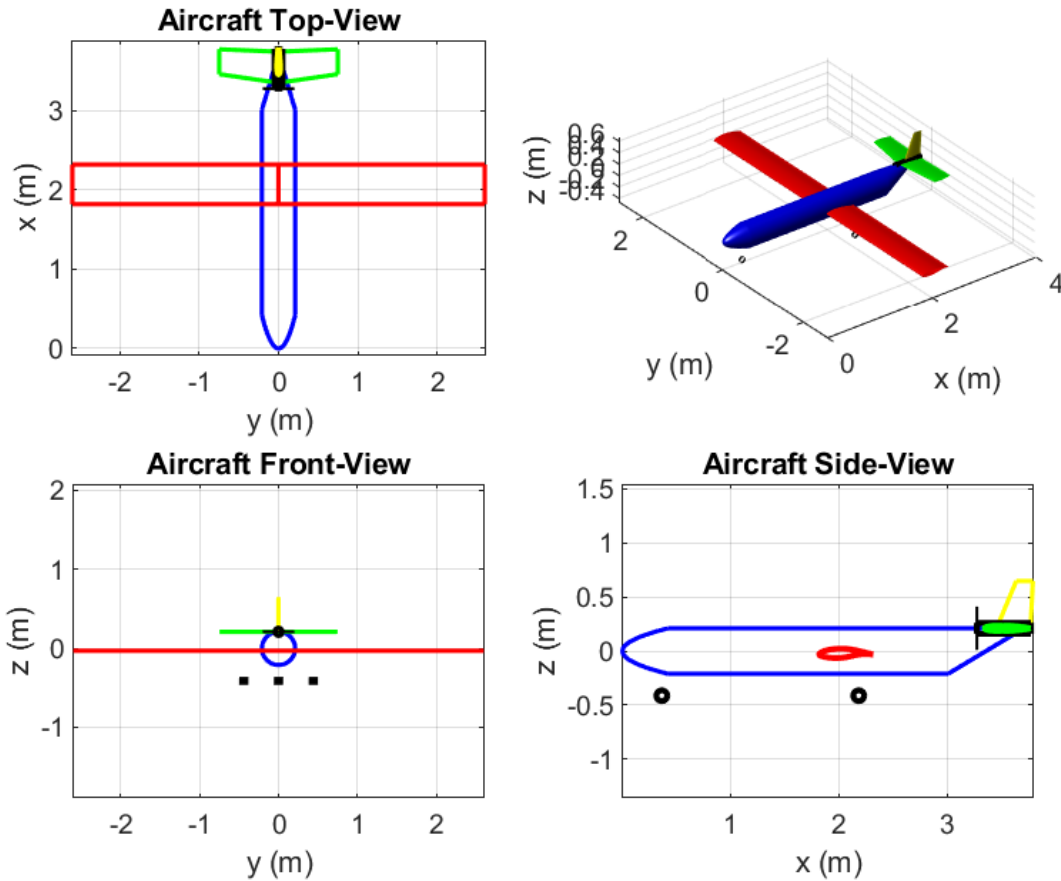


Flight Loads: DroneVLA aircraft



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Chapter 1. Introduction

This document defines the SUBPART C - Structure - Flight Loads of the:DroneVLA.The boundaries of the flight envelope will be defined within this document. All speeds are calibrated airspeeds (CAS) (requirement 4.4 [1])and given in knots if not stated otherwise.All other units used are metric (SI units).The weights are given in mass units (kg) but the formulas require force units as input,therefore these are calculated in place wherever they are used.Note: The speeds defined within this document should be used for the placards,speed markings, aeroplane flight manual (limitations), load calculations and need to be verified by flight test.

Chapter 2. References

1. ASTM F2245-12d," ASTM."ASTM F2245-12d, ASTM.
2. ABCD-FL-57-00 Wing Load Calculation, EASA.
3. ISO 2533:1975, International Standardization Organization, 1975.
4. CS-LSA Certification Specifications and Acceptable Means of Compliance, Amnd.1 29.Jul.2013, EASA, 2013.
5. "ABCD-FTR-01-00 Flight Test Report," EASA.
6. L. Smith, "NACA technical note 1945, 'Aerodynamic characteristics of 15 NACA airfoil sections at seven Reynolds numbers from 0.7×10^6 to 9×10^6 ," 1949.
7. ABCD-WB-08-00 Weight and Balance Report, EASA.

HERE BELOW AN EXAMPLE OF REFERENCES TO BE EDITED

Chapter 3. List of Abbreviations

- CL = lift coefficient
- CD....
- ...
- ...
- ...
- ...
- ...

ADD HERE list of abbreviations as a formatted table....to be created

Chapter 4. Aircraft data

Add here all the aircraft geometrical, aero and inertial and masses data useful for following paragraph

4.1. Geometry

The aircraft reference geometry is summarized in table:[Ref:wingRef:horiRef:vertRef:fus](#)

Table 4.1. Wing Geometrical Parameters

Wing parameters	Value	Measure unit
b	5.2	meters
S	2.589	square meters
AR	10.446	-
taper	1	Non dimensional
sweep	0	degrees
sweep_location	0	percentage
secondary_sweep_location	0	percentage
croot	0.498	m
ctip	0.498	m
xle	1.638	meters
yle	0	meters
zle	0.165	meters
xtip_le	NaN	% fuselage length
dihedral	0	degrees
mac	0.498	m
xmac	NaN	% fuselage length
ymac	NaN	% semispan
ypos	NaN	% semispan
zpos	NaN	% fuselage diameter
camberloc	0.15	Percentage
thickchord	0.18	Percentage
twist_angle	3	degrees
y	0 0.068421 0.13684 0.20526 0.27368 0.34211 0.41053 0.47895 0.54737 0.61579 0.68421 0.75263 0.82105 0.88947 0.95789 1.0263 1.0947 1.1632 1.2316 1.3 1.3684 1.4368 1.5053 1.5737 1.6421 1.7105 1.7789 1.8474 1.9158 1.9842 2.0526 2.1211 2.1895 2.2579 2.3263 2.3947 2.4632 2.5316 2.6	m
half_span_y	0 0.068421 0.13684 0.20526 0.27368 0.34211 0.41053 0.47895 0.54737 0.61579 0.68421 0.75263 0.82105 0.88947 0.9	m

Wing parameters	Value	Measure unit
	5789 1.0263 1.0947 1.1632 1.2316 1.3 1.3684 1.4368 1.5053 1.5737 1.6421 1.7105 1.7789 1.8474 1.9158 1.9842 2.0526 2.1211 2.1895 2.2579 2.3263 2.3947 2.4632 2.5316 2.6	

The aircraft reference geometry is summarized in table:[Ref:wingRef:horiRef:vertRef:fus](#)

Table 4.2. horizontal Geometrical Parameters

horizontal parameters	Value	Measure unit
S	0.529	square meters
l	1.492	meters
camber	0	percentage
camberloc	NaN	percentage
thickchord	0.12	percentage
twist	0	degrees
twistloc	0.25	percentage
xloc0	1.49	meters
xloc	3.128	meters
yloc	0	meters
zloc	0.15	meters
xrot	0	meters
yrot	0	meters
zrot	0	meters
b	1.496	meters
ctip	0.3136	meters
croot	0.3929	meters
sweep	15	degrees
sweeploc	0	percentage
secsweeploc	1	percentage
dihedral	0	degrees
location_of_camber	0.2	percentage
secondary_sweep_location	1	percentage

The aircraft reference geometry is summarized in table:[Ref:wingRef:horiRef:vertRef:fus](#)

Table 4.3. Vertical Geometrical Parameters

vertical parameters	Value	Measure unit
xle	0.95	% of fuselage length
croot	0.3136	m
ctip	0.15347	m

vertical parameters	Value	Measure unit
x _{tip_le}	1	% of fuselage length
b	0.4375	m
z _{pos}	1	% of df
MAC	0.23354	m
l _{vt}	1.65	m

The aircraft reference geometry is summarized in table:[Ref:wingRef:horRef:vertRef:fus](#)

Table 4.4. Fuselage Geometrical Parameters

Fuselage parameters	Value	Measure unit
length	3.64	meters
diameter	0.42	meters
Non_dim_radius_of_gyration	0.34	Non dimensional
Radius_of_gyration	NaN	meters

4.2. Aerodynamic

The aircraft reference aerodynamic is in figure:[polars wb](#)

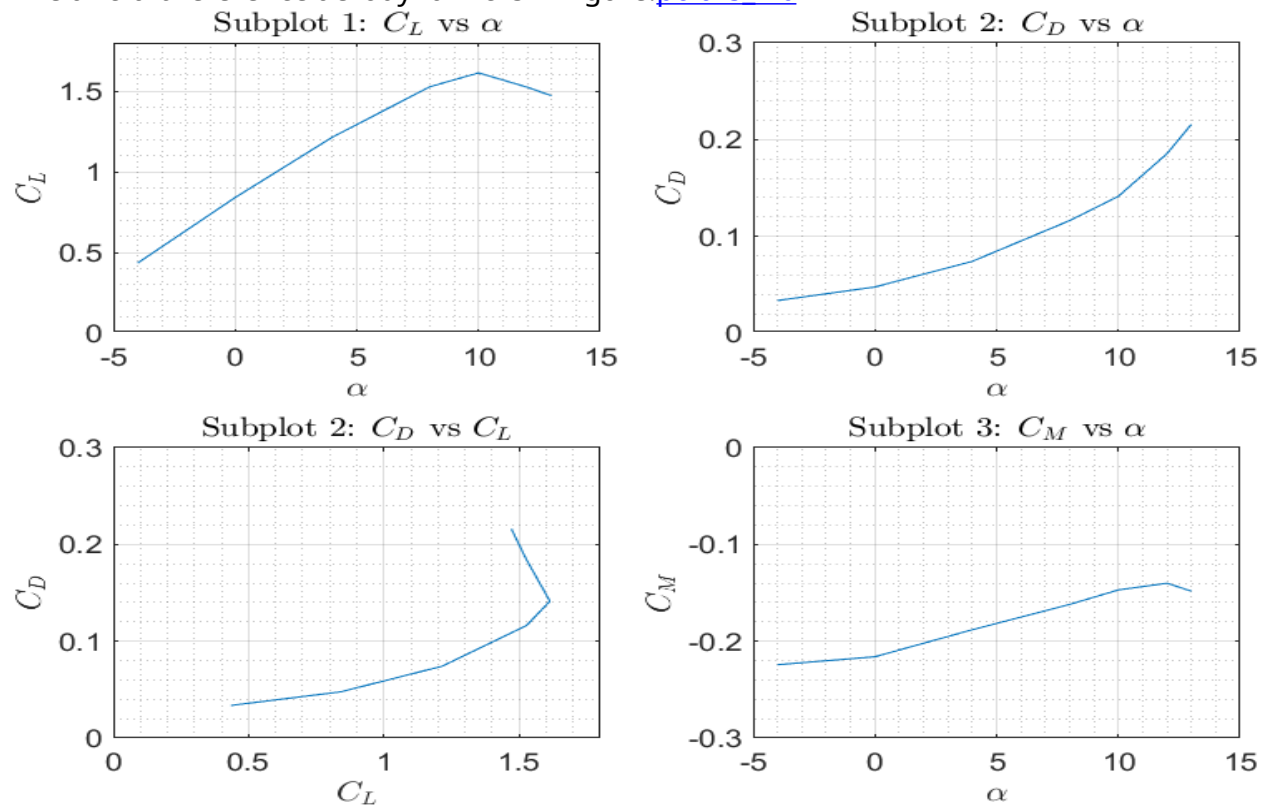


Figure 4.1. Wing-Body reference Aerodynamics

Chapter 5. Design Airspeeds

This chapter defines the operating and design airspeeds as required for certification
REFFFF

5.1. Maximum speed in level flight VH

According to flight tests [5] at maximum weight and maximum continuous power at sea level conditions, the maximum speed in level flight has been determined: $V_H = 130 \text{ kts}$

5.2. Stall speeds VS, VS0, VS1

These speeds will be verified by flight test according to requirement 4.4.1 [1]. In order to calculate the stall speed, the maximum lift coefficient of the aeroplane as a whole is determined first. The maximum lift coefficient of the aeroplane has been calculated starting from the polar curve of the wing profile taken from ref. [6] (p. 236, $Re = 2.9E6$ flaps retracted $c_{l_profile_max} = 1.35$ and p. 237, $\delta_f = 40^\circ$ for the flaps in landing configuration $c_{l_profile_flapped_max} = 2.15$, and $\delta_f = 10^\circ$ in take-off configuration $c_{l_profile_flapped_to} = 1.70$). Considering the horizontal tail balancing force and the lower total wing lift due to wing lift distribution, the total aeroplane lift coefficient has been lowered by 15% with respect to the one of the profile.

Flaps retracted (clean configuration):

$$V_S = \sqrt{\frac{2 W_{MTOM}}{\rho_0 C_{L_{MAX_{Clean}}} S}} = \sqrt{\frac{2 * 981}{1.225 * 1.6137 * 2.589}} = 19.7891 \text{ m/s}$$

Flaps extended (Landing configuration):

$$V_{S_0} = \sqrt{\frac{2 W_{MTOM}}{\rho_0 C_{L_{MAX_{Landing}}} S}}$$

Flaps extended (Take-off configuration):

$$V_{S_1} = \sqrt{\frac{2 W_{MTOM}}{\rho_0 C_{L_{MAX_{Takeoff}}} S}}$$

Therefore aeroplane lift coefficient is estimated to $c_{l_clean_max} = 0.85 * 1.35 = 1.15$ and for the landing configuration (since the span extension of the flaps is half of the span of the wing): $c_{l_flaps_max} = (c_{l_profile_flapped_max} + c_{l_profile_max}) / 2 * 0.85 = (2.15 + 1.35) / 2 * 0.85 = 1.49$

The stall speed in landing configuration (flaps fully extended to α_{max} degrees) is V_{S_0} kts. Therefore it is in accordance with CS-LSA.5 [4]. In Take-Off configuration (flaps extended to α_{max} degrees) the stall speed is V_{S_1} kts.

(Note: These speeds are estimates. The methods for the estimation can be various. It is important that these estimations are as precise as possible. Flight tests will be used to validate the stall speeds. In case the flight tests show different values, this might have an impact on the speeds used for design and ultimately might impair the compliance to the CS-LSA.5.)

5.3. Design manoeuvring speed V_A

According to requirement ADD here reference REGULATION paragraph

5.4. Flaps maximum operating speed V_F

According to requirement ADD HERE REF, such speed shall be not less than the greater of example 1.4 V_S 1.8 V_{S0}

The speed has been selected as: ADD HERE value of V_F ,

5.5. Flaps maximum operating speed V_{FE}

On this aeroplane the maximum flap extension speed is identical to the flap operating speed $V_{FE} = V_F = 90$ kts. This speed is the maximum speed for flaps in take-off and landing configuration.

5.6. Design cruising speed V_C

According to requirement ADD req. par V_C may not be less than: $V_{Cmin} = 4.77 \sqrt{\frac{W_{MTOM}}{S}} = 4.77 \sqrt{\frac{600 \times 9.81}{15.1}} = 94$ kts and need not be greater than: $V_{Cmax} = \{0.9 V_H = 0.9 \times 140 = 126\}$ kts. The speed has been selected as: $V_C = 120$ kts

5.7. Design dive speed V_D

According to requirement ADD req par $V_D = 1.4 V_{Cmin} = 1.4 \times 94 = 132$ kts. For V_D a higher value than the one above has been chosen: $V_D = 160$ kts

5.8. Demonstrated dive speed V_{DF}

ADD TEXTS:

5.9. Never exceed speed V_{NE}

ADD TEXTS:

Chapter 6. Altitude

The maximum permissible operational altitude is ADD H13000ft. Despite the CS-LSA requirements do not require to accounts for the effects of altitude, such effects have been considered up to 10000 ft. In fact the gust load factor have been calculated at such altitude. This is considered acceptable since it covers the operational range within which the aeroplane will fly most of the time.

(Note: the CS-LSA requirement does not require to account for the effects of altitude. Calculating the loads at sea level would be acceptable. In this case, the choice to consider such effect up to 10000 ft is a decision of a designer, which would be accepted by the team.)

Chapter 7. Manoeuvring and Gust load factors n

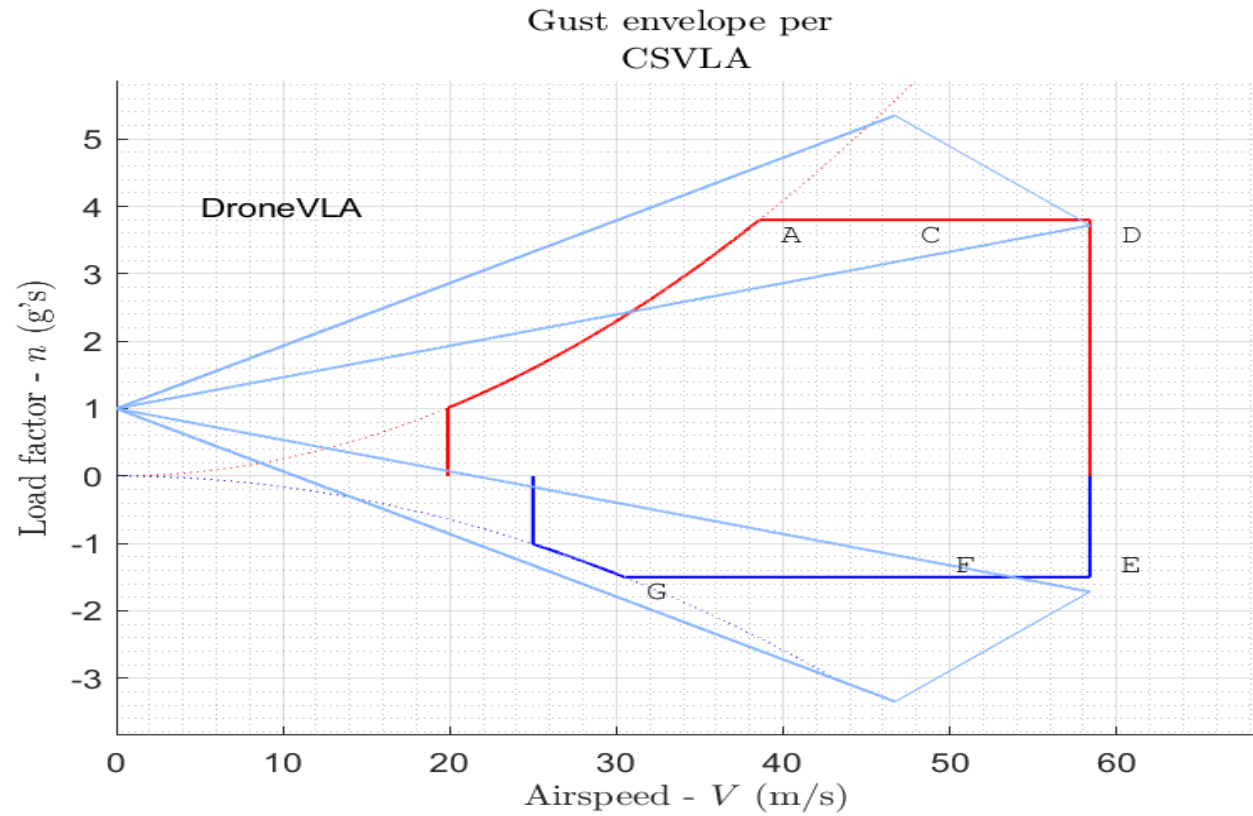


Figure 7.1. Maneuver and Gust load factors and diagram

ADD HERE Manoeuvring and Gust load factors n , figures, tables....ecc. ecc.

Chapter 8. V-n Envelope

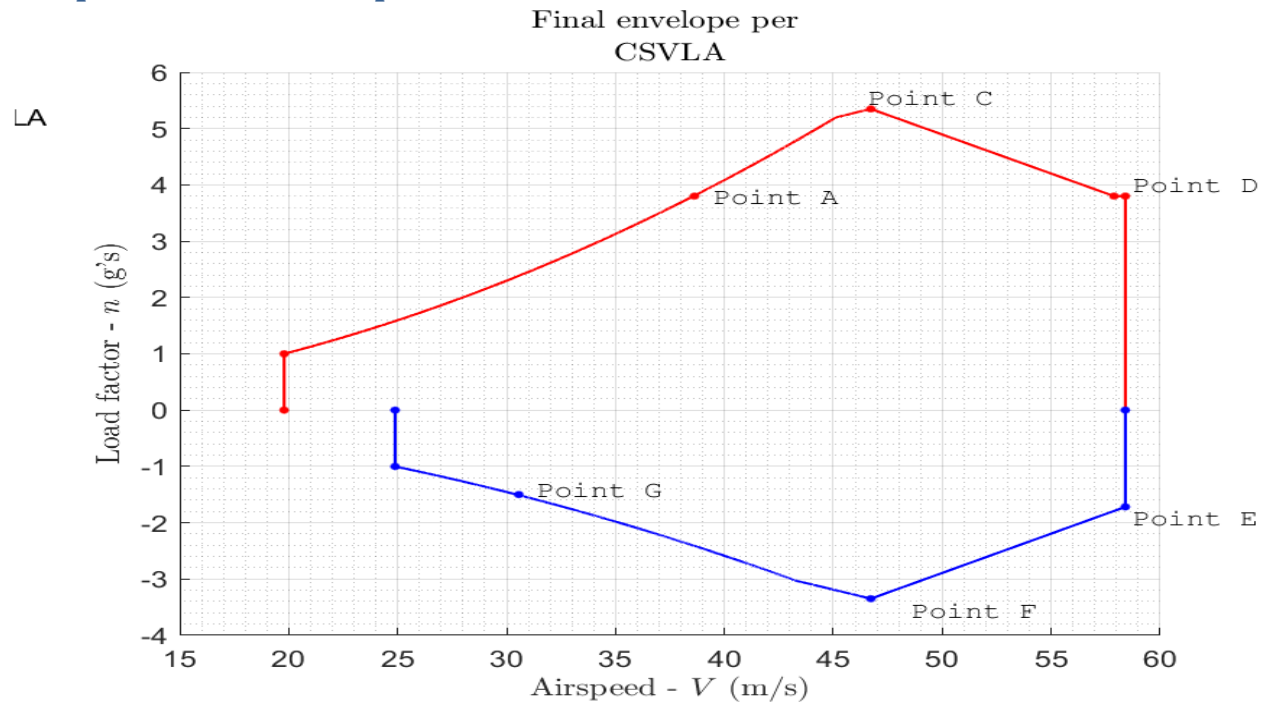


Figure 8.1. Maneuver and Gust load factors and diagram

ADD HERE V-n Envelope

Chapter 9. Loads on the aeroplane

ADD HERE details for balancing Equation

ADD HERE details for balancing Equation

9.1. Reference axes and sign convention

9.1.1. aaaaa

ADD HERE details for balancing Equation

9.2. Symmetrical flight conditions

ADD HERE details for balancing Equation

9.3. Aerodynamic centre

ADD HERE details for balancing Equation

9.4. Pitching moment of the wing

Chapter 10. Loads on the wing

ADD HERE details for balancing Equation

ADD HERE details for fuselage effect how are they accounted?

10.1. Influence of the fuselage

ADD HERE details for balancing Equation

10.2. Forces and moments acting on the wings

10.2.1. SpanWise Airloads Distribution

10.2.2. Normal and parallel component

10.2.3. Shear, Bending and Torsion

10.2.4. Critical load condition

ADD HERE details for uns loads

10.3. Unsymmetrical loads

10.3.1. Rolling condition

10.3.2. Effect of aileron displacement on the wing torsion

Chapter 11. Loads on the horizontal tail

ADD HERE details

ADD HERE details

11.1. Balancing loads

ADD HERE details

11.2. Manoeuvring loads

11.2.1. Unchecked manoeuvre

11.2.2. Checked manoeuvre

11.2.3. Gust loads

ADD HERE details

11.3. Horizontal tail loads summary

ADD HERE details

11.4. Unsymmetrical loads

Chapter 12. Loads on the vertical tail

ADD HERE details

ADD HERE details

12.1. Manoeuvring loads

12.1.1. a(1)

12.1.2. a(2)

12.1.3. a(3)

12.1.4. Gust loads

Chapter 13. Loads on the wing flaps

ADD HERE details

ADD HERE details

13.1. Manoeuvring and gust envelope

Chapter 14. Loads on the control surfaces

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ADD HERE details

14.1. Ailerons

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14.2. Elevator

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14.3. Rudder

Chapter 15. Power plant

ADD HERE details

ADD HERE details

15.1. Engine torque

ADD HERE details

15.2. Side load on engine mount

ADD HERE details

15.3. Inertia load on engine mount

ADD HERE details

15.4. Gyroscopic loads