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CAM 6

CIVIL AERONAUTICS MANUALS—Volume II

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Supplement No. 16

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January 15, 1958

SUBJECT: Revisions to CAM 3 dated October 1956, and CAM 6 dated November 1956.

The supplement to CAM 3 includes appendix D which provides a simplified procedure for determining wing load distribution for airplanes incorporating wing tip tanks.

The supplement to CAM 6 explains standards applicable to anticollision lights when installed in rotorcraft.

The new material is indicated by brackets.

Remove and destroy the following pages:

CAM 3—v and vi
xvii and xviii
27 and 28

CAM 6—ix and x
34-1

Insert the following new pages:

CAM 3—v and vi
xvii and xviii
27 through 28-1
123 through 126

CAM 6—ix and x
34-1

Roy Keeley

ROY KEELEY,
Director, Office of Flight
Operations and Airworthiness.

Attachments.

18 JAN 1958

	Section	Page
Use of ballast.....	3.72	12
Use of ballast (<i>CAA policies which apply to sec. 3.72</i>).....	3.72-1	12
Empty weight.....	3.73	12
New production aircraft; empty weight and c. g. determination (<i>CAA policies which apply to sec. 3.73</i>).....	3.73-1	12
Empty weight items (<i>CAA interpretations which apply to sec. 3.73</i>).....	3.73-2	13
Unusable fuel supply and undrainable oil (<i>CAA interpretations which apply to sec. 3.73</i>).....	3.73-3	13
Maximum weight.....	3.74	13
Minimum weight.....	3.75	13
Center of gravity position.....	3.76	13
Center of gravity position (<i>CAA policies which apply to sec. 3.76</i>).....	3.76-1	14

Performance Requirements

General

Alternate performance requirements.....	3.80	14
Performance.....	3.81	14
Definition of stalling speeds.....	3.82	14
"Zero thrust" (<i>CAA interpretations which apply to sec. 3.82</i>).....	3.82-1	14
Stalling speed.....	3.83	14

Takeoff

Takeoff.....	3.84	15
Takeoff performance (<i>CAA policies which apply to sec. 3.84</i>).....	3.84-1	15
Measurement of seaplane takeoff distances (<i>CAA interpretations which apply to sec. 3.84 (a)</i>).....	3.84-2	15
Takeoff speed (<i>CAA interpretations which apply to sec. 3.84 (b)</i>).....	3.84-3	16
Takeoff requirements; airplanes of 6,000 lbs. or less.....	3.84a	16

Climb

Climb.....	3.85	16
Rate of climb (<i>CAA policies which apply to sec. 3.85</i>).....	3.85-1	16
"Normal climb" and "cooling test procedure for single-engine airplanes" (<i>CAA interpretations which apply to sec. 3.85</i>).....	3.85-2	16
"Rapid retraction" (<i>CAA interpretations which apply to sec. 3.85</i>).....	3.85-3	17
Weight for items of performance and flight characteristics (<i>CAA interpretations which apply to sec. 3.85</i>).....	3.85-4	17
Low-pitch propeller setting in normal climb position (<i>CAA interpretations which apply to sec. 3.85 (a)</i>).....	3.85-5	17
Climb requirements; airplanes of 6,000 lbs. or less.....	3.85a	17

Landing

Landing.....	3.86	18
Landing distances (<i>CAA policies which apply to sec. 3.86</i>).....	3.86-1	18
Use of camera equipment (<i>CAA policies which apply to sec. 3.86</i>).....	3.86-2	18
Landing requirements; airplanes of 6,000 lbs. or less.....	3.87	18

Flight Characteristics

Requirements.....	3.105	18
-------------------	-------	----

Controllability

General.....	3.106	18
Approved acrobatic maneuvers.....	3.107-U	19
Acrobatic maneuvers.....	3.108-A	19
Longitudinal control.....	3.109	19
Lateral and directional control.....	3.110	19
Minimum control speed (V_{mc}).....	3.111	20

(Rev. 1/15/58)

450053 O-57

Trim		
	<i>Section</i>	<i>Page</i>
Requirements	3.112	20
Trim during a glide (<i>CAA policies which apply to sec. 3.112</i>).....	3.112-1.....	21
Stability		
General	3.113	21
Static longitudinal stability	3.114	21
Specific conditions	3.115	21
Instrumented stick force measurements	3.116	22
Dynamic longitudinal stability	3.117	22
Directional and lateral stability	3.118	22
Test conditions (<i>CAA policies which apply to sec. 3.118 (a) (3)</i>).....	3.118-1.....	23
Large displacements of flight controls in directional and lateral stability tests (<i>CAA policies which apply to sec. 3.118</i>).....	3.118-2.....	23
Flight tests for adverse control force reversal or control locking (<i>CAA policies which apply to sec. 3.118 (a) (3)</i>).....	3.118-3.....	23
Stalls		
Stalling demonstration	3.120	23
Measuring loss of altitude during stall (<i>CAA policies which apply to sec. 3.120</i>).....	3.120-1.....	24
Indications of stall warnings (<i>CAA policies which apply to sec. 3.120</i>).....	3.120-2.....	24
Climbing Stalls	3.121	25
Climbing stall flight tests for limited control airplanes (<i>CAA interpretations which apply to sec. 3.121</i>).....	3.121-1.....	25
Turning flight stalls	3.122	25
One-engine-inoperative stalls	3.123	25
Spinning		
Spinning	3.124	25
Spin tests for category N airplanes (<i>CAA interpretations which apply to sec. 3.124 (a)</i>).....	3.124-1.....	26
Spin tests for category A airplanes (<i>CAA interpretations which apply to sec. 3.124 (c)</i>).....	3.124-2.....	26
Ground and Water Characteristics		
Requirements	3.143	26
Longitudinal stability and control	3.144	26
Directional stability and control	3.145	26
Shock absorption	3.146	27
Spray characteristics	3.147	27
Flutter and Vibration		
Flutter and vibration	3.159	27
Subpart C—Strength Requirements		
General		
Loads	3.171	27
Design criteria (<i>CAA policies which apply to sec. 3.171 (c)</i>).....	3.171-1.....	27
Design loads and load distributions (<i>CAA policies which apply to sec. 3.171 (b)</i>).....	3.171-2.....	27
Factor of safety	3.172	27
Strength and deformations	3.173	27
Dynamic tests (<i>CAA policies which apply to sec. 3.173</i>).....	3.173-1.....	27
Proof of structure	3.174	28
Material correction factors (<i>CAA policies which apply to sec. 3.174</i>).....	3.174-1.....	28

Emergency Flotation and Signaling Equipment

	Section	Page
Rafts and life preservers.....	3.716.....	91
Life rafts and life preservers (<i>CAA rules which apply to sec. 3.718</i>).....	3.716-1.....	91
Installation.....	3.717.....	91
Signaling device.....	3.718.....	91

Radio Equipment; Installation

General.....	3.721.....	91
Radio equipment installation (<i>CAA interpretations which apply to sec. 3.721</i>).....	3.721-1.....	91
Radio equipment installations (<i>CAA policies which apply to sec. 3.721</i>).....	3.721-2.....	91

Miscellaneous Equipment; Installation

Accessories for multiengine airplanes.....	3.725.....	91
--	------------	----

Hydraulic Systems

General.....	3.726.....	91
Tests.....	3.727.....	91
Accumulators.....	3.728.....	92

Subpart G—Operating Limitations and Information

General.....	3.735.....	92
--------------	------------	----

Limitations

Limitations.....	3.737.....	92
------------------	------------	----

Air Speed

Air speed.....	3.738.....	92
Never-exceed speed (V_{ne}).....	3.739.....	92
Maximum structural cruising speed (V_{no}).....	3.740.....	92
Maneuvering speed (V_p).....	3.741.....	92
Flaps-extended speed (V_{fe}).....	3.742.....	92
Minimum control speed (V_{mc}).....	3.743.....	92

Power Plant

Power plant.....	3.744.....	92
Take-off operation.....	3.745.....	92
Maximum continuous operation.....	3.746.....	92
Fuel octane rating.....	3.747.....	92

Airplane Weight

Airplane weight.....	3.748.....	93
----------------------	------------	----

Minimum Flight Crew

Minimum flight crew.....	3.749.....	93
--------------------------	------------	----

Types of Operation

Types of operations.....	3.750.....	93
--------------------------	------------	----

Markings and Placards

Markings and placards.....	3.755.....	93
Markings and placards for an airplane certificated in more than one category (<i>CAA policies which apply to sec. 3.755 (b)</i>).....	3.755-1.....	93
Markings and placards for flap settings (<i>CAA policies which apply to sec. 3.755 (a)</i>).....	3.755-2.....	94

(Rev. 1/15/58)

Instrument Markings

	Section	Page
Instrument markings.....	3.756	94
Air-speed indicator.....	3.757	94
White arc on air-speed indicator (<i>CAA interpretations which apply to sec. 3.757 (a) (4)</i>).....	3.757-1	94
Magnetic direction indicator.....	3.758	95
Powerplant instruments.....	3.759	95
Powerplant instrument markings (<i>CAA interpretations which apply to sec. 3.759</i>).....	3.759-1	95
Oil quantity indicators.....	3.760	95
Fuel quantity indicator.....	3.761	95

Control Markings

General.....	3.762	95
Marking of button-type starter switches (<i>CAA interpretations which apply to sec. 3.762</i>).....	3.762-1	95
Aerodynamic controls.....	3.763	95
Power-plant fuel controls.....	3.764	95
Accessory and auxiliary controls.....	3.765	95

Miscellaneous

Baggage compartments, ballast location, and special seat loading limitations.....	3.766	96
Fuel, oil, and coolant filler openings.....	3.767	96
Emergency exit placards.....	3.768	96
Approved flight maneuvers.....	3.769	96
Operating limitations placard.....	3.770	96
Airspeed placards.....	3.771	96

Airplane Flight Manual

Airplane Flight Manual.....	3.777	96
Preparation of airplane flight manuals for airplanes in the normal, utility, and acrobatic categories (<i>CAA policies which apply to sec. 3.777</i>).....	3.777-1	96
Calculated effects of temperature and altitude variations (<i>CAA policies which apply to sec. 3.777</i>).....	3.777-2	99
Performance data for altered airplanes of this part (<i>CAA policies which apply to sec. 3.777</i>).....	3.777-3	99
Performance data and flight tests for ski installations on airplanes of this part (<i>CAA policies which apply to sec. 3.777</i>).....	3.777-4	99
Operating limitations.....	3.778	99
Operating procedures.....	3.779	101
Performance information.....	3.780	101
Calculated effects of temperature and altitude variations (<i>CAA policies which apply to sec. 3.780</i>).....	3.780-1	101
Performance data for altered airplanes of this part (<i>CAA policies which apply to sec. 3.780</i>).....	3.780-2	102
Performance data and flight tests for ski installations on airplanes of this part (<i>CAA policies which apply to sec. 3.780</i>).....	3.780-3	102

Subpart H—Identification Data

Identification plate.....	3.791	102
Airworthiness certificate number.....	3.792	103

Appendices

APPENDIX A—Simplified Design Load Criteria for Airplanes Having a Design Weight Equal to or Less Than 6,000 Pounds.....	104
APPENDIX B—Figures.....	115
APPENDIX C—Special Civil Air Regulations Which Affect Part 3.....	121
APPENDIX D—Simplified Method for Determining Air Loads and Air Load Distributions for Wing-Store Combinations.....	123

pilot in power-off landings at normal landing speed and during which brakes or engine power are not used to maintain a straight path.

(c) Means shall be provided for adequate directional control during taxiing.

3.146 Shock absorption. The shock-absorbing mechanism shall not produce damage to the structure when the airplane is taxed on the roughest ground which it is reasonable to expect the airplane to encounter in normal operation.

3.147 Spray characteristics. For seaplanes, spray during taxiing, take-off, and landing shall at no time dangerously obscure the vision of the pilots nor produce damage to the propeller or other parts of the airplane.

Flutter and Vibration

3.159 Flutter and vibration. All parts of the airplane shall be demonstrated to be free from flutter and excessive vibration under all speed and power conditions appropriate to the operation of the airplane up to at least the minimum value permitted for V_a in section 3.184. There shall also be no buffeting condition in any normal flight condition severe enough to interfere with the satisfactory control of the airplane or to cause excessive fatigue to the crew or result in structural damage. However, buffeting as stall warning is considered desirable and discouragement of this type of buffeting is not intended.

Subpart C—Strength Requirements

General

3.171 Loads.

(a) Strength requirements are specified in terms of limit and ultimate loads. Limit loads are the maximum loads anticipated in service. Ultimate loads are equal to the limit loads multiplied by the factor of safety. Unless otherwise described, loads specified are limit loads.

(b) Unless otherwise provided, the specified air, ground, and water loads shall be placed in equilibrium with inertia forces, considering all items of mass in the airplane. All such loads shall be distributed in a manner conservatively approximating or closely representing actual conditions. If deflections under load would change significantly the distribution of

external or internal loads, such redistribution shall be taken into account.

(c) Simplified structural design criteria shall be acceptable if the Administrator finds that they result in design loads not less than those prescribed in sections 3.181 through 3.265.

3.171-1 Design criteria (CAA policies which apply to sec. 3.171 (c)). The Administrator finds that the simplified structural design criteria contained in Appendix A to Civil Aeronautics Manual 3, result in design loads not less than those prescribed in sections 3.181 through 3.265.

(Supp. 16, effective Jan. 31, 1953, 17 F. R. 11786, Dec. 30, 1952.)

[3.171-2 Design loads and load distributions (CAA policies which apply to sec. 3.171 (b)). The simplified method in appendix D to Civil Aeronautics Manual 3 may be used to determine the air loads and air load distributions resulting from the use of tip stores for low speed, low altitude (design Mach number less than 0.4; design altitude less than 15,000 ft.) airplanes with small amounts of sweep (i. e., midchord angles of sweep less than 15 degrees).]

(22 F. R. 10016, Dec. 13, 1957, effective Jan. 15, 1958.)

3.172 Factor of safety. The factor of safety shall be 1.5 unless otherwise specified.

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 sec. 3.173).

(a) Section 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 sections 3.245, 3.246, and 3.247, it is necessary to employ a

procedure which will not result in the accepting of landing gears weaker than those qualified for acceptance under present procedures, i. e., stress analysis or static testing.

(b) The Administrator will accept, as an adequate procedure for this purpose, the following dynamic tests:

The structure shall be dropped a minimum of 10 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 shall 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.

(Supp. 1, 12 F. R. 3435, May 28, 1947, as amended by Amdt. 1, 14 F. R. 36, Jan. 5, 1949.)

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. Dynamic tests including structural flight tests shall be acceptable, provided that it is demonstrated that the design load conditions have been simulated. In all cases certain portions of the structure must be subjected to tests as specified in Subpart D of this part.

3.174-1 *Material correction factors* (CAA policies which apply to sec. 3.174).

(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 percent 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 must 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. (Secs. 1.654 and 1.655 of ANC-5a 1949 edition⁷ 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.

(Supp. 6, 15 F. R. 619, Feb. 4, 1950.)

3.174-2 *Structural testing of new projects* (CAA policies which apply to sec. 3.174).

(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

⁷ ANC-5a, "Strength of Aircraft Elements" is published by the Army-Navy-Civil Committee on Aircraft Design Criteria and may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

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

[Appendix D

[Simplified Method for Determining Air Loads and Air Load Distributions for Wing-Store Combinations

[The following simplified approach may be used to determine the loads and load distributions resulting from the use of tip stores for low speed, low altitude (design Mach number less than 0.4; design altitude less than 15,000 ft.) aircraft with small amounts of sweep (i. e., mid-chord angles of sweep less than 15 degrees).

[*Lift distribution on wing-store combination*

$$L_{TOTAL} = L_w + \Delta L.$$

where:

L_{TOTAL} = total spanwise load distribution expressed in terms of unit wing loading parameter $\frac{C_{Lc}}{C_{L\bar{c}}}$ for the wing-store combination.

L_w = spanwise load distribution for wing alone expressed in terms of $\left(\frac{C_{Lc}}{C_{L\bar{c}}}\right)$ which is obtained by standard methods.

ΔL = additional lift due to tank alone and induced effects of tank on the wing and the wing on the tank expressed in terms of $\left(\frac{\Delta C_{Lc}}{C_{L\bar{c}}}\right)$. (Obtain from fig. 1.)

[See figure 2 for typical wing with tip-tank air load distribution as determined by above simplified method. For this example, a typical air load distribution for a wing with aspect ratio of 6.17 and span of 400 inches was used. To this wing, a 20-inch diameter tip-tank 80 inches in length was added. It was further assumed that the wing-tip-tank configuration and the wing torsional rigidity are such that deflections under load will not significantly change the air load distribution (i. e., sec. 3.171 (b) is complied with). Note that the ordinates of the $\frac{C_{Lc}}{C_{L\bar{c}}} + \frac{\Delta C_{Lc}}{C_{L\bar{c}}}$ curve should be modified so that the area under the new curve will equal the area under the original wing alone curve (i. e., total lift to remain constant).

[*Moment due to stores*

$$M_T = M_1 + M_2.$$

where M_T = total aerodynamic store moment about the wing tip elastic axis.

$M_1 = 2 K_1 q \alpha V_o$ = moment of load on store which is independent of the wing.

$M_2 = .4 L_5 C_t$ = moment of load on store which is induced by the wing.

K_1 = factor proportional to length of tank expressed in diameters. (See table 1.)

q = dynamic pressure (p. s. f.).

α = angle of attack (radians).

V_o = volume of store.

L_5 = total load on store induced by wing obtained from distribution of tank load of figure 1.

C_t = tip chord.

NOTE: Moment coefficient, C_M , of the wing may be assumed not to be changed by presence of tip stores.

[*Lift curve slope*

[The slope of the lift curve for the wing-store combination may be approximated by the formula:

$$m_T = [K_2(2D/b) + 1]m_w.$$

where m_T = slope of the lift curve of the wing-store combination.

m_w = slope of the lift curve of the wing alone.

D = store diameter.

b = wing span.

$K_2 = 1.58$ for aspect ratio 5.

$K_2 = 1.25$ for aspect ratio 7.

$K_2 = 1.12$ for aspect ratio 10 with straight line variation for intermediate aspect ratios.

TABLE 1.—Aerodynamic factor K_1

L/D^1	K_1	L/D^1	K_1
1	0	6.01	0.873
1.5	.316	6.97	.897
2.0	.493	8.01	.916
2.51	.607	9.02	.930
2.99	.681	9.97	.939
3.99	.778	∞	1.000
4.99	.836		

¹ L=length of store (ft.).

D=diameter of store (ft.).

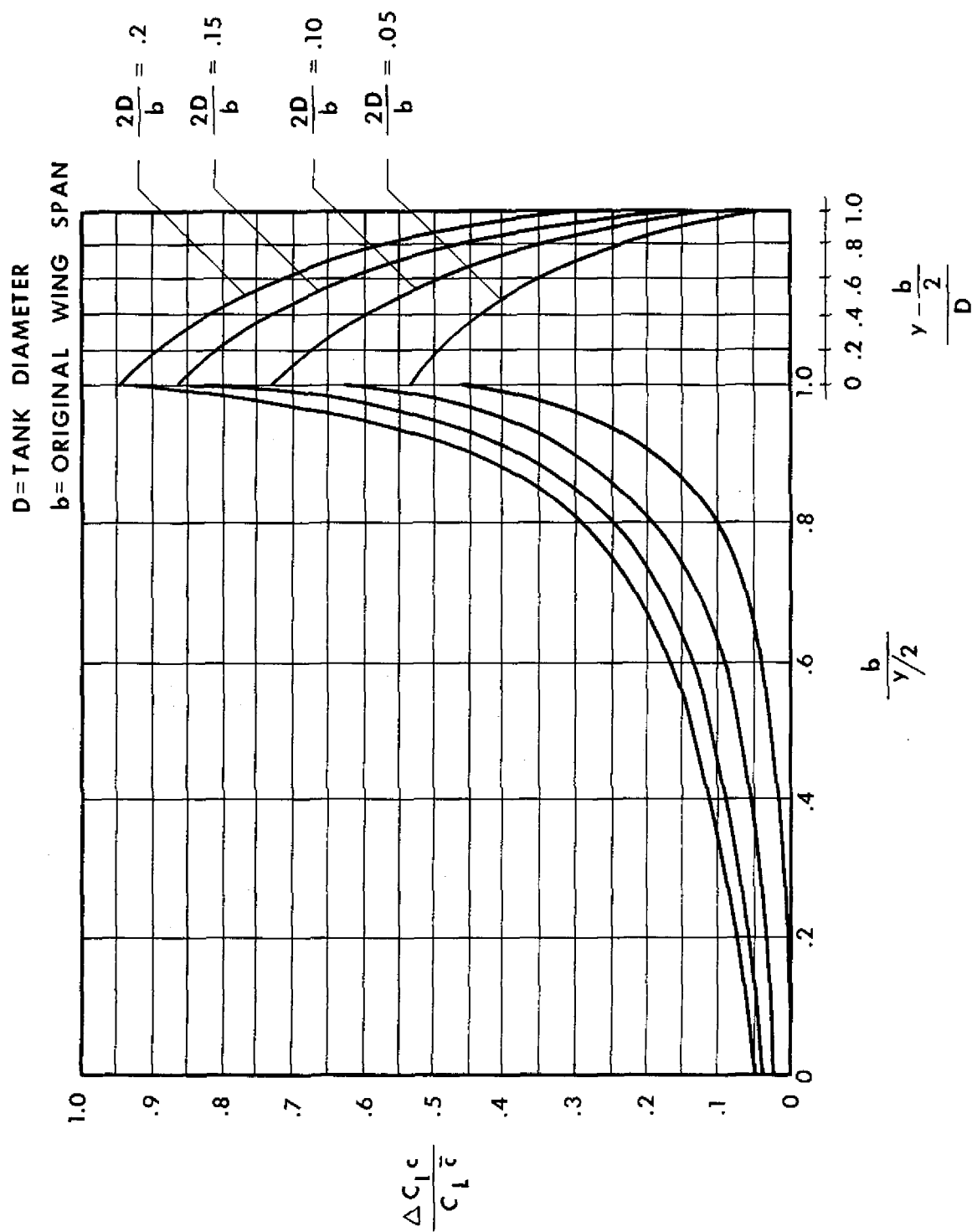
【The requirements of section 3.171(b) concerning deflections under load which could change the distribution of external or internal loads should be considered in evaluating each wing-tip-tank configuration. Inertia loads of tip-tanks with varying fuel quantities, different fuel c. g. locations, and the wing torsional rigidity should be considered.

【For stores whose cross section is other than circular (e. g., elliptical), an equivalent store with circular cross section should be assumed. For example, for an elliptical cross section, the equivalent diameter may be assumed equal to the sum of the minor and major diameters divided by 2.

【The simplified procedures are based on the theoretical methods outlined in the following documents:

NACA Research Memorandum RM L53B18, "A Method for Calculating the Aerodynamic Loading on Wing-Tip-Tank Combinations in Subsonic Flow" by S. W. Robinson and M. Zlotnick.

Aeronautic Research Council Report No. 2469, "Theoretical Load Distributions on Wings with Cylindrical Bodies at the Tips" by D. E. Hartley. (British.)

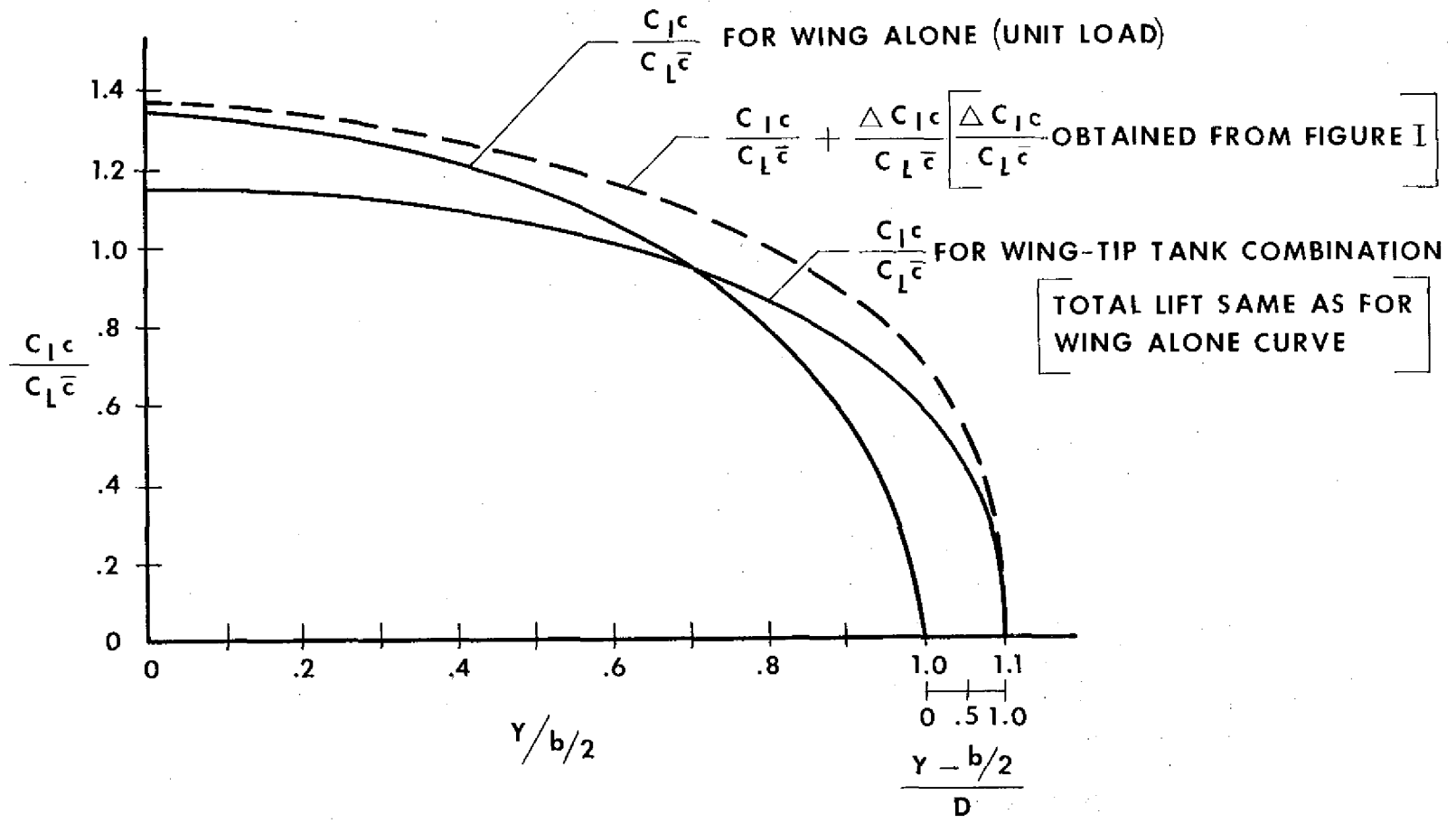


(Rev. 1/15/58)

TANK DATA

$$\frac{D}{b/2} = .10$$

$$\frac{L}{D} = 4.0$$



Powerplant Fire Protection

	Section	Page
General.....	6.480.....	28
Ventilation.....	6.481.....	28
Shut-off means.....	6.482.....	28
Fire wall.....	6.483.....	28
Engine cowling and engine compartment covering.....	6.484.....	29
Lines and fittings.....	6.485.....	29
Flammable fluids.....	6.486.....	29

Equipment

General

Scope.....	6.600.....	28
Functional and installational requirements.....	6.601.....	28
Required basic equipment.....	6.602.....	28
Flight and navigational instruments.....	6.603.....	28
Powerplant instruments.....	6.604.....	29
Miscellaneous equipment.....	6.605.....	29

Instruments; Installation

General.....	6.610.....	30
Arrangement and visibility of instrument installations.....	6.611.....	30
Flight and navigational instruments.....	6.612.....	30
Powerplant instruments.....	6.613.....	30

Electrical Systems and Equipment

Installation.....	6.620.....	31
Batteries.....	6.621.....	31
Generator system.....	6.622.....	31
Master switch.....	6.623.....	31
Load circuit connections with respect to the master switch (CAA policies which apply to sec. 6.623).....	6.623-1.....	31
Master switch installation.....	6.624.....	32
Protective devices.....	6.625.....	32
Automatic reset circuit breakers (CAA policies which apply to sec. 6.625).....	6.625-1.....	32
Circuit breakers (CAA policies which apply to sec. 6.625).....	6.625-2.....	32
Protective devices installation.....	6.626.....	32
Electric cables.....	6.627.....	32
Electric cable for power distribution (CAA policies which apply to sec. 6.627).....	6.627-1.....	32
Switches.....	6.628.....	32

Lights

Instrument lights.....	6.630.....	32
Landing lights.....	6.631.....	32
Position light system installation.....	6.632.....	32-1
Position light system dihedral angles.....	6.633.....	32-1
Position light distribution and intensities.....	6.634.....	33
Color specifications.....	6.635.....	34
Riding light.....	6.636.....	34
Anti-collision light system.....	6.637.....	34
[Anticollision light standards (CAA policies which apply to sec. 6.637).....]	6.637-1.....	34-1

Safety Equipment

General.....	6.640.....	34-1
Flares.....	6.641.....	34-1
Flare installation.....	6.642.....	34-1
Safety belts.....	6.643.....	34-1
Emergency flotation and signaling equipment.....	6.644.....	34-1

(Rev. 1/15/58)

Miscellaneous Equipment

	Section	Page
Hydraulic systems.....	6.650	35

Operating Limitations and Information

General

Scope.....	6.700	35
------------	-------	----

Operating Limitations

Air-speed limitations; general.....	6.710	35
Never-exceed speed V_{NE}	6.711	35
Operating speed range.....	6.712	35
Rotor speed.....	6.713	35
Powerplant limitations.....	6.714	35
Limiting height-speed envelope.....	6.715	36
Rotorcraft weight and center of gravity limitations.....	6.716	36
Minimum flight crew.....	6.717	36
Types of operation.....	6.718	36
Maintenance manual.....	6.719	36

Markings and Placards

General.....	6.730	36
Instrument markings; general.....	6.731	36
Air-speed indicator.....	6.732	36
Magnetic direction indicator.....	6.733	37
Powerplant instruments; general.....	6.734	37
Oil quantity indicator.....	6.735	37
Fuel quantity indicator.....	6.736	37
Control markings.....	6.737	37
Miscellaneous markings and placards.....	6.738	37

Rotorcraft Flight Manual

General.....	6.740	38
Operating limitations.....	6.741	38
Operating procedures.....	6.742	39
Performance information.....	6.743	39
Marking and placard information.....	6.744	39

Rotorcraft Identification Data

Identification plate.....	6.750	39
Identification marks.....	6.751	39

Appendices

APPENDIX A—Methods of Rotor Service Life Determination.....	41
APPENDIX B—Special Civil Air Regulations Which Affect Part 6.....	49

[6.637-1 Anticollision light standards (CAA policies which apply to sec. 6.637). The anticollision light standards in section 6.637 apply to rotorcraft for which an application for a type certificate is made on or after April 1, 1957. When anticollision lights are installed on rotorcraft for which an application for a type certificate was made before April 1, 1957, the applicant may conform either to section 6.637 or to the standards listed below:

[(a) Anticollision lights (when installed) should be of the rotating beacon type installed on top of the fuselage in such a location that the light will not be detrimental to the crew's vision and will not detract from the conspicuity of the position lights. If there is no acceptable location on top of the fuselage, a bottom fuselage installation may be used.

[(b) The color of the anticollision light should be aviation red in accordance with the specifications of section 6.635.

[(c) The arrangement of the anticollision light, i. e., number of light sources, beam width, speed of rotation, etc., should be such as to give an effective flash frequency of not less than 40 and not more than 100 cycles per minute with an on-off ratio of not less than 1:75.]

(22 F. R. 10016, Dec. 13, 1957, effective Jan. 15, 1958.)

Safety Equipment

6.640 General. Required safety equipment which the crew is expected to operate at a time of emergency, such as flares and automatic life-raft releases, shall be readily accessible. (See also sec. 6.738 (e).)

6.641 Flares. When parachute flares are installed, they shall be of an approved type, and their installation shall be in accordance with section 6.642.

6.642 Flare installation.

(a) Parachute flares shall be releasable from the pilot compartment and installed to minimize the danger of accidental discharge.

(b) It shall be demonstrated in flight that the flare installation is such that ejection can be accomplished without hazard to the rotorcraft and its occupants.

(c) If recoil loads are involved in the ejection of the flares, the structure of the rotorcraft shall be designed to withstand such loads.

6.643 Safety belts. Rotorcraft manufactured on or after the effective date of this part shall be equipped with safety belts of an approved type. (See sec. 6.18.) In no case shall the rated strength of the safety belt be less than that corresponding with the ultimate load factors specified, taking due account of the dimensional characteristics of the safety belt installation for the specific seat or berth arrangement. Safety belts shall be attached so that no part of the anchorage will fail at a load lower than that corresponding with the ultimate load factors specified. (See sec. 6.260.)

6.644 Emergency flotation and signaling equipment. When emergency flotation and signaling equipment is required by the operating rules of the Civil Air Regulations, such equipment shall comply with the provisions of paragraphs (a) through (c) of this section.

(a) Rafts and life preservers shall be of an approved type and shall be so installed as to be readily available to the crew and passengers.

(b) Rafts released automatically or released by the pilot shall be attached to the rotorcraft by means of lines to keep them alongside the rotorcraft. The strength of the lines shall be such that they will break before submerging the empty raft.