low 14° at 42 in. sta.		
Power Instrument	(a) Fuel quantity guage: Fuel remaining in tank when indicator is in the region marked in RED can not safely be used in flight. (b) Oil temperature: Unsafe if indicator exceeds RED line (200° F) (c) Tachometer: RED line at rated engine speed. DO NOT EXCEED.		
Airspeed limits (True indicated airspeed)		Normal Category	Utility Category
	Never exceed	150 mph	165 mph
	Max. structural cruising	120 mph	120 mph
	Maneuvering	110 mph	110 mph
	Flaps extended	90 mph	90 mph
Flight load factors	Max. positive load factors	3.9	4.5
	Max. negative load factor:	No inverted maneuvers approved.	
Maximum weight		2100 lbs.	1900 lbs.

C. G. range: (+11.0) to (+22.4)
Datum - L.E. of wing.

NOTE: It is the responsibility of the airplane owner and the pilot to insure that the airplane is properly loaded.

(a) No acrobatic maneuvers approved for Normal Category operation.

(b) The following maneuvers are approved for operation in the Utility Category only, with recommended entry speeds shown:

CHANDELLES - 110 MPH TIAS LAZY EIGHTS - 105 MPH TIAS
STEEP TURNS - 100 MPH TIAS SPINS
STALLS (EXCEPT WHIP STALLS)

Airspeed instrument markings and their significance

(a) Radial RED line marks the never exceed speed which is the maximum safe airspeed.

(b) YELLOW arc on indicator denotes range of speeds in which operations should be conducted with caution and only in smooth air.

(c) GREEN arc denotes normal operating speed range.

(d) WHITE arc denotes speed range in which flaps may safely be lowered.

NOTE: Maneuvers involving approach to stalling angle or full application of elevator rudder or aileron should be confined to speeds below maneuvering speed.

2. PROCEDURES

Normal operating procedures

(a) Rear seat must not be occupied when airplane is operated in the Utility Category.

SAMPLE SHEET

C.A.A. Approved
January 1, 1947

3. PERFORMANCE INFORMATION

The following performance figures were obtained during Civil Aeronautics Administration type tests and may be realized under conditions indicated with the airplane and engine in good condition and with average piloting technique.

All performance is given for 2100 lbs. weight, with no wind and on level, paved runways. In using the following data, allowance for actual conditions must be made.

ITEM	ALTITUDE	OUTSIDE AIR TEMPERATURES				
		0°F.	25°F.	50°F.	75°F.	100°F.
Take-off Distance (in feet)	Sea Level	625	750	900	1000	1075
Distance req'd to take-off and climb 50 ft. Full throttle	2000 ft.	1125	1275	1475	1600	1700
80 mph climb speed Flaps down 10°	4000 ft.	1625	1875	2050	2200	2550
	6000 ft.	2100	2300	2500	2700	3000
Landing Distance (in feet) Distance req'd to land	Sea Level	1200	1250	1300	1350	1400
over 50 ft. obstacle and stop.	2000 ft.	1260	1320	1380	1440	1500
Flaps full down	4000 ft.	1340	1400	1450	1510	1570
Approach at 75 mph	6000 ft.	1420	1480	1520	1580	1640
Normal Rate of climb (ft. per min.)	Sea Level	800	760	720	680	640
Full throttle Flaps up	2000 ft.	680	640	600	560	520
Airspeed 80 mph	4000 ft.	550	510	470	430	390
	6000 ft.	420	380	340	300	260
Balked Landing Climb (feet per minute)	Sea Level	600	570	530	500	470
Full throttle Flaps down	2000 ft.	490	450	420	380	350
Airspeed 80 mph	4000 ft.	380	340	300	270	240
	6000 ft.	260	230	190	160	120
Stalling Speeds (mph) Power off	Angle of Bank	0°	20°	40°	50°	60°
	Flaps up	55	57	64	70	80
	Flaps full down	50				

(Following the performance information would be the section on weight and balance. The manufacturer may merely append his regular weight and balance forms if he desires).

absolute ceiling and a temperature range from 60° F. below the standard temperature to 40° F. above the standard temperature at the altitude involved.

3.780-2 PERFORMANCE DATA FOR ALTERED PART 3 AIRPLANES. (CAA policy which applies to section 3.780, previously 3.632).

Performance data for altered CAR 3 airplanes must be changed in the Airplane Flight Manual if the alteration decreases the performance below that given in the existing manual. If performance can be shown to equal or exceed original values then a statement in the manual to this effect is sufficient.

3.780-3 PERFORMANCE DATA AND FLIGHT TESTS FOR SKI INSTALLATIONS ON PART 3 AIRPLANES. (CAA policies which apply to section 3.780, previously 3.632).

(a) TAKE-OFF AND LANDING DISTANCES. It will not be necessary, in complying with CAR 3.780 (a) (3) and (4), to make take-off and landing distance tests on skiplane installations where landplane distances are given in the Airplane Flight Manual. The following, or similar, statements should be given in the performance information section of the Airplane Flight Manual.

(1) TAKE-OFF. Under the most favorable conditions of smooth packed snow at temperatures approximating 32° F. the skiplane take-off distance is approximately 10% greater than that shown for the landplane.

> Note: In estimating take-off distances for other conditions caution should be exercised in that lower temperatures or other snow conditions will usually increase these distances.

(2) LANDING. Under the most favorable conditions of smooth packed snow at temperatures approximating 32°F. the skiplane landing distance is approximately 20% greater than that shown for the landplane.

> Note: In estimating landing distances for other conditions caution should be exercised in that other temperatures or other snow conditions may either decrease or increase these distances.

(b) CLIMB PERFORMANCE. In cases where the landing gear is fixed (both landplane and skiplane), where the climb requirements are not critical, and the climb reduction is small (30 to 50 ft. per minute), the CAA will accept a statement of the approximate reduction in climb performance

"CAR 3.780 Performance information. (a) Information relative to the following items of performance shall be included:

"(1) The stalling speed, V_{s_o}, at maximum weight,

"(2) The stalling speed, V_{s_1}, at maximum weight and with landing gear and wing flaps retracted,

"(3) The take-off distance determined in accordance with section 3.84, including the air speed at the 50-foot height, and the airplane configuration, if pertinent,

"(4) The landing distance determined in accordance with section 3.86, including the airplane configuration, if pertinent.

"(5) The steady rate of climb determined in accordance with section 3.85 (a), (c), and, as appropriate, (b), including the air speed, power, and airplane configuration, if pertinent.

"(b) The effect of variation in (a) (2) with angle of bank up to 60 degrees shall be included.

"(c) The calculated approximate effect of variations in subparagraphs (3), (4) and (5) of this paragraph with altitude and temperature shall be included."

3.780-1 CALCULATED EFFECTS OF TEMPERATURE AND ALTITUDE VARIATIONS. (CAA policies which apply to section 3.780 (c), previously 3.780 (a) (3)).

(a) CAR 3.780 (c) requires that the calculated effects of variations in temperature and altitude on the take-off distance, (CAR 3.84), the landing distance, (CAR 3.86), and the steady rate of climb, (CAR 3.85), shall be included in the Airplane Flight Manual. The following ranges of these variables are considered acceptable:

(1) The altitudes and temperatures for which performance in take-off distance, landing distance, take-off climb and balked landing climb shall be calculated are sea-level to 7,000 ft. and 0° F. to 100° F. respectively, except that take-off and landing distances for a seaplane need not show temperatures below 30° F. at altitudes above 1,000 ft.

(2) For multi-engined aircraft, the climb with the critical engine inoperative should be calculated for an altitude range of sea-level to

placed in the Airplane Flight Manual performance information section. For larger variations in climb performance, or where the minimum requirements are critical, or where the landing gear of the landplane was retractable, appropriate climb data should be obtained to determine the changes, and new curves, tables, or a note should be incorporated in the Airplane Flight Manual.

(c) FLIGHT AND HANDLING TESTS. At least a general flight check should be made prior to approval. This should include more than one landing to determine the ground handling characteristics as well as take-off and landing characteristics. Note should be taken of ski angle at landing contact during tail high and tail low landings to avoid having the ski dig in or fail from localized stress. Ground control should be sufficient to satisfactorily complete a landing run with a turn off at slow speed in cases where brakes are not provided. In flight the ski should ride steady with no unusual drag and produce no unsatisfactory flight characteristics. Spin checks should be made on all aircraft in which spins are an approved maneuver. When spins are approved under CAR 3.124 (a), investigation with ski installations need not be made unless the spin characteristics of the type are known to be marginal.

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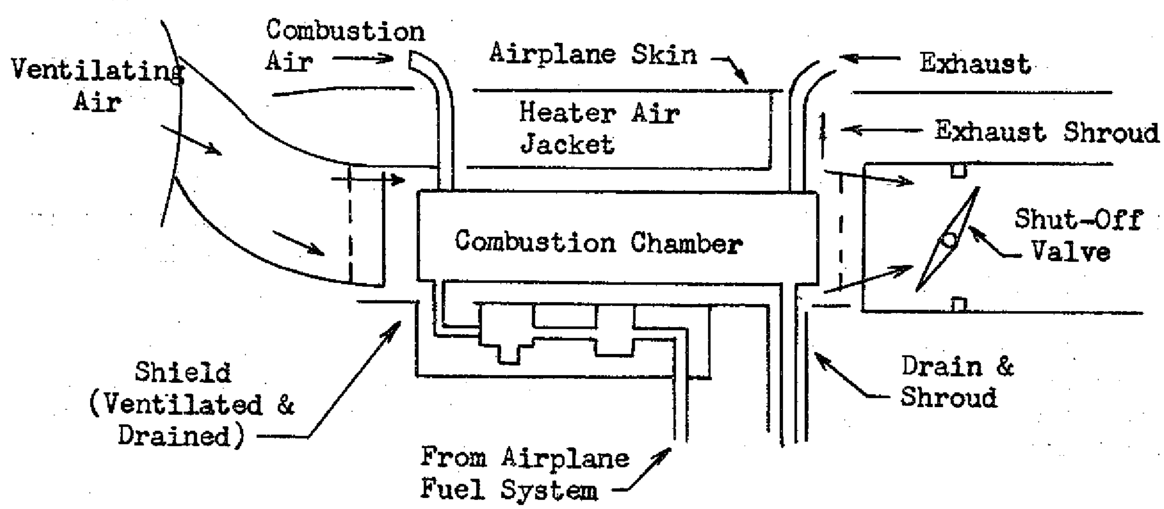
"CAR 3.388 <u>Fire precautions</u>. (a) <u>Cabin interiors</u>. Only materials which are flash-resistant shall be used. In compartments where smoking is to be permitted, the materials of the cabin lining, floors, upholstery, and furnishings shall be flame-resistant. Such compartments shall be equipped with an adequate number of self-contained ash trays. All other compartments shall be placarded against smoking.

"(b) <u>Combustion heaters</u>. Gasoline operated combustion heater installations shall comply with applicable parts of the power-plant installation requirements covering fire hazards and precautions. All applicable requirements concerning fuel tanks, lines, and exhaust systems shall be considered."

3.388-1 HEATER ISOLATION. <u>(CAA policies which apply to section 3.388 (b), previously 3.38132)</u>.

(a) Under CAR 3.388 (b) and 3.623, heaters should be isolated from the remainder of the airplane by means of a fireproof shield. However, this need not necessarily mean a complete shield around the entire heater unit (although this would be satisfactory) since in many heater designs, a fireproof air jacket largely surrounds the flame chamber. Thus, the heater design itself practically provides a steel shield between the combustion unit and the remainder of the airplane. In such cases, it should suffice to provide isolation for the fuel system components mounted on the heater and for the heater exhaust and combustion chamber drains.

(b) The following schematic sketch shows an example of an installation which should be satisfactory:



(e) Detectors may be dispensed with as an alternative to fireproof isolation, only when the heater is so located that the occurrence of fire would immediately be noted by the crew.

3.388-3 HEATER FUEL SYSTEM. (CAA policies which apply to section 3.388 (b), previously 3.38132).

(a) The heater fuel system should comply with airworthiness standards for the engine fuel system as regards fuel lines, fittings and accessories.

(b) Valves should be provided for shutting off in flight the flow of fuel at its source, unless equivalent provisions in the form of a separate heater fuel pump are available.

(c) All pressure lines should comply with the provisions of CAR 3.432 regarding pressure cross feed arrangements.

3.388-4 COMBUSTION HEATERS. (CAA rules which apply to section 3.388 (b), previously 3.38132).

The minimum safety requirements for combustion heaters which are intended for use in civil aircraft have been established by the Administrator in Technical Standard Order No. TSO-C20, effective June 15, 1949, "Combustion Heaters."

"CAR 3.390 Seats and berths. (a) Passenger seats and berths. All seats and berths and supporting structure shall be designed for a passenger weight of 170 pounds (190 pounds with parachute for the acrobatic and utility categories) and the maximum load factors corresponding to all specified flight and ground load conditions including the emergency conditions of section 3.386.

"(b) Pilot seats. Pilot seats shall be designed for the reactions resulting from the application of the pilot forces to the primary flight controls as specified in section 3.231.

"(c) Categories U and A. All seats designed to be occupied in the U and A categories under section 3.74 (c) (4) shall be designed to accommodate passengers wearing parachutes."

3.390-1 APPROVAL OF SEATS AND BERTHS, AND THEIR INSTALLATIONS. (CAA policies which apply to section 3.390, previously 3.3822).

(a) Seats and berths and their installations, as well as related aircraft components, can be approved by any one of the three following procedures:

(1) Proof of compliance with the strength and deformation requirements of the regulations may be obtained on the basis of structural analysis alone when the structure conforms with conventional types for which the existing methods of analysis are known to be reliable.

(2) Proof of such compliance may be obtained by a combination of analysis and load tests to limit loads.

(3) Proof of such compliance may be obtained by static load tests alone, when such tests are carried to design ultimate loads.

(b) All seats shall be designed for the weights stipulated in this section (170 pounds for normal category; 190 pounds for utility and acrobatic category). When designed for a lower weight than those referred to above, the seat should be placarded to indicate the permissible, maximum weight of the occupant (see CAR 3.766).

"CAR 3.391 <u>Safety belt or harness provisions</u>. Provisions shall be made at all seats and berths for the installation of belts or harness of sufficient strength to comply with the emergency conditions of section 3.386."

3.391-1 SAFETY BELT ATTACHMENT LOADS. <u>(CAA interpretations which apply to section 3.391, previously 3.38221)</u>.

All airplanes to which CAR 3.391 is applicable under CAR 3.2, should have structural provisions and attachments adequate for the safety belt loads corresponding to the requirements of CAR 3.386, even though certificated safety belts meeting these requirements may not yet be available.

"CAR 3.392 Cargo compartments. Each cargo compartment shall be designed for the placarded maximum weight of contents and critical load distributions at the appropriate maximum load factors corresponding to all specified flight and ground load conditions. Suitable provisions shall be made to prevent the contents of cargo compartments from becoming a hazard by shifting. Such provisions shall be adequate to protect the passengers from injury by the contents of any cargo compartment when the ultimate forward acting accelerating force is 4.5g."

3.392-1 LOAD FACTORS FOR DESIGN OF CARGO COMPARTMENTS LOCATED IN THE FUSELAGE. (CAA interpretations which apply to section 3.392, previously 3.3823).

(a) It would seem on examination of CAR 3.392 and CAR 3.386 that there is a conflict between the load factors required for the design of cargo compartments which are located in the fuselage. The following explanation should clarify this possible misconception:

(1) CAR 3.392 was specially promulgated to overcome objections to the excessively heavy cargo compartment structure that would be required to meet the crash conditions of CAR 3.386. In past cases of crashes, injuries to passengers caused by shifting cargo or baggage have not been prevalent despite the fact that in many cases the lower design factors of Bulletin 7a and CAR 4a were in effect. Because of this, CAR 3.392 was incorporated in the requirements, to apply specifically to cargo compartments. It should therefore not be necessary to consider the strength requirements of CAR 3.386 in their design.

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"CAR 3.419 Speed limitations for fixed-pitch propellers, ground adjustable pitch propellers, and automatically varying pitch propellers which cannot be controlled in flight. (a) During take-off and initial climb at best rate-of-climb speed, the propeller, in the case of fixed pitch or ground adjustable types, shall restrain the engine to a speed not exceeding its maximum permissible take-off speed and, in the case of automatic variable-pitch types, shall limit the maximum governed engine revolutions per minute to a speed not exceeding the maximum permissible take-off speed. In demonstrating compliance with this provision the engine shall be operated at full throttle or the throttle setting corresponding to the maximum permissible take-off manifold pressure.

"(b) During a closed throttle glide at the placard, 'never-exceed speed' (see section 3.739), the propeller shall not cause the engine to rotate at a speed in excess of 110 percent of its maximum allowable continuous speed."

3.419-1 PROPELLER PITCH AND SPEED LIMITATIONS. (CAA interpretations which apply to section 3.419, previously 3.41110).

(a) The low pitch setting should comply with CAR 3.419 (a) which states that the propeller shall not exceed the rated engine take-off r.p.m. with take-off power (full throttle unless limited by manifold pressure) during take-off and initial climb at best rate of climb speed. It is not permissible to use a lower pitch setting than that specified above in order to obtain take-off r.p.m. at the best angle of climb speed for the purpose of showing compliance with CAR 3.85 (c), Balked Landing Climb. An exception to the above may be granted in the specific case covered by CAM 3.85-5, when satisfactory engine cooling can be demonstrated at the best angle of climb speed in the balked landing configuration (CAR 3.85 (c)). However, in cases where the interpretation of CAR 3.85 does not govern, it will be necessary to conduct the balked landing climb with whatever r.p.m. is possible without exceeding the engine take-off limitations with the low pitch setting determined in accordance with CAR 3.419 (a).

(b) In cases where the airplane is to be operated using either the water injection or dry take-off power ratings of the engines, the low pitch stop setting shall be determined on the basis of whichever rating will result in the lower pitch. This will generally be the "dry" rating. In instances where the airplane is intended to be operated only at the water injection take-off power ratings of the engines, the low pitch stop for the propellers should be determined on that basis. These settings are to be determined in the usual manner with the airplane static unless there are unconventional features in the propeller installation requiring this determination by some other means.

(c) In cases where dual engines drive a single propeller through free wheeling clutches, the setting of the low pitch stop should be such that the propeller will not overspeed when take-off power is applied to one engine at an airplane speed of V_2.

"CAR 3.422 Propeller clearance. With the airplane loaded to the maximum weight and most adverse center of gravity position and the propeller in the most adverse pitch position, propeller clearances shall not be less than the following, unless smaller clearances are properly substantiated for the particular design involved:

"(a) Ground clearance. (1) Seven inches (for airplanes equipped with nose wheel type landing gears) or 9 inches (for airplanes equipped with tail wheel type landing gears) with the landing gear statically deflected and the airplane in the level, normal take-off, or taxiing attitude, whichever is most critical.

"(2) In addition to subparagraph (1) of this paragraph, there shall be positive clearance between the propeller and the ground when, with the airplane in the level take-off attitude, the critical tire is completely deflated and the corresponding landing gear strut is completely bottomed.

"(b) Water clearance. A minimum clearance of 18 inches shall be provided unless compliance with section 3.147 can be demonstrated with lesser clearance.

"(c) Structural clearance. (1) One inch radial clearance between the blade tips and the airplane structure, or whatever additional radial clearance is necessary to preclude harmful vibration of the propeller or airplane.

"(2) One-half inch longitudinal clearance between the propeller blades or cuffs and stationary portions of the airplane. Adequate positive clearance shall be provided between other rotating portions of the propeller or spinner and stationary portions of the airplane."

3.422-1 PROPELLER CLEARANCE ON TRICYCLE GEAR AIRPLANES. (CAA interpretation which applies to section 3.422 (a) (1), previously 3.4112 (a) (1)).

In determining minimum propeller clearance for aircraft equipped with tricycle gear, dynamic effects need not be considered.

3.422-2 PROPELLER CLEARANCE ON AIRCRAFT WITH LEAF SPRING TYPE SHOCK STRUTS. (CAA interpretation which applies to section 3.422 (a) (2), previously 3.4112 (a) (2)).

CAR 3.422 (a) (2) applies only to conventional landing gear struts employing fluid and for mechanical means for absorbing landing shocks. Aircraft employing struts of the leaf spring type need only be loaded to one load factor to determine whether positive clearance exists.

"CAR 3.442 Fuel tank installation. (a) The method of support for tanks shall not be such as to concentrate the loads resulting from the weight of the fluid in the tanks. Pads shall be provided to prevent chafing between the tank and its supports. Materials employed for padding shall be nonabsorbent or shall be treated to prevent the absorption of fluids. If flexible tank liners are employed, they shall be so supported that the liner is not required to withstand fluid loads. Interior surfaces of compartments for such liners shall be smooth and free of projections which are apt to cause wear of the liner, unless provisions are made for protection of the liner at such points or unless the construction of the liner itself provides such protection.

"(b) Tank compartments shall be ventilated and drained to prevent the accumulation of inflammable fluids or vapors. Compartments adjacent to tanks which are an integral part of the airplane structure shall also be ventilated and drained.

"(c) Fuel tanks shall not be located on the engine side of the fire wall. Not less than one-half inch of clear air space shall be provided between the fuel tank and the fire wall. No portion of engine nacelle skin which lies immediately behind a major air egress opening from the engine compartment shall act as the wall of an integral tank. Fuel tanks shall not be located in personnel compartments, except in the case of single-engine airplanes. In such cases fuel tanks the capacity of which does not exceed 25 gallons may be located in personnel compartments, if adequate ventilation and drainage are provided. In all other cases, fuel tanks shall be isolated from personnel compartments by means of fume and fuel proof enclosures."

3.442-1 BLADDER TYPE FUEL CELLS LOCATED IN A PERSONNEL COMPARTMENT. (CAA interpretations which apply to section 3.442, previously 3.4231).

In the case where a bladder type fuel cell having a fuel capacity in excess of 25 gallons is located in a personnel compartment, a separate fume and fuel proof enclosure for the fuel cell and its retaining shell is not deemed necessary provided the retaining shell is at least equivalent to a conventional metal fuel tank in structural integrity and fume and fuel tightness. The shell surrounding the tank should be adequately drained to the exterior of the airplane.

"OIL SYSTEM"

"CAR 3.561 Oil system. Each engine shall be provided with an independent oil system capable of supplying the engine with an ample quantity of oil at a temperature not exceeding the maximum which has been established as safe for continuous operation. The oil capacity of the system shall not be less than 1 gallon for every 25 gallons of fuel capacity. However, in no case shall the oil capacity be less than 1 gallon for each 75 maximum continuous horsepower of the engine(s) involved unless lower quantities can be substantiated."

3.561-1 CAPACITY. (CAA interpretations which apply to section 3.356, previously 3.43).

The word "capacity" as used in CAR 3.561 is interpreted by the Administrator as follows:

(a) Only the usable fuel system capacity need be considered.

(b) In a conventional oil system (no transfer system provided) only the usable oil tank capacity should be considered. The quantity of oil in the engine oil lines, the oil radiator, or in the feathering reserve should not be included. When an oil transfer system is installed, and the transfer pump is so located that it can pump some of the oil in the transfer lines into the main engine oil tanks, the quantity of oil in these lines which can be pumped by the transfer pump may be added to the oil capacity.

"TESTS"

"CAR 3.582 Cooling tests. Compliance with the provisions of section 3.581 shall be demonstrated under critical ground, water, and flight operating conditions. If the tests are conducted under conditions which deviate from the highest anticipated summer air temperature (see section 3.583), the recorded power-plant temperatures shall be corrected in accordance with the provisions of sections 3.584 and 3.585. The corrected temperatures determined in this manner shall not exceed the maximum established safe values. The fuel used during the cooling tests shall be of the minimum octane number approved for the engines involved, and the mixture settings shall be those appropriate to the operating conditions. The test procedures shall be as outlined in sections 3.586 and 3.587."

3.582-1 WATER TAXIING TESTS. (CAA interpretation which applies to section 3.582, previously 3.440).

No water taxiing tests need be conducted on aircraft certificated under CAR 3, except in the case of flying boats which may reasonably be expected to be taxied for extended periods.

"CAR 3.583 Maximum anticipated summer air temperatures. The maximum anticipated summer air temperature shall be considered to be 100° F. at sea level and to decrease from this value at the rate of 3.6° F. per thousand feet of altitude above sea level."

3.583-1 POWERPLANT WINTERIZATION EQUIPMENT. (CAA interpretations which apply to section 3.583, previously 3.4400).

(a) Cooling test results for winterization installations may be corrected to any temperature desired by the manufacturer rather than the conventional 100° F. hot day. For example, if a manufacturer chooses to demonstrate cooling to comply with requirements for a 50 or 60° F. day with winterization equipment installed, he may do so. In such a case the sea level temperature for correction purposes should be considered to be the value elected by the manufacturer with a rate of temperature drop of 3.6° F. per thousand feet above sea level.

(b) Cooling tests and temperature correction methods should be the same as for conventional cooling tests.

(c) The airplane flight manual should clearly indicate that winterization equipment must be removed whenever the temperature reaches the limit for which adequate cooling has been demonstrated. The cockpit should also be placarded accordingly. In addition, the airplane should be equipped with an ambient air temperature gauge or, alternatively, a cylinder head, barrel, or oil inlet temperature gauge (depending upon which is critical).

(d) If practical, winterization equipment such as baffles for oil radiators or for engine cooling air openings should be marked clearly to indicate the limiting temperature at which this equipment should be removed.

(e) Since winterization equipment is often supplied in kit form, accompanied by instructions for its installation, suitable information regarding temperature limitations should be included in the installation instructions for such kits.

"CAR 3.587 Cooling test procedure for multiengine airplanes. (a) Airplanes which meet the minimum one-engine-inoperative climb performance specified in section 3.85 (b). The engine cooling test for these airplanes shall be conducted with the airplane in the configuration specified in section 3.85 (b), except that the operating engine(s) shall be operated at maximum continuous power or at full throttle when above the critical altitude. After stabilizing temperatures in flight, the climb shall be started at the lower of the two following altitudes and shall be continued until at least 5 minutes after the highest temperature has been recorded:

"(1) 1,000 feet below the engine critical altitude or at the lowest practicable altitude (when applicable).

"(2) 1,000 feet below the altitude at which the single-engine-inoperative rate of climb is $0.02\ V_{s_o}^{\ 2}$.

"The climb shall be conducted at a speed not in excess of the highest speed at which compliance with the climb requirement of section 3.85 (b) can be shown. However, if the speed used exceeds the speed for best rate of climb with one engine inoperative, a cylinder head temperature indicator shall be provided as specified in section 3.675.

"(b) Airplanes which cannot meet the minimum one-engine-inoperative climb performance specified in section 3.85 (b). The engine cooling test for these airplanes shall be the same as in paragraph (a) of this section, except that after stabilizing temperatures in flight, the climb (or descent, in the case of airplanes with zero or negative one-engine-inoperative rate of climb) shall be commenced at as near sea level as practicable and shall be conducted at the best rate-of-climb speed (or the speed of minimum rate of descent, in the case of airplanes with zero or negative one-engine-inoperative rate of climb)."

3.587-1 COOLING TEST PROCEDURE FOR TWIN ENGINE AIRCRAFT WHICH DO NOT MEET THE MINIMUM ONE-ENGINE-INOPERATIVE CLIMB PERFORMANCE. (CAA interpretation which applies to section 3.587 (b), previously 3.4404 (b)).

In order to provide a practicable test procedure for compliance with this requirement, the engine temperatures should be stabilized in flight at the lowest practicable altitude above the ground, with maximum continuous power from the engine on which cooling is being investigated, and with just sufficient power on the other engine to maintain level flight at the speed for minimum rate of descent.

"CAR 3.606 Induction system de-icing and anti-icing provisions. The engine air induction system shall incorporate means for the prevention and elimination of ice accumulations in accordance with the provisions in this section. It shall be demonstrated that compliance with the provisions outlined in the following paragraphs can be accomplished when the airplane is operating in air at a temperature of 30° F. when the air is free of visible moisture.

"(a) Airplanes equipped with sea level engines employing conventional venturi carburetors shall be provided with a preheater capable of providing a heat rise of 90° F. when the engine is operating at 75 percent of its maximum continuous power.

"(b) Airplanes equipped with altitude engines employing conventional venturi carburetors shall be provided with a preheater capable of providing a heat rise of 120° F. when the engine is operating at 75 percent of its maximum continuous power.

"(c) Airplanes equipped with altitude engines employing carburetors which embody features tending to reduce the possibility of ice formation shall be provided with a preheater capable of providing a heat rise of 100° F. when the engine is operating at 60 percent of its maximum continuous power. However, the preheater need not provide a heat rise in excess of 40° F. if a fluid de-icing system complying with the provisions of sections 3.607-3.609 is also installed."

3.606-1 INDUCTION SYSTEM DE-ICING PROVISIONS. (CAA policies which apply to section 3.606, previously 3.450).

(a) A series of pressure type carburetors for small engines has been developed which incorporate the feature of injecting fuel into the intake air at a point downstream from the throttle and carburetor venturi. This feature tends to greatly reduce the possibility of ice formation in the engine induction system and the results of extensive tests have demonstrated the carburetors to be relatively free of icing hazards.

(b) In order to outline the limitations of our approval for the elimination of preheat on the carburetors, and to provide what are considered equivalent safety margins the following is stipulated:

(1) This approval applies only to sea level engines of the general power class with which the largest of these pressure carburetors has been tested. No tests have as yet been conducted on any altitude engines. The largest of these carburetors which has been tested at present is a model which is intended for use on engines in the general range of approximately 220 horsepower.

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(2) Unless the main carburetor air intake is located in a sheltered position where it is free from impact icing possibilities, a sheltered alternate air intake should be provided even though there is no preheater.

(c) During tests of the non-icing qualities of these carburetors, it was found that in some cases poor idling of the engine was encountered and this was attributed to a possible ice formation in the internal carburetor passage which acts as the air bleed for the main discharge nozzle. As a result, it is necessary to provide a small intensifier tube to supply hot air to the air bleed side of the main discharge nozzle on installation in which the carburetor and a portion of the induction system are exposed to the exterior of the airplane. When the installation is completely cowled, the hot air bleed will not be necessary.

"FIRE WALL AND COWLING"

"CAR 3.623 Fire walls. All engines, auxiliary power units, fuel burning heaters, and other combustion equipment which are intended for operation in flight shall be isolated from the remainder of the airplane by means of fire walls, or shrouds, or other equivalent means."

3.623-1 FIRE-PROOF MATERIALS FOR FIREWALLS. (CAA rules which apply to section 3.623, previously 3.470).

(a) The test for demonstrating compliance with criteria for fire-proof material or components shall subject the material or unit to a $2000 \pm 50^{\circ}$ F. flame. Sheet materials shall be tested by subjecting a sample approximately 10 inches square to a flame from a suitable burner. The flame shall be large enough to maintain the required test temperature over an area approximately five inches square.

(b) Firewall materials and fittings shall resist flame penetration for 15 minutes.

(c) The following materials are considered satisfactory for use in firewalls or shrouds without being tested as outlined in sub-paragraphs (a) and (b):

(1) Stainless steel sheet, .015 inches thick.
(2) Mild steel sheet coated with aluminum or otherwise protected against corrosion, .018 inches thick.
(3) Terne plate, .018 inches thick.
(4) Monel metal, .018 inches thick.
(5) Steel or copper base alloy firewall fittings.

"CAR 3.672 Fuel quantity indicator. Means shall be provided to indicate to the flight personnel the quantity of fuel in each tank during flight. Tanks, the outlets and air spaces of which are interconnected, may be considered as one tank and need not be provided with separate indicators. Exposed sight gauges shall be so installed and guarded as to preclude the possibility of breakage or damage. Fuel quantity indicators shall be calibrated to read zero during level flight when the quantity of fuel remaining in the tank is equal to the unusable fuel supply as defined by section 3.437."

3.672-1 MEANS TO INDICATE FUEL QUANTITY. (CAA policies which apply to section 3.672, previously 3.5222)

The Administrator will accept, as a "means to indicate to the flight personnel the quantity of fuel in each tank during flight," a fuel tank calibrated to read in either gallons or pounds, providing the gauge is clearly marked to indicate which scale is being used.

"ELECTRICAL SYSTEMS AND EQUIPMENT"

"CAR 3.681 Installation. (a) Electrical systems in airplanes shall be free from hazards in themselves, in their method of operation, and in their effects on other parts of the airplane. Electrical equipment shall be of a type and design adequate for the use intended. Electrical systems shall be installed in such a manner that they are suitably protected from fuel, oil, water, other detrimental substances, and mechanical damage.

"(b) Items of electrical equipment required for a specific type of operation are listed in other pertinent parts of the Civil Air Regulations."

3.681-1 SHIELDING OF FLARE CIRCUITS. (CAA policy which applies to section 3.681, previously 3.53).

Flare circuits should be shielded or separated from other circuits far enough to preclude induction of other current into flare circuit.

"MASTER SWITCH"

"CAR 3.688 Arrangement. If electrical equipment is installed, a master switch arrangement shall be provided which will disconnect all sources of electrical power from the main distribution system at a point adjacent to the power sources.

3.688-1 STALL WARNING INDICATOR CIRCUITS. (CAA policies which apply to section 3.688, previously 3.532).

(a) WIRING OF CIRCUIT BY THE MASTER SWITCH. Airplanes on which the indicators are required for type certification as a result of the particular stall characteristics of the airplane, should have the indicator circuit by-pass the master switch. A circuit protector should be installed for the protection of the indicator wiring and this protector should be located as near as is practicable to the source of electric power.

(b) WIRING OF CIRCUIT THROUGH THE MASTER SWITCH. Where the indicator is installed as an accessory but not as required equipment, it is permissible to wire the indicator through the master switch or direct to the source of power. A circuit protector should be installed for the protection of the indicator wiring and this protector should be located as near as is practicable to the source of the electric power.

"INSTRUMENT LIGHTS"

"CAR 3.696 Instrument lights. If instrument lights are required, they shall be of such construction that there is sufficient distance or insulating material between current-carrying parts and the housing so that vibration in flight will not cause shorting. They shall provide sufficient illumination to make all instruments and controls easily readable and discernible, respectively.

3.696-1 INSTRUMENT LIGHTS. (CAA interpretation which applies to section 3.696, previously 3.536).

The use of the cabin dome light is not considered adequate to comply with the provision of CAR 3.696.

"CAR 3.702 Rear position light installation. The rear position light shall be mounted as far aft as practicable and so installed that unbroken light is directed symmetrically aft in such a manner that the axis of the maximum cone of illumination is parallel to the flight path. In addition, the intersection of the two planes forming dihedral angle A given in Part 15 of this chapter shall be vertical."

3.702-1 REAR POSITION LIGHT INSTALLATION. (CAA interpretation which applies to section 3.702, previously 3.5381).

A single rear position light may be installed in a position displaced laterally from the plane of symmetry of an airplane if the axis of the maximum cone of illumination is parallel to the flight path in level flight, and if there is no obstruction aft of the light and between planes 70° to the right and left of the axis of maximum illumination.

"EMERGENCY FLOTATION AND SIGNALING EQUIPMENT"

"CAR 3.716 Rafts and life preservers. An approved life raft or approved life preserver, when required by other parts of the Civil Air Regulations, is one approved by either the Administrator, the Bureau of Marine Inspection and Navigation, the United States Army Air Forces, or the Bureau of Aeronautics, Navy Department."

3.716-1 LIFE RAFTS AND LIFE PRESERVERS. (CAA rules which apply to section 3.716, previously 3.5440).

(a) The minimum safety requirements for life preservers and life rafts which are intended for use in certificated civil aircraft engaged in over-water operations have been established by the Administrator in the following Technical Standard Orders:

(1) No. TSO-C12, "Life Rafts," effective August 1, 1948.

(2) No. TSO-C13, "Life Preservers," effective August 1, 1948.

"RADIO EQUIPMENT; INSTALLATION"

"CAR 3.721 General. Radio equipment and installations in the airplane shall be free from hazards in themselves, in their method of operation, and in their effects on other components of the airplane."

3.721-1 RADIO EQUIPMENT INSTALLATION. (CAA interpretation which applies to section 3.721, previously 3.550).

Engineering flight tests are not required for equipment installations unless a particular installation could conceivably interfere with flight operation of airplane or change the airplane configuration so that performance or flight characteristics became adversely affected.

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"MARKINGS AND PLACARDS"

"CAR 3.755 Markings and placards. (a) The markings and placards specified are required for all airplanes. Placards shall be displayed in a conspicuous place and both shall be such that they cannot be easily erased, disfigured, or obscured. Additional informational placards and instrument markings having a direct and important bearing on safe operation may be required by the Administrator when unusual design, operating, or handling characteristics so warrant.

"(b) When an airplane is certificated in more than one category, the applicant shall select one category on which all placards and markings on the airplane shall be based. The placard and marking information for the other categories in which the airplane is certificated shall be entered in the Airplane Flight Manual. A reference to this information shall be included on a placard which shall also indicate the category on which the airplane placards and markings are based."

3.755-1 MARKINGS AND PLACARDS FOR AN AIRPLANE CERTIFICATED IN MORE THAN ONE CATEGORY. (CAA policies which apply to section 3.755 (b), previously 3.62).

(a) The following suggestions are given to assist in making placards and markings as simple and straightforward as possible:

(1) The applicant (who may be the manufacturer or an individual operator) should select a "basic" category on which all markings and placards will be based and installed on a particular airplane. However, this does not prevent the selection of some other category as "basic" for the placarding and marking of other airplanes of the same model.

(2) Placards of markings pertaining to other categories should be installed only when this can be done without confusing the placards or markings for the "basic" category. For example, previous attempts to put dual sets of markings on airspeed indicators have proven unsatisfactory. On the other hand, it may be desirable to install baggage capacity and number of persons placards which cover both normal and utility categories.

(3) A statement on the placard, required by CAR 3.769 and CAR 3.770, should refer the operator to the "Approved Airplane Flight Manual" for information on the placards and markings appropriate to the other categories in which the airplane is certificated.

(4) All placards should be arranged to present the necessary information to the pilot in as simple and practical a manner as possible. In many cases, it may be convenient to consolidate various placards.

(5) The following is an example of a possible (but not necessarily complete) form for a consolidated placard for an airplane certificated in Normal and Utility Categories, using the Normal Category as the "basic" category for purposes of placarding and marking:

> THIS AIRPLANE MUST BE OPERATED AS A NORMAL OR UTILITY CATEGORY AIRPLANE IN COMPLIANCE WITH THE APPROVED AIRPLANE FLIGHT MANUAL
>
> All markings and placards on this airplane apply to its operation as a Normal Category Airplane. For Utility Category operations, refer to the Airplane Flight Manual
>
> NO ACROBATIC MANEUVERS (INCLUDING SPINS) ARE APPROVED FOR NORMAL CATEGORY OPERATIONS.

(6) When the category selected for marking and placarding is the Utility Category, the appropriate placards for limiting the weight to the approved utility value should, of course, be posted. This may, for example, require placards on some of the seats, "Not to be occupied during Utility operations," and "Maximum baggage capacity during Utility Category operations, _____ pounds."

When the number of occupants permitted for the Utility Category is less than the number of seats, but the seating arrangement makes no difference, it may be more convenient to omit the seat placards and substitute a statement such as the following on the consolidated placard, "Maximum number of persons for Utility Category Operations, ______ ."

(7) For Utility Category maneuvering limitations, see CAM 3.6-1.

3.755-2 MARKINGS AND PLACARDS FOR FLAP SETTINGS. <u>(CAA policies which apply to section 3.755 (a), previously 3.62)</u>.

(a) FLAP SETTINGS AS RELATED TO PERFORMANCE. Instructions on flap settings relating to airplane performance should be included in the "performance information" section of the Manual, and should be identified with the corresponding performance data given in CAM 3.777-1 (g). If the applicant has demonstrated compliance with the pertinent performance requirements for a range of flap settings, the range may be given instead of a single setting. In this case, performance data should be shown for both extremes of the range, or for the critical setting within the range, plus explanation of the qualitative effect on performance of using other settings within the range.

(b) FLAP SETTINGS RESULTING IN UNSAFE CHARACTERISTICS. If improper setting of the flaps can result in dangerous characteristics, a suitable item should be included in the "operating limitations" section of the Flight Manual, and on a placard in view of the pilot.

Typical examples of "dangerous characteristics" would be cases in which a flap take-off setting less than that marked on the flap indicator would cause unusual difficulty in take-off by greatly extending the take-off distance, or affecting controllability (e.g. porpoising, or inability to raise nose wheel). Reasonable and gradual variations in performance with change in flap setting would not be considered dangerous. Cases of obvious pilot error need not be considered such as take-off with flaps in landing setting, provided the pertinent settings are adequately marked on the flap indicator.

"CAR 3.757 Air-speed indicator. (a) True indicated air speed shall be used:

"(1) The never-exceed speed, V_{ne}—a radial red line (see section 3.739).

"(2) The caution range—a yellow arc extending from the red line in (1) above to the upper limit of the green arc specified in (3) below.

"(3) The normal operating range--a green arc with the lower limit at V_{s_1}, as determined in section 3.82 with maximum weight, landing gear and wing flaps retracted, and the upper limit at the maximum structural cruising speed established in section 3.740.

"(4) The flap operating range—a white arc with the lower limit at V_{s_0} as determined in section 3.82 at the maximum weight, and the upper limit at the flaps-extended speed in section 3.742.

"(b) When the never-exceed and maximum structural cruising speeds vary with altitude, means shall be provided which will indicate the appropriate limitations to the pilot throughout the operating altitude range."

3.757-1 WHITE ARC ON AIR-SPEED INDICATOR. (CAA interpretations which apply to section 3.757 (a) (4), previously 3.6200 (d)).

The white arc on the air-speed indicator should extend to the "basic" flaps extended speed specified in CAR 3.742. Additional combinations of flap setting, airspeed and power established in accordance with CAR 3.742 should be listed in the airplane flight manual and may be listed on a placard if the manufacturer desires.

"CAR 3.759 Power-plant instruments. All required power-plant instruments shall be marked with a red radial line at the maximum and minimum (if applicable) indications for safe operation. The normal operating ranges shall be marked with a green arc which shall not extend beyond the maximum and minimum limits for continuous operation. Take-off and precautionary ranges shall be marked with a yellow arc."

3.759-1 POWER-PLANT INSTRUMENT MARKINGS. (CAA interpretations which apply to section 3.759, previously 3.6202).

(a) Where the propeller is restricted against operation in a definite r.p.m. range, because of vibrating stress considerations, such restrictions should be indicated by a red arc on the tachometer extending from the low to the high engine r.p.m. speeds corresponding to the restricted propeller speed r.p.m. ranges. This policy follows the general practice of the regulations in prescribing the use of red markings instead of yellow markings in indicating restrictions that are more than precautionary.

(b) Tachometer dial should not be marked to indicate restricted operating range due to propeller vibratory stress considerations when this consideration applies only under certain conditions such as when landing gear is extended. It is considered satisfactory for a placard covering such restricted ranges to be provided.

"CONTROL MARKINGS"

"CAR 3.762 General. All cockpit controls, with the exception of the primary flight controls, shall be plainly marked as to their function and method of operation."

3.762-1 MARKING OF BUTTON-TYPE STARTER SWITCHES. (CAA interpretation which applies to section 3.762, previously 3.621).

Simple push-button type starter switches need not be marked to indicate method of operation.

"AIRPLANE FLIGHT MANUAL"

"CAR 3.777 Airplane Flight Manual. An Airplane Flight Manual shall be furnished with each airplane. The portions of this document listed below shall be verified and approved by the Administrator, and shall be segregated, identified, and clearly distinguished from portions not so approved. Additional items of information having a direct and important bearing on safe operation may be required by the Administrator when unusual design, operating, or handling characteristics so warrant."

3.777-1 PREPARATION OF AIRPLANE FLIGHT MANUALS FOR AIRPLANES IN THE NORMAL, UTILITY, AND ACROBATIC CATEGORIES. (CAA policies which apply to section 3.777, previously 3.63).

(a) This section outlines an acceptable arrangement for the Airplane Flight Manual as required by CAR 3.777. It should be noted that the items outlined below for inclusion in the document will not all be necessary for a given airplane, and the Civil Aeronautics Administration is desirous of holding the document to the smallest practicable amount of material. Only the material required by CAR 3 should be included in the Civil Aeronautics Administration approved portion of the manual. However, if desired, the manufacturer may add other data in a distinctly separate section in the same cover. The portion of the material that is to be approved by the Civil Aeronautics Administration must be so marked and clearly separated from any other material so that no one could easily err in regard to the part that is approved.

(b) The page size for the Airplane Flight Manual will be left to the decision of the manufacturer. Some sort of a cover should be provided where more than one page is involved and should indicate the nature of the contents with the following title: "Airplane Flight Manual." Each page of the approved portion should bear the notation "CAA Approved" and the date of issuance. The material should be bound in some semipermanent fashion so that pages will not easily be lost, but should be so bound that revised pages can be inserted. In the case of small airplanes where the document consists of only one or two pages, superseding the entire document would be preferable to issuing revised pages. The aircraft specification will identify the manual by the approval date, and when different versions of the airplane (skiplanes, seaplanes, etc.) are covered in separate manuals, each will be listed. Also, the latest approved revisions will be shown.

(1) When an aircraft has tentative approval only, the following statement should appear on the inside of the front covering page of the manual:

"The certificate of airworthiness issued to the aircraft described hereon, subject to the final issuance of a covering type certificate, is based upon tentative approval of aircraft of this model. Upon issuance of a covering type certificate, it may become necessary to make certain modifications or adjustments to the subject aircraft in order that the certificate of airworthiness may remain effective."

(c) The Airplane Flight Manual should contain as much of the material in sub-paragraphs (d) through (h) as is applicable to the individual model. It is suggested that the document be divided into sections as indicated in sub-paragraphs (d) through (h). The sequence of sections and of items within sections should follow the outline in so far as is practicable. This will facilitate revising the document when an airplane is altered in the field.

(d) ADMINISTRATIVE SECTION. (This section will be unnecessary in the case of small uncomplicated airplanes where the limitations consist of only one or two pages. In such cases the data noted for inclusion on the title page can be placed at the top of the first page.)

(1) TITLE PAGE. This page should include the manufacturer's name, airplane model and the registration number.

(2) TABLE OF CONTENTS. This page will not be necessary where the document consists of only a few pages.

(3) LOG OF REVISIONS. Should provide spaces in which to record revised pages and the date inserted. This page will not be necessary where the document is short and will be superseded completely if changes are necessary.

(e) LIMITATIONS SECTION:

(1) ENGINE POWER AND SPEED LIMITS. Should also list engine and propeller manufacturer and model.

(2) TEMPERATURE AND MANIFOLD PRESSURE LIMITS. Include, if applicable, minimum climbing airspeeds for hot weather operation.

(3) FUEL GRADE. This item as well as (1) and (2) above may, in the case of most airplanes, be covered together.

(4) PROPELLER. Should list propeller manufacturer and model.

(5) POWER-PLANT DOOR AND FLAP SETTINGS. Pertains only when cowl flaps, cooler doors or other similar devices are installed.

(6) PLACARDS (POWER-PLANT ONLY). Should list all power-plant operating placards and explain their significance, where pertinent.

(7) INSTRUMENT MARKINGS (POWER-PLANT INSTRUMENTS). Should list all power-plant instrument markings.

(8) AIRSPEED LIMITATIONS. Should include "never exceed speed," "maximum structural cruising speed," "maneuvering speed," "flaps extended speed," and "landing gear extended speed" where applicable.

(9) FLIGHT LOAD FACTORS. The pertinent load factors should be given in terms of accelerations.

(10) MAXIMUM WEIGHT. This should list maximum weights.

(11) C.G. RANGE. The approved c.g. limits and datum should be listed in inches.

(12) MANEUVERS. This should list the approved maneuvers with recommended entry speeds.

(13) PLACARDS (EXCEPT POWER-PLANT PLACARDS). Should list all flight placards and explain their significance where pertinent.

(14) INSTRUMENT MARKINGS (EXCEPT POWER-PLANT INSTRUMENTS). Should list all flight instrument markings, and explain their significance. (In most cases this will involve only the airspeed indicator.)

(15) MINIMUM CREW. This section should be used only when the minimum crew is more than one. Where used, the section should explain the basic duties of each crew member.

(f) PROCEDURES SECTION:

(1) NORMAL OPERATING PROCEDURES. For the small conventional airplane where all procedures are conventional, this section will not be necessary. Only unconventional features and peculiarities of the particular airplane should be covered here, and, in the case of more complex airplanes, the following should be covered where pertinent.

(i) One engine inoperative. Applies only to multiengine types and should contain all necessary procedures for such operation.

(ii) Propeller feathering. Applies only to multiengine types equipped with feathering propellers. Should contain full instructions on feathering and unfeathering.

(iii) Circuit breakers. Should contain full information on the location and method of resetting all circuit breakers installed.

(iv) Fire procedures. Pertains only to airplanes equipped with a built-in fire extinguishing system. Should contain full instructions on the operation of such systems as well as associated fire protection equipment and procedures.

(v) Emergency procedures for flaps, landing gear, fuel dumping, etc.

(vi) Other special operating procedures (if any).

(g) PERFORMANCE INFORMATION SECTION:

(1) TAKE-OFF DATA. Should include distance to clear 50 ft. obstacle, etc. at various altitudes and temperatures.

(2) CLIMB DATA. Should give normal rate of climb, balked landing climb (landing gear extended and wing flaps in landing position) and one-engine inoperative climb (for multiengine types) at various altitudes and temperatures.

(3) LANDING DATA. Should give distance to complete landing over 50 ft. obstacle and approach speed for various altitudes and temperatures.

(4) STALLING DATA. Should give stall speeds, stall warning indications and other pertinent data including stalling speeds at various angles of bank.

(v) WEIGHT AND BALANCE DATA SECTION. This section will not be included in the approved portion of the Airplane Flight Manual. It is the intention of the Civil Aeronautics Administration to place the responsibility for the control of weight and balance with the manufacturer and operator. The manufacturer will furnish a weight and balance report for each new airplane. The Civil Aeronautics Administration representative will not approve each individual report but will make only occasional spot checks to ascertain that the manufacturer's weight control procedure is adequate. The manufacturer will be expected to furnish complete information with the airplane, not only regarding its actual weight and balance, but also to include sketches, samples and other data that will assist the operator in checking the balance after alterations. The Repair and Alteration Form (ACA-337) has been revised to include space for recording the new empty weight, empty weight C.G. and useful load on the form after each change. A copy of this form will be given to the owner and his file of such forms, together with the manufacturer's original data will afford the owner with a complete and up-to-date file. In cases where the permissible C.G. positions vary with gross weight, it is suggested that a note be included in the weight and balance report advising owners to contact the airplane manufacturer when any change is made to the airplane which would appreciably affect the location of the empty C.G. or location of useful load items. The manufacturer is asked to cooperate in an educational program to inform the owner of his responsibility and the means whereby he can discharge it. To this end, a statement substantially as follows should be prominently displayed in the weight and balance section:

> "Note: It is the responsibility of the airplane owner and the pilot to insure that the airplane is loaded properly. The empty weight, empty weight C.G. and useful load are noted below for this airplane as delivered from the factory. If the airplane has been altered, refer to the latest approved Repair and Alteration Form (ACA-337) for this information."

(1) WEIGHT LIMITS. Should list and explain (where necessary) the various weight limits. In the case of a small airplane, only the maximum (gross) weight would be applicable.

(2) C.G. LIMITS. Approved operating C.G. range.

(3) EMPTY WEIGHT C.G. LIMITS WHERE PRACTICABLE. This applies to the empty weight C.G. range which will automatically assure compliance with the operating C.G. limits under the most adverse loading conditions.

(4) EMPTY WEIGHT AND EMPTY WEIGHT C.G. LOCATION.

(5) EQUIPMENT LIST. All equipment included in the empty weight. Equipment items should normally be identified by the item number and name used in the Aircraft Specification.

(6) WEIGHT COMPUTATIONS. The computations necessary to determine the empty weight C.G. location and the check of forward and aft C.G. locations where applicable.

(7) LOADING SCHEDULE. Supply where necessary.

(8) LOADING SCHEDULE INSTRUCTIONS. Complete instructions in the use of the loading schedule.

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(9) UNCONVENTIONAL AIRPLANES. The material in sub-paragraph (h) is believed to be complete and adequate for a conventional airplane. In the case of unconventional airplanes or airplanes with special features, the foregoing should be modified or amplified as necessary to cover the case.

(i) NUMBER OF COPIES. Three copies of the above material, less the Weight and Balance Data Section, should be submitted to the appropriate Civil Aeronautics Administration regional office by the manufacturer for an original approval. One copy will be signed by the Chief, Aircraft Division, and returned to the manufacturer. Revisions to the manual will be approved in the regional office. One copy of the Weight and Balance Data Section should be included in the manual by the manufacturer for each airplane at the time of certification.

(j) SAMPLE OF AIRPLANE FLIGHT MANUAL. A sample of an Airplane Flight Manual that fulfills the requirements in the case of a small uncomplicated airplane is given on the attached sheet, and is identified by number as CAM 3.777-1 (k).

3.777-2 CALCULATED EFFECTS OF TEMPERATURE AND ALTITUDE VARIATIONS. CAA policies which apply to section 3.777, previously 3.63).

See CAM 3.780-1.

3.777-3 PERFORMANCE DATA FOR ALTERED PART 3 AIRPLANES. (CAA policies which apply to section 3.777, previously 3.63).

See CAM 3.780-2.

3.777-4 PERFORMANCE DATA AND FLIGHT TESTS FOR SKI INSTALLATIONS ON PART 3 AIRPLANES. (CAA policies which apply to section 3.777, previously 3.63).

See CAM 3.780-3.

SAMPLE SHEET

THIS DOCUMENT MUST BE KEPT IN AIRPLANE AT ALL TIMES

C.A.A. Approved
January 1, 1947

RONSON AIRCRAFT CO.
LOS ANGELES
MAINE

RONSON 98

CAA Identification No. _____

NORMAL AND
UTILITY CATEGORIES

AIRPLANE FLIGHT MANUAL

1. LIMITATIONS

The following limitations must be observed in the operation of this airplane:

Engine	Motors model 150A
Engine limits	For all operations - 2500 rpm, 150 hp
Fuel	73 minimum octane aviation gasoline
Propeller	Hamilton Standard constant speed, hub 2D30, blades 6167A-15. Pitch settings, high 29°, low 14° at 42 in. sta.
Power Instrument	(a) Fuel quantity guage: Fuel remaining in tank when indicator is in the region marked in RED can not safely be used in flight. (b) Oil temperature: Unsafe if indicator exceeds RED line (200° F) (c) Tachometer: RED line at rated engine speed. DO NOT EXCEED.

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		Normal Category	Utility Category
Airspeed limits (True indicated airspeed)	Never exceed	150 mph	165 mph
	Max. structural cruising	120 mph	120 mph
	Maneuvering	110 mph	110 mph
	Flaps extended	90 mph	90 mph
Flight load factors	Max. positive load factors	3.9	4.5
	Max. negative load factor:	No inverted maneuvers approved.	
Maximum weight		2100 lbs.	1900 lbs.

C. G. range
(+11.0) to (+22.4)
Datum - L.E. of wing.

NOTE: It is the responsibility of the airplane owner and the pilot to insure that the airplane is properly loaded.

(a) No acrobatic maneuvers approved for Normal Category operation.

(b) The following maneuvers are approved for operation in the Utility Category only, with recommended entry speeds shown:

CHANDELLES - 110 MPH TIAS   LAZY EIGHTS - 105 MPH TIAS
STEEP TURNS - 100 MPH TIAS   SPINS
STALLS (EXCEPT WHIP STALLS)

Airspeed instrument markings and their significance
(a) Radial RED line marks the never exceed speed which is the maximum safe airspeed.
(b) YELLOW arc on indicator denotes range of speeds in which operations should be conducted with caution and only in smooth air.
(c) GREEN arc denotes normal operating speed range.
(d) WHITE arc denotes speed range in which flaps may safely be lowered.

NOTE: Maneuvers involving approach to stalling angle or full application of elevator rudder or aileron should be confined to speeds below maneuvering speed.

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2. PROCEDURES

Normal operating procedures
(a) Rear seat must not be occupied when airplane is operated in the Utility Category.

SAMPLE SHEET

C.A.A. Approved
January 1, 1947

3. PERFORMANCE INFORMATION

The following performance figures were obtained during Civil Aeronautics Administration type tests and may be realized under conditions indicated with the airplane and engine in good condition and with average piloting technique.

All performance is given for 2100 lbs. weight, with no wind and on level, paved runways. In using the following data, allowance for actual conditions must be made.

ITEM	ALTITUDE	OUTSIDE AIR TEMPERATURES				
		0°F.	25°F.	50°F.	75°F.	100°F.
Take-off Distance (in feet) Distance req'd to take-off and climb 50 ft. Full throttle 80 mph climb speed Flaps down 10°	Sea Level	625	750	900	1000	1075
	2000 ft.	1125	1275	1475	1600	1700
	4000 ft.	1625	1875	2050	2200	2550
	6000 ft.	2100	2300	2500	2700	3000
Landing Distance (in feet) Distance req'd to land over 50 ft. obstacle and stop. Flaps full down Approach at 75 mph	Sea Level	1200	1250	1300	1350	1400
	2000 ft.	1260	1320	1380	1440	1500
	4000 ft.	1340	1400	1450	1510	1570
	6000 ft.	1420	1480	1520	1580	1640
Normal Rate of climb (ft. per min.) Full throttle Flaps up Airspeed 80 mph	Sea Level	800	760	720	680	640
	2000 ft.	680	640	600	560	520
	4000 ft.	550	510	470	430	390
	6000 ft.	420	380	340	300	260
Balked Landing Climb (feet per minute) Full throttle Flaps down Airspeed 80 mph	Sea Level	600	570	530	500	470
	2000 ft.	490	450	420	380	350
	4000 ft.	380	340	300	270	240
	6000 ft.	260	230	190	160	120
Stalling Speeds (mph) Power off	Angle of Bank	0°	20°	40°	50°	60°
	Flaps up	55	57	64	70	80
	Flaps full down	50				

(Following the performance information would be the section on weight and balance. The manufacturer may merely append his regular weight and balance forms if he desires).

absolute ceiling and a temperature range from 60° F. below the standard temperature to 40° F. above the standard temperature at the altitude involved.

3.780-2 PERFORMANCE DATA FOR ALTERED PART 3 AIRPLANES. (CAA policy which applies to section 3.780, previously 3.632).

Performance data for altered CAR 3 airplanes must be changed in the Airplane Flight Manual if the alteration decreases the performance below that given in the existing manual. If performance can be shown to equal or exceed original values then a statement in the manual to this effect is sufficient.

3.780-3 PERFORMANCE DATA AND FLIGHT TESTS FOR SKI INSTALLATIONS ON PART 3 AIRPLANES. (CAA policies which apply to section 3.780, previously 3.632).

(a) TAKE-OFF AND LANDING DISTANCES. It will not be necessary, in complying with CAR 3.780 (a) (3) and (4), to make take-off and landing distance tests on skiplane installations where landplane distances are given in the Airplane Flight Manual. The following, or similar, statements should be given in the performance information section of the Airplane Flight Manual.

(1) TAKE-OFF. Under the most favorable conditions of smooth packed snow at temperatures approximating 32° F. the skiplane take-off distance is approximately 10% greater than that shown for the landplane.

> Note: In estimating take-off distances for other conditions caution should be exercised in that lower temperatures or other snow conditions will usually increase these distances.

(2) LANDING. Under the most favorable conditions of smooth packed snow at temperatures approximating 32°F. the skiplane landing distance is approximately 20% greater than that shown for the landplane.

> Note: In estimating landing distances for other conditions caution should be exercised in that other temperatures or other snow conditions may either decrease or increase these distances.

(b) CLIMB PERFORMANCE. In cases where the landing gear is fixed (both landplane and skiplane), where the climb requirements are not critical, and the climb reduction is small (30 to 50 ft. per minute), the CAA will accept a statement of the approximate reduction in climb performance

"CAR 3.780 Performance information. (a) Information relative to the following items of performance shall be included:

"(1) The stalling speed, V_{s_o}, at maximum weight,

"(2) The stalling speed, V_{s_1}, at maximum weight and with landing gear and wing flaps retracted,

"(3) The take-off distance determined in accordance with section 3.84, including the air speed at the 50-foot height, and the airplane configuration, if pertinent,

"(4) The landing distance determined in accordance with section 3.86, including the airplane configuration, if pertinent.

"(5) The steady rate of climb determined in accordance with section 3.85 (a), (c), and, as appropriate, (b), including the air speed, power, and airplane configuration, if pertinent.

"(b) The effect of variation in (a) (2) with angle of bank up to 60 degrees shall be included.

"(c) The calculated approximate effect of variations in subparagraphs (3), (4) and (5) of this paragraph with altitude and temperature shall be included."

3.780-1 CALCULATED EFFECTS OF TEMPERATURE AND ALTITUDE VARIATIONS. (CAA policies which apply to section 3.780 (c), previously 3.780 (a) (3)).

(a) CAR 3.780 (c) requires that the calculated effects of variations in temperature and altitude on the take-off distance, (CAR 3.84), the landing distance, (CAR 3.86), and the steady rate of climb, (CAR 3.85), shall be included in the Airplane Flight Manual. The following ranges of these variables are considered acceptable:

(1) The altitudes and temperatures for which performance in take-off distance, landing distance, take-off climb and balked landing climb shall be calculated are sea-level to 7,000 ft. and 0° F. to 100° F. respectively, except that take-off and landing distances for a seaplane need not show temperatures below 30° F. at altitudes above 1,000 ft.

(2) For multi-engined aircraft, the climb with the critical engine inoperative should be calculated for an altitude range of sea-level to

placed in the Airplane Flight Manual performance information section. For larger variations in climb performance, or where the minimum requirements are critical, or where the landing gear of the landplane was retractable, appropriate climb data should be obtained to determine the changes, and new curves, tables, or a note should be incorporated in the Airplane Flight Manual.

(c) FLIGHT AND HANDLING TESTS. At least a general flight check should be made prior to approval. This should include more than one landing to determine the ground handling characteristics as well as take-off and landing characteristics. Note should be taken of ski angle at landing contact during tail high and tail low landings to avoid having the ski dig in or fail from localized stress. Ground control should be sufficient to satisfactorily complete a landing run with a turn off at slow speed in cases where brakes are not provided. In flight the ski should ride steady with no unusual drag and produce no unsatisfactory flight characteristics. Spin checks should be made on all aircraft in which spins are an approved maneuver. When spins are approved under CAR 3.124 (a), investigation with ski installations need not be made unless the spin characteristics of the type are known to be marginal.

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