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AIRCRAFTS

CHARTLE16

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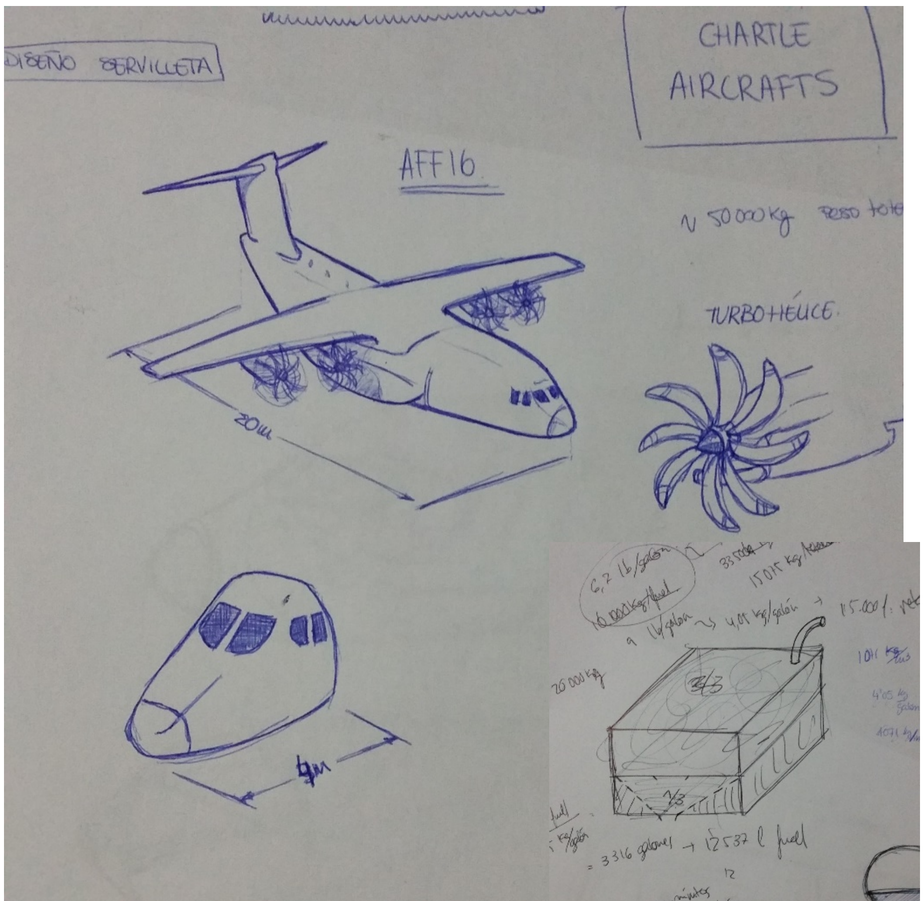
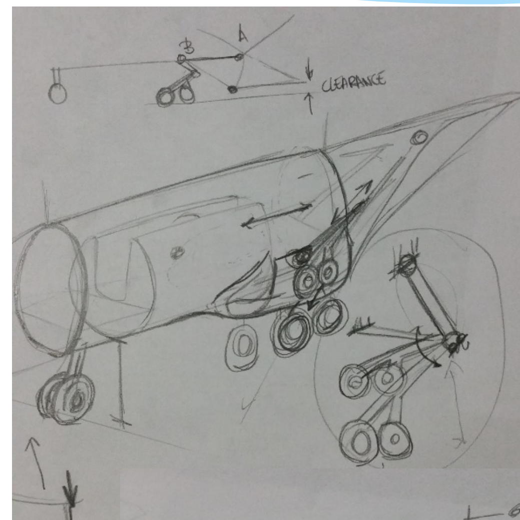
DEPARTAMENTO DE DISEÑO Y SISTEMAS

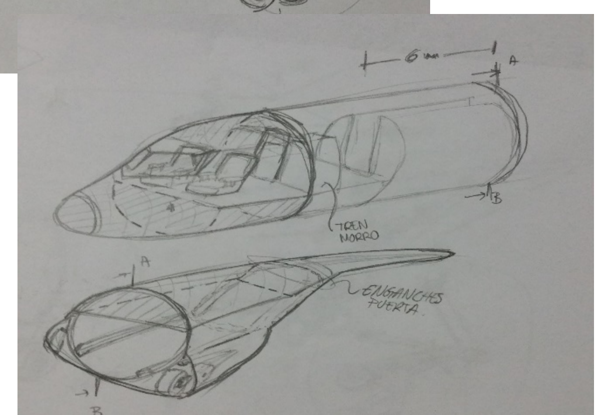
AFF AIRCRAFTS

CHARTLE16

Diseño preliminar







Evolución del diseño

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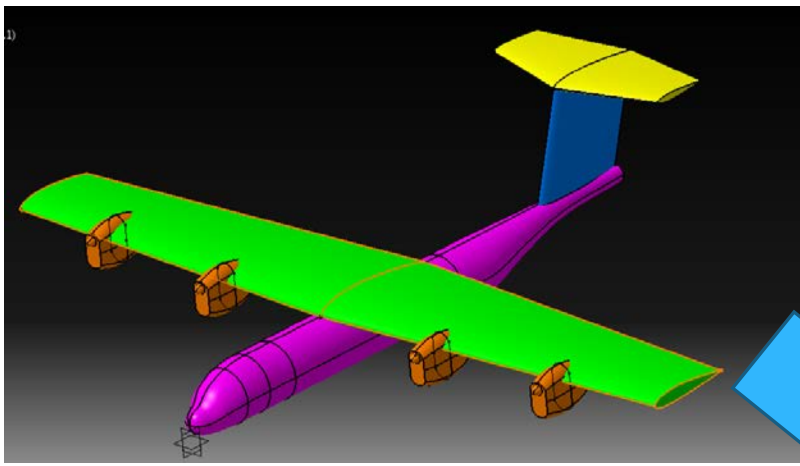

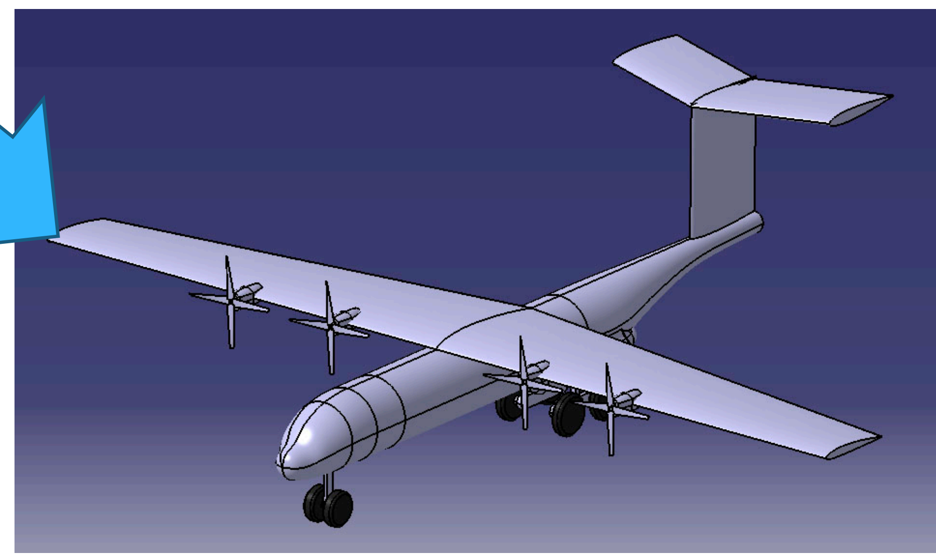

DISEÑO FINAL I

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DISEÑO FINAL II

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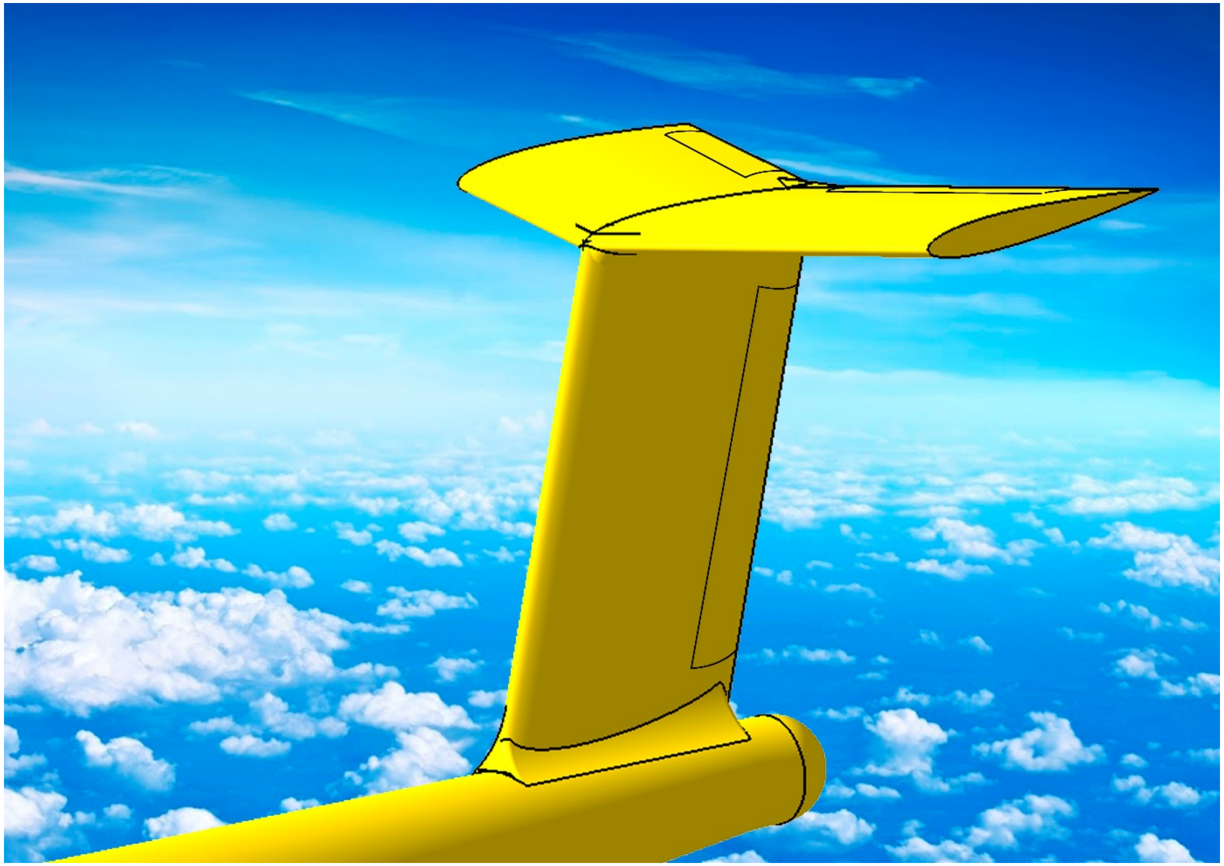
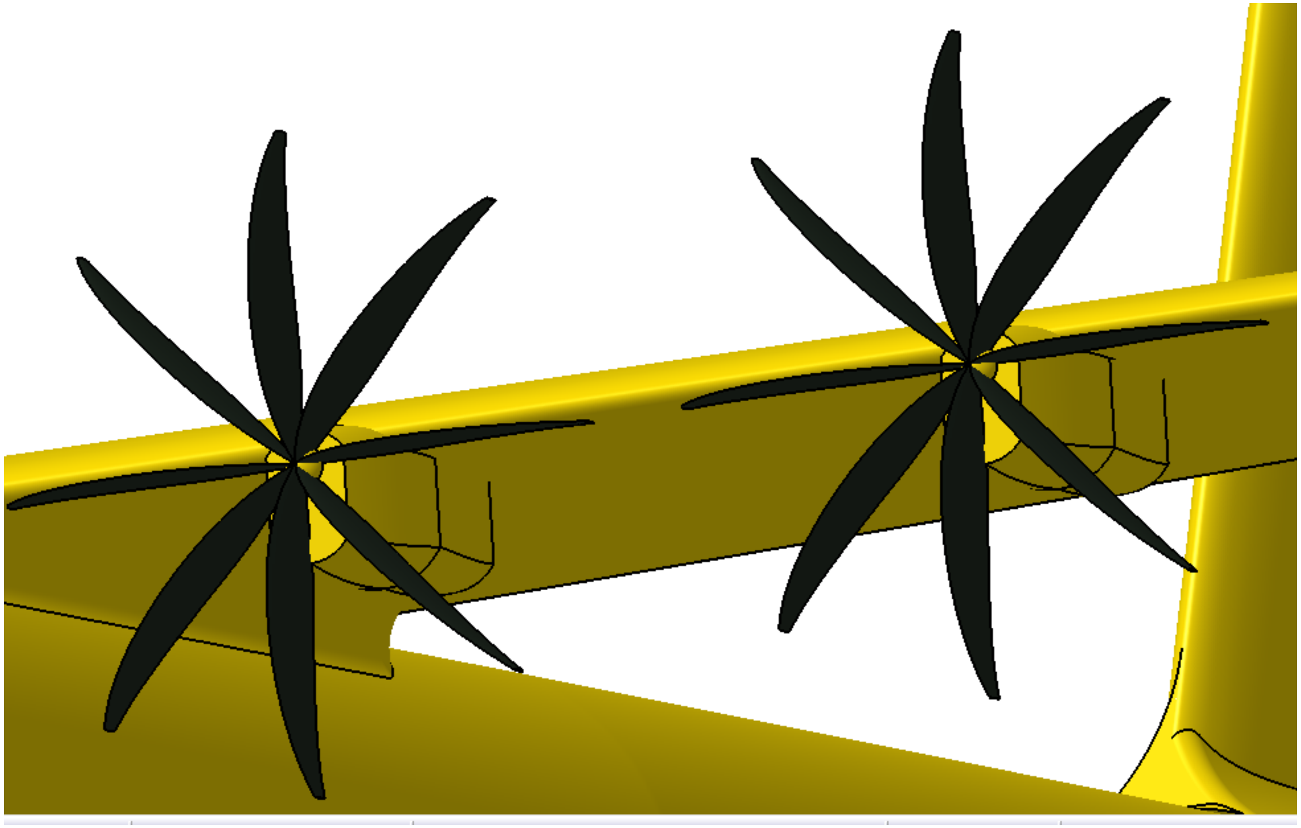
Configuración del avión I

AFF AIRCRAFTS

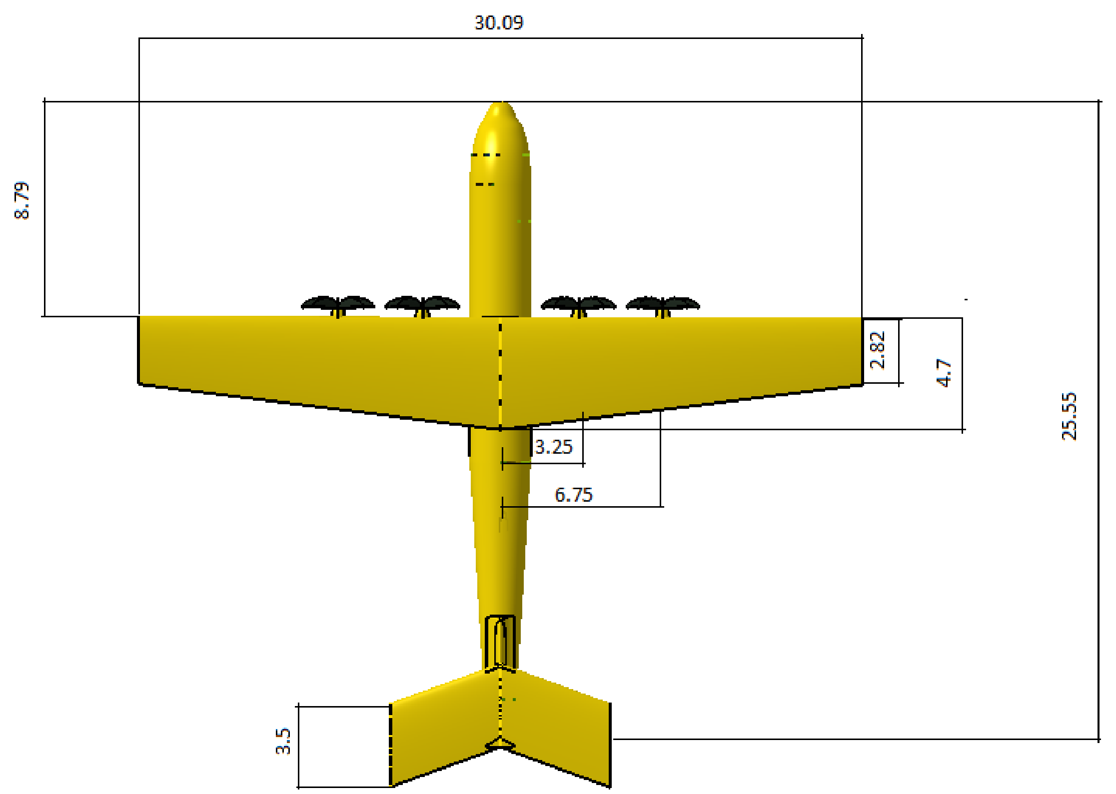
Configuración del avión II



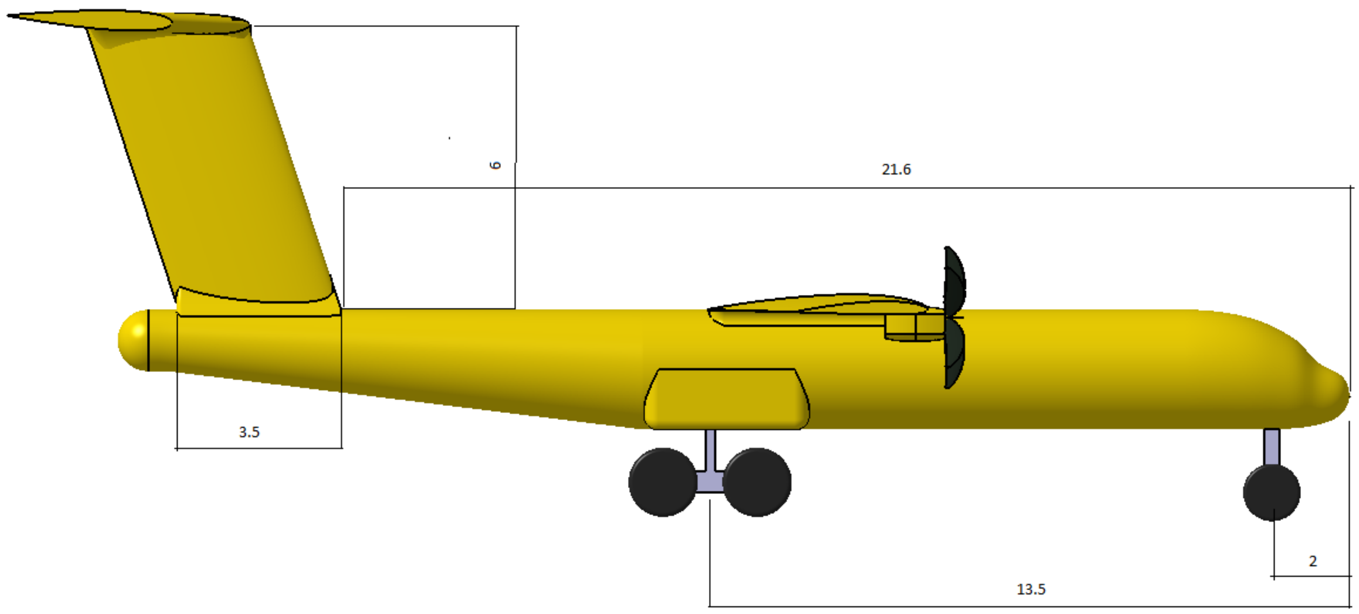
Configuración del avión III



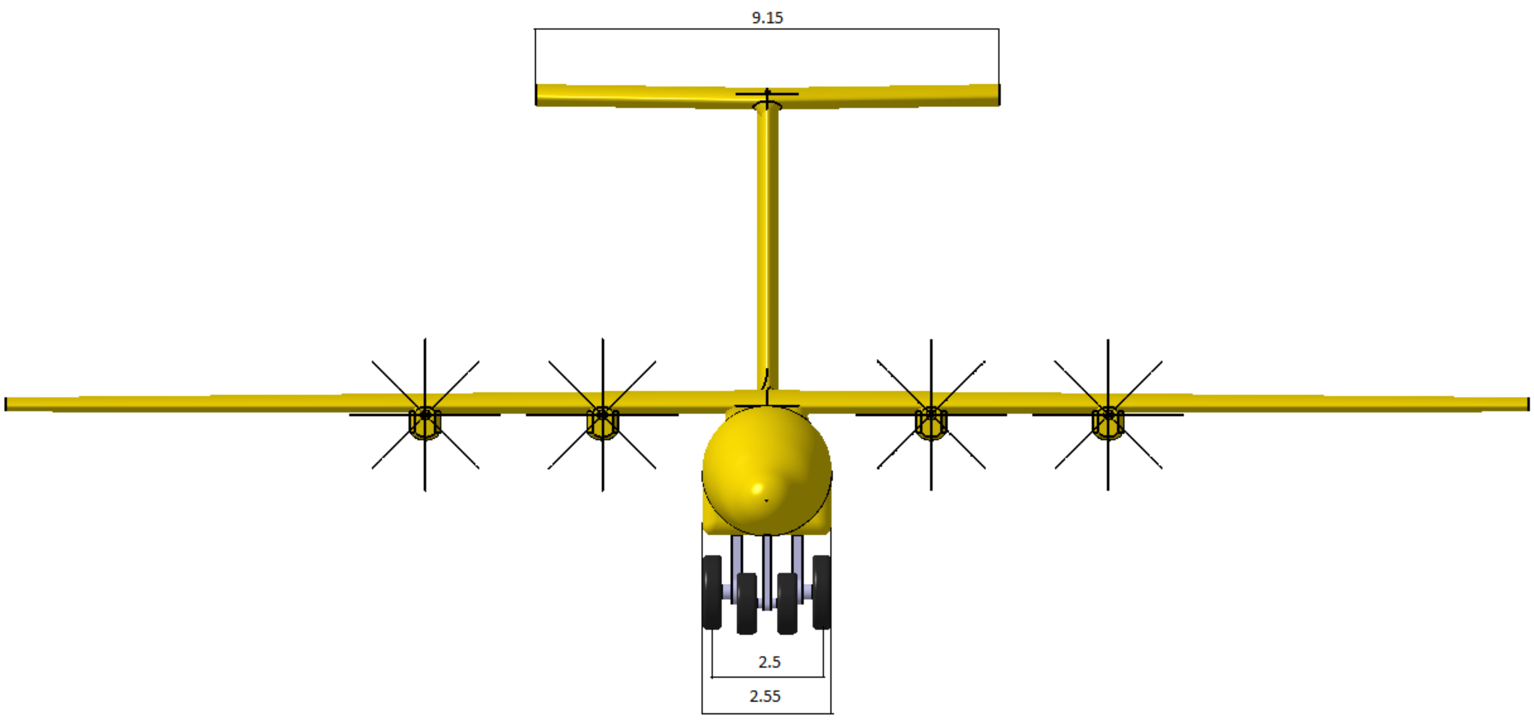
Descripción geométrica I



Descripción geométrica II



Descripción geométrica III



Estructura

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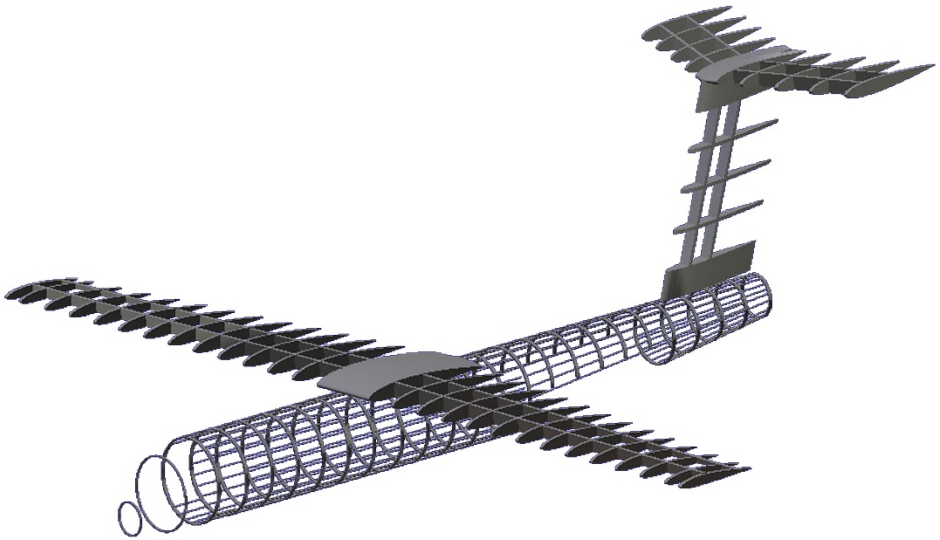
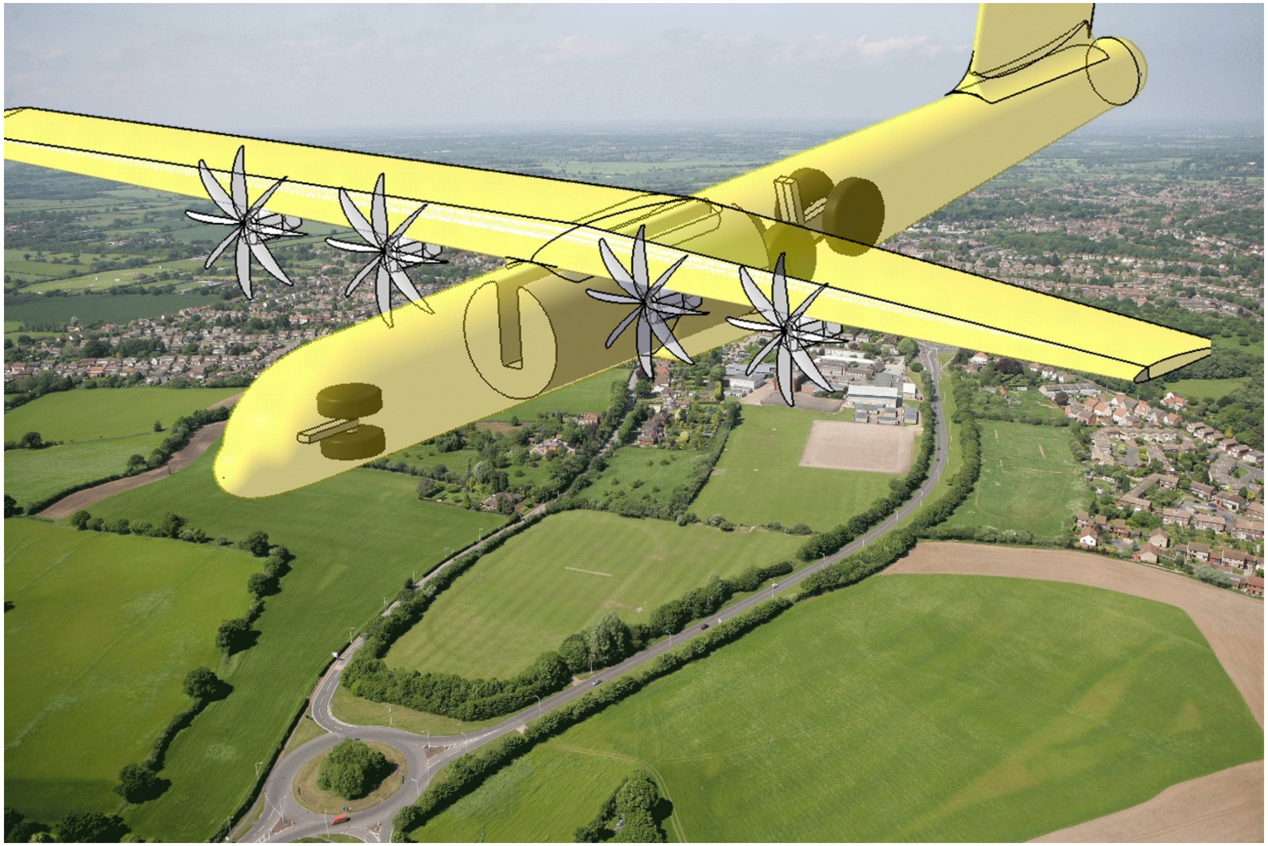
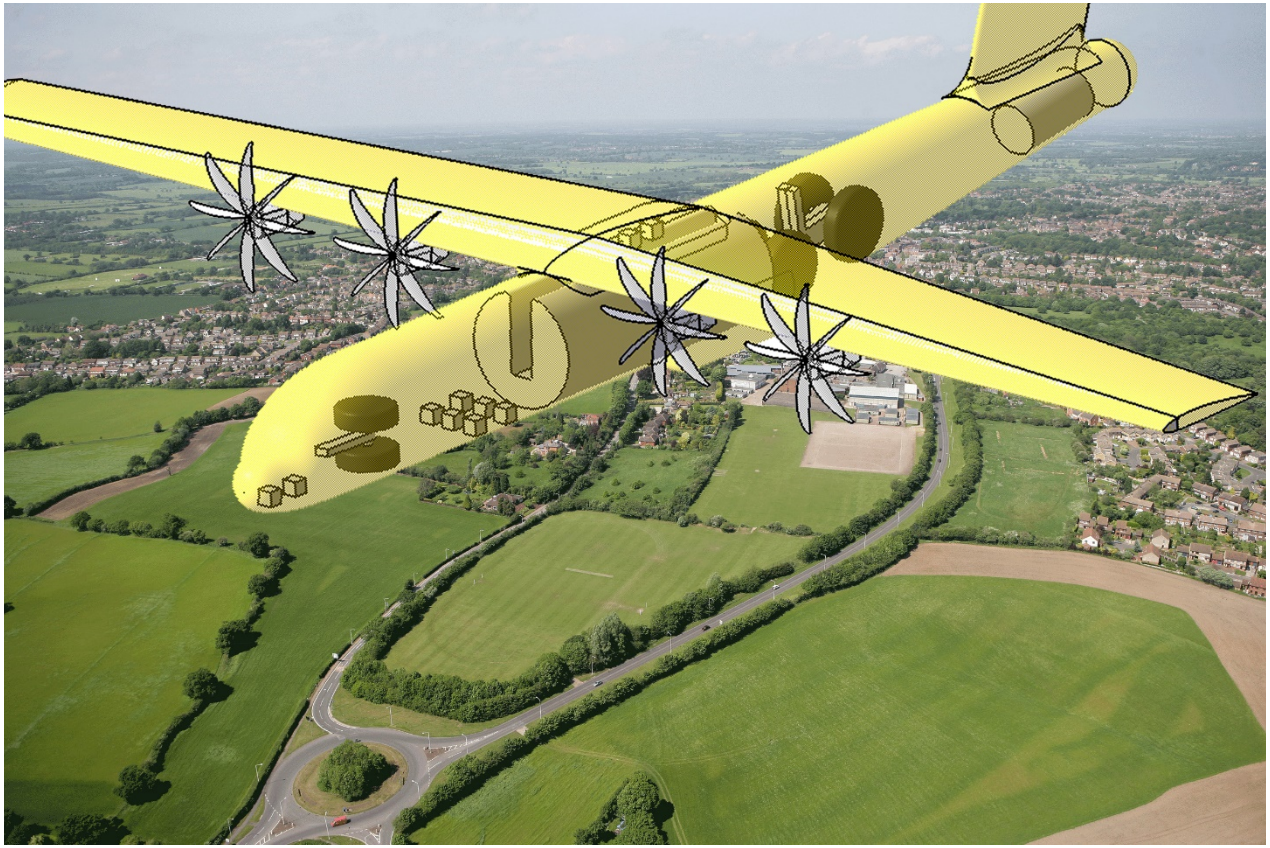


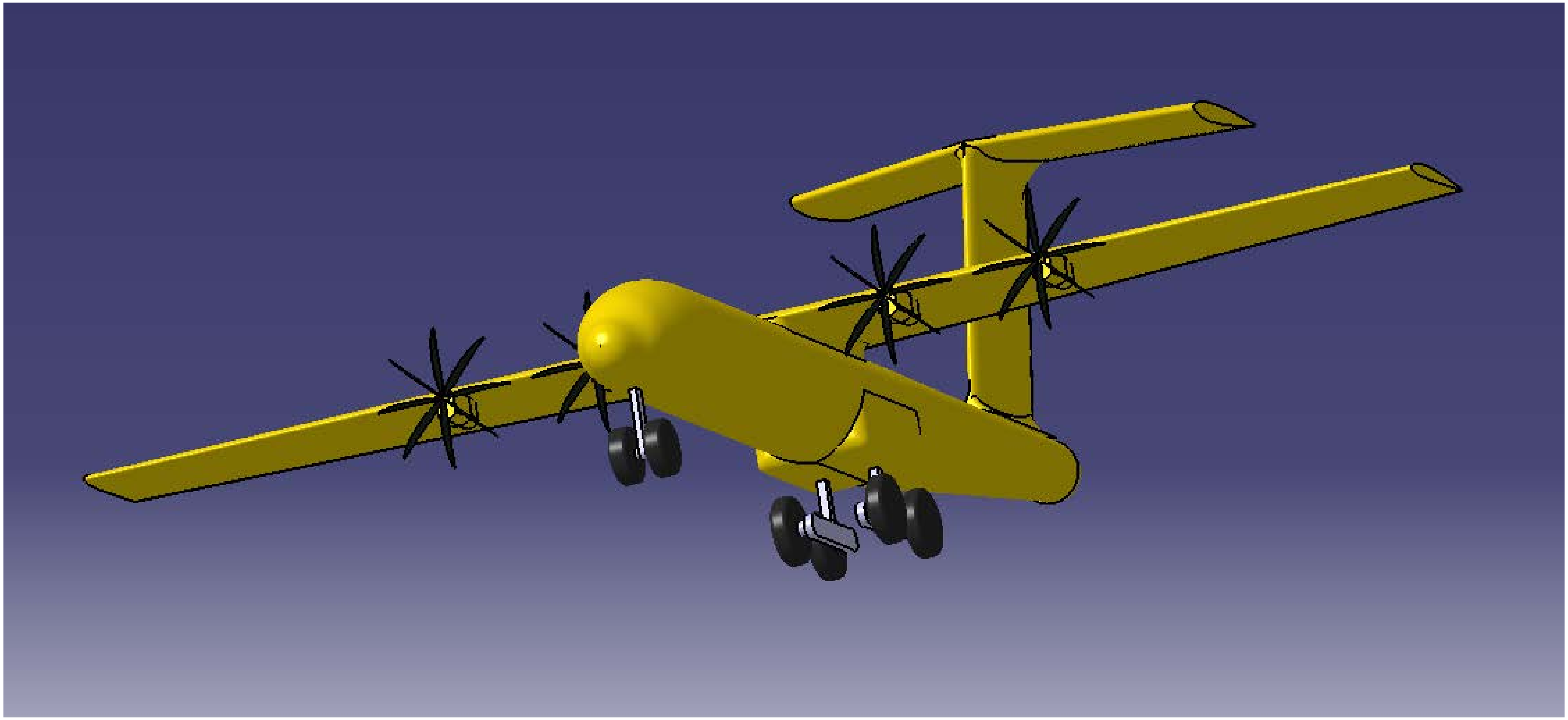
Distribución interna I



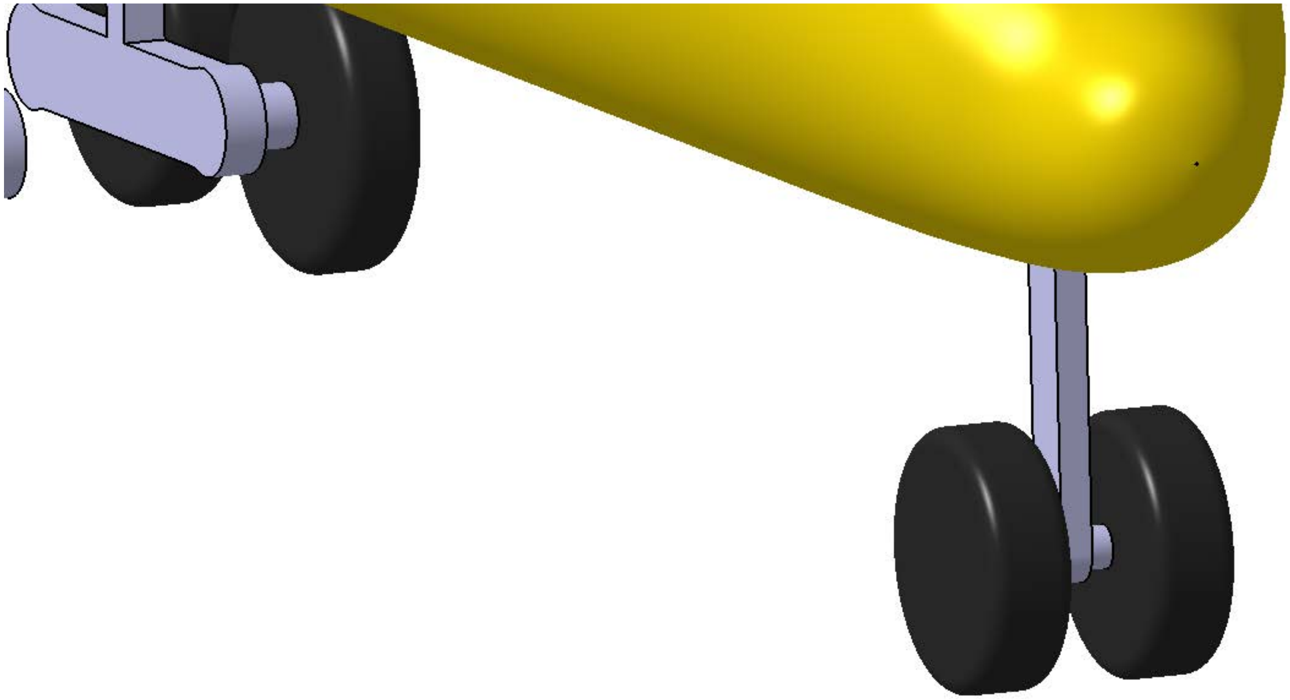
Distribución interna II



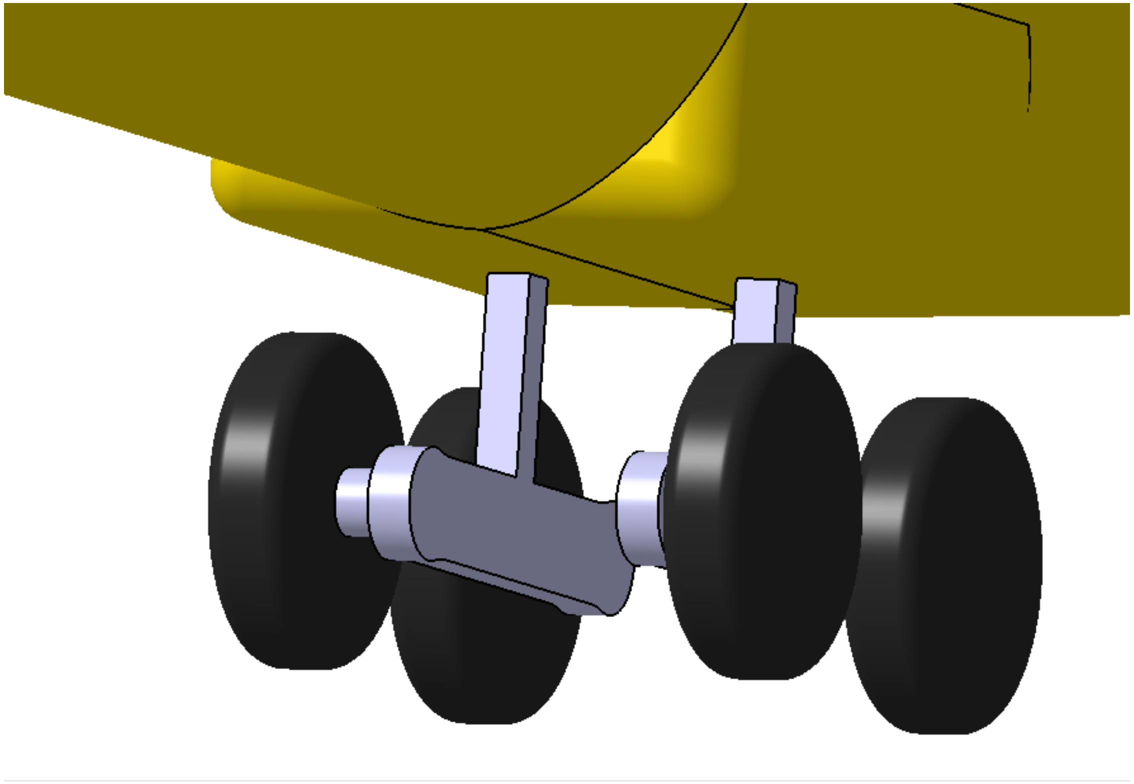
Tren de Aterrizaje I



Tren de Aterrizaje II

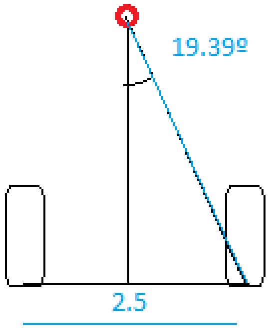


Tren de Aterrizaje III



Tren de Aterrizaje IV

AFF AIRCRAFTS



$\alpha_C = 48.57$

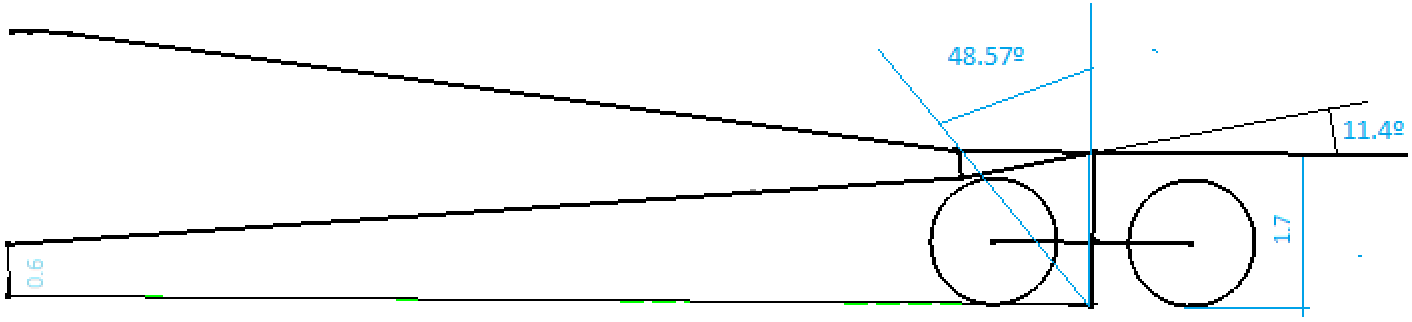
$\alpha_{TO} = 11.4$

$\emptyset_T = 19.39$

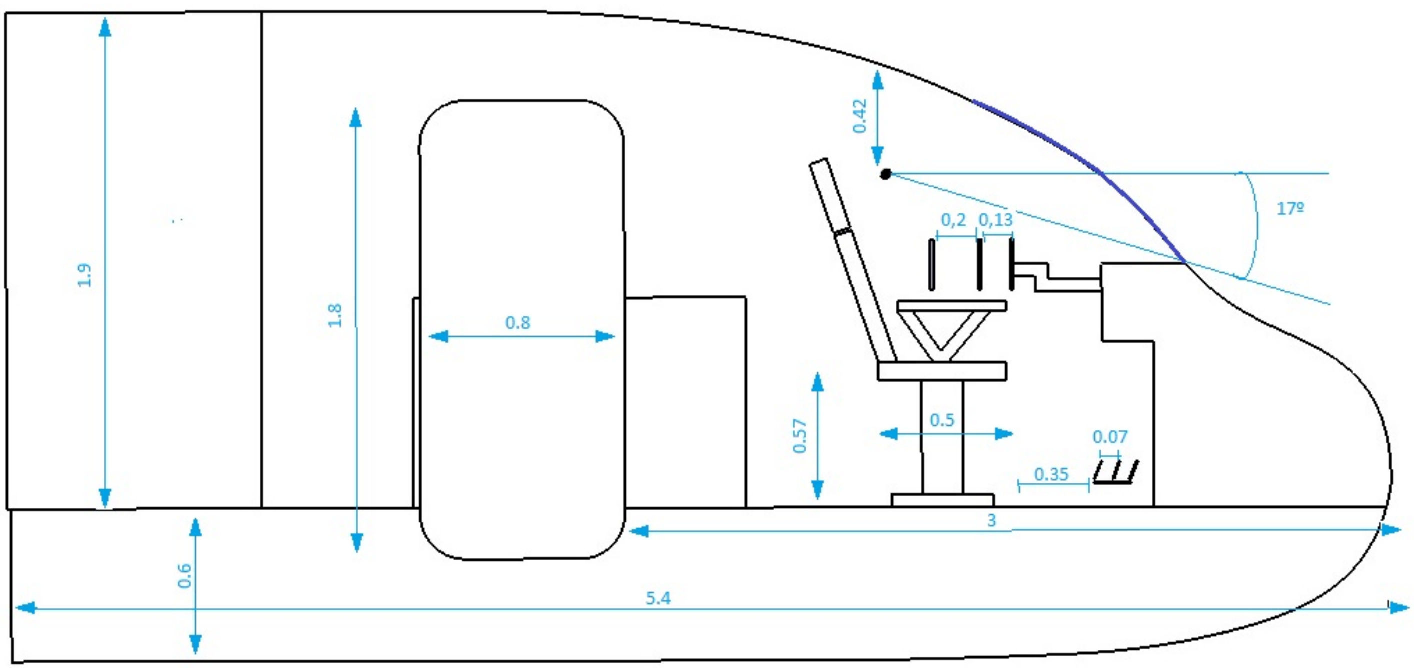
$H = 1.7$ m

B=11 m

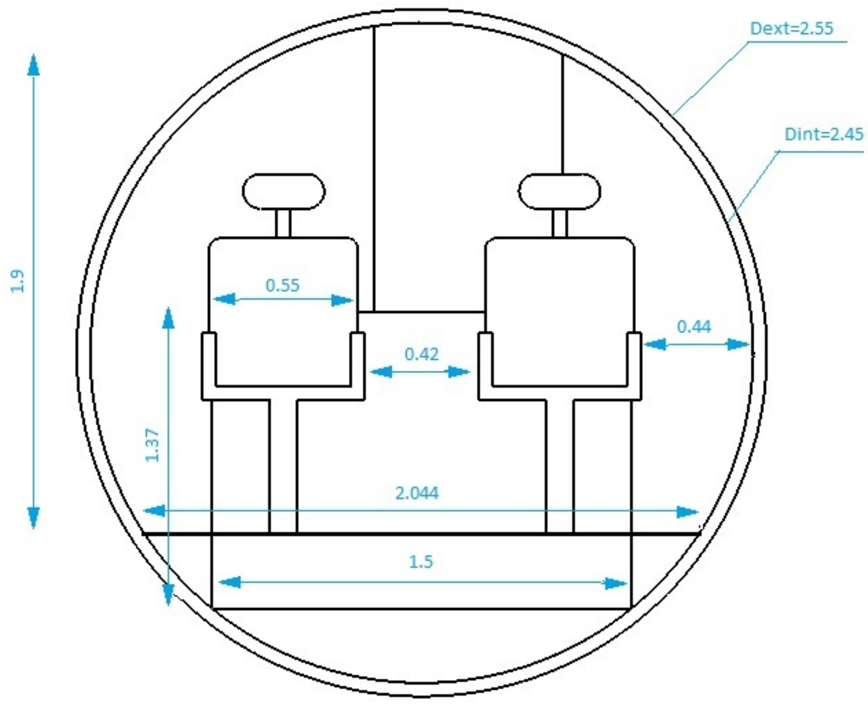
T=2.5 m



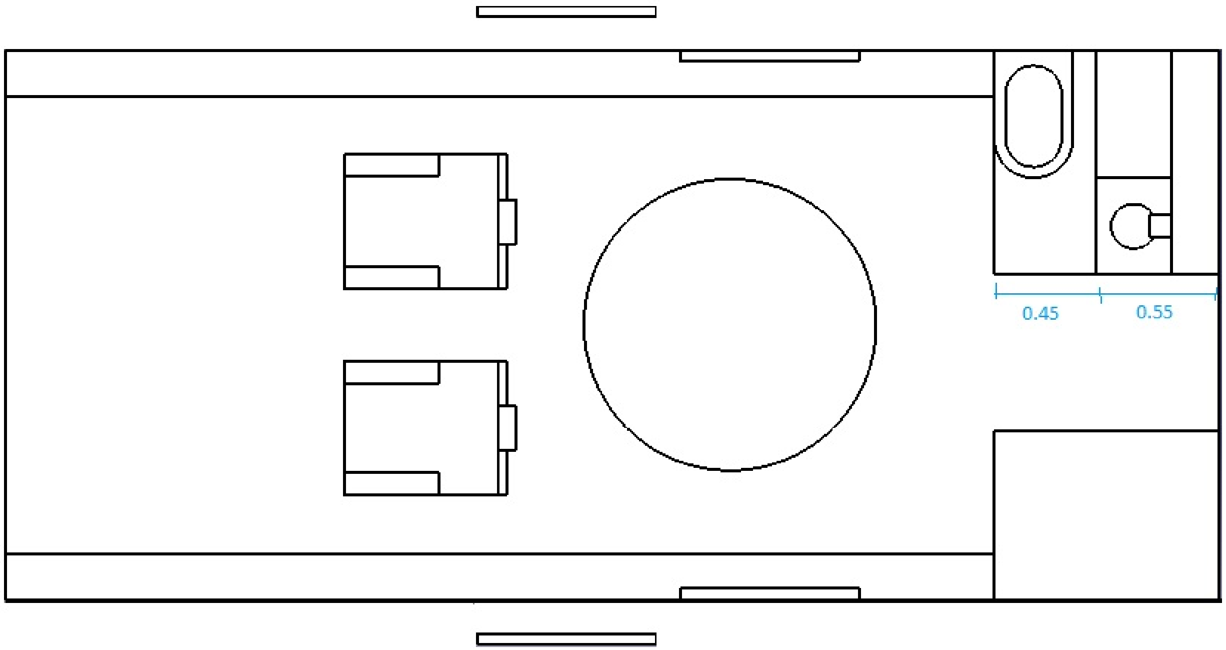
Cabina I



Cabina II



Cabina III



S. Eléctrico

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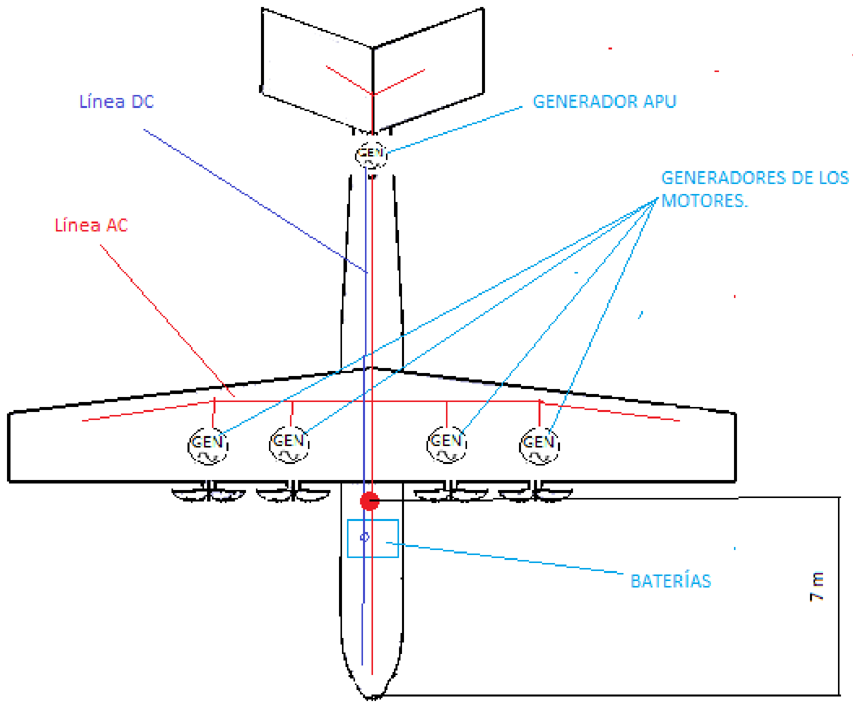
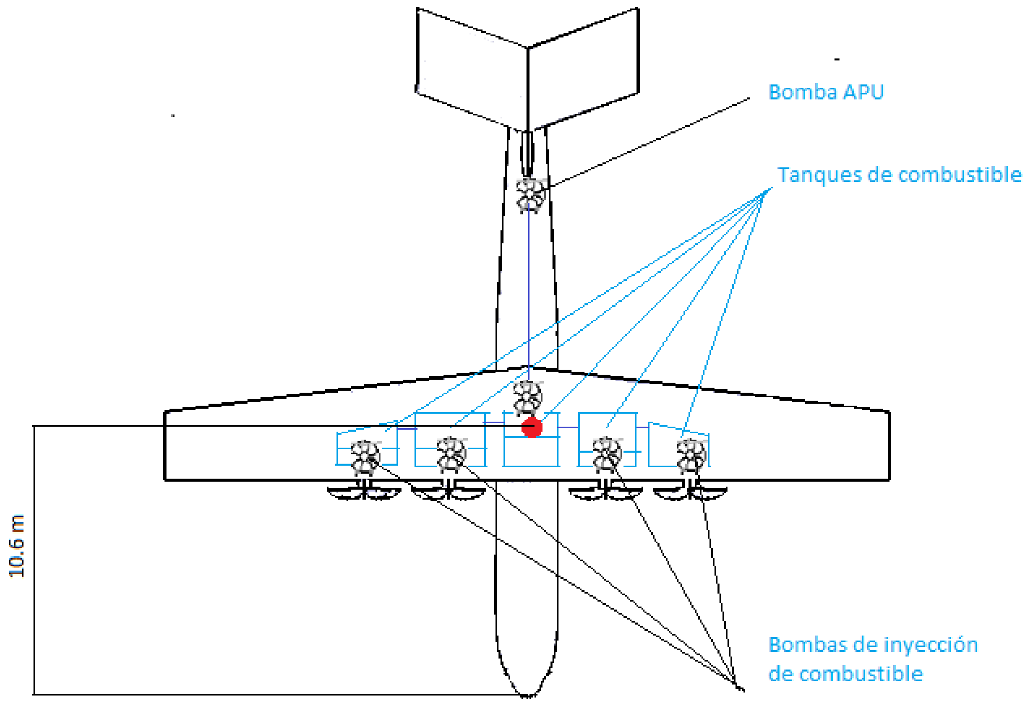
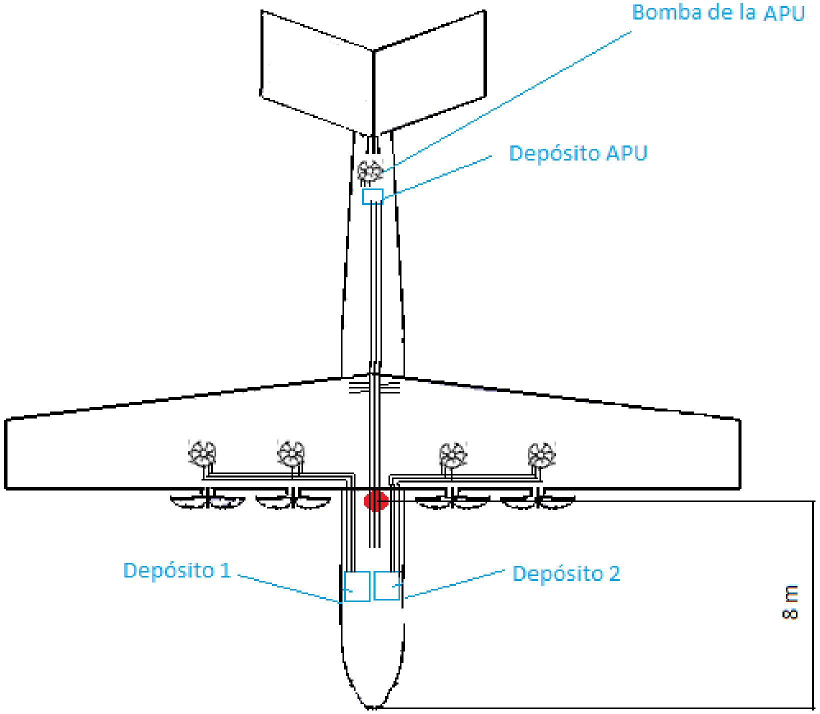


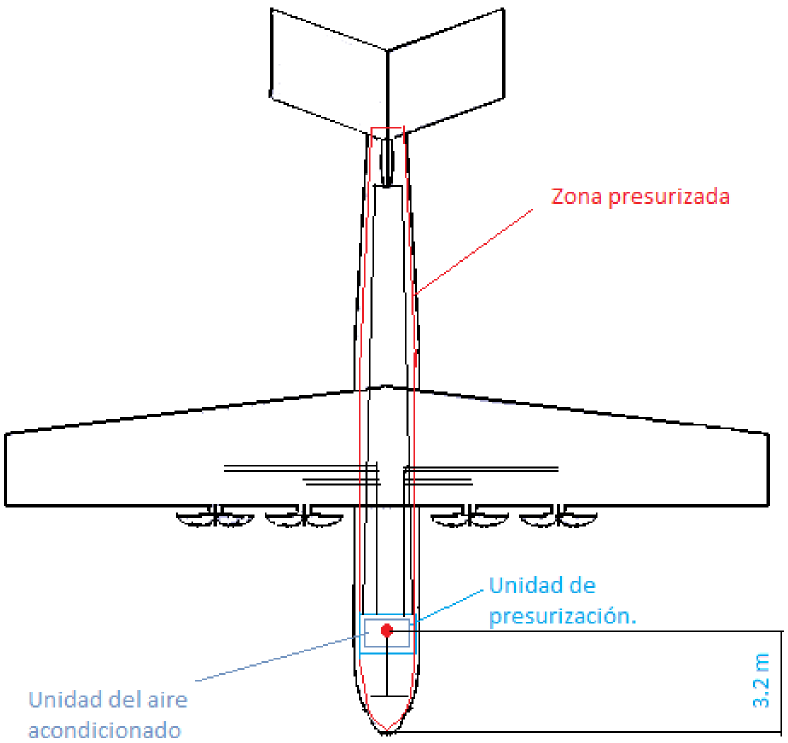
S. Combustible



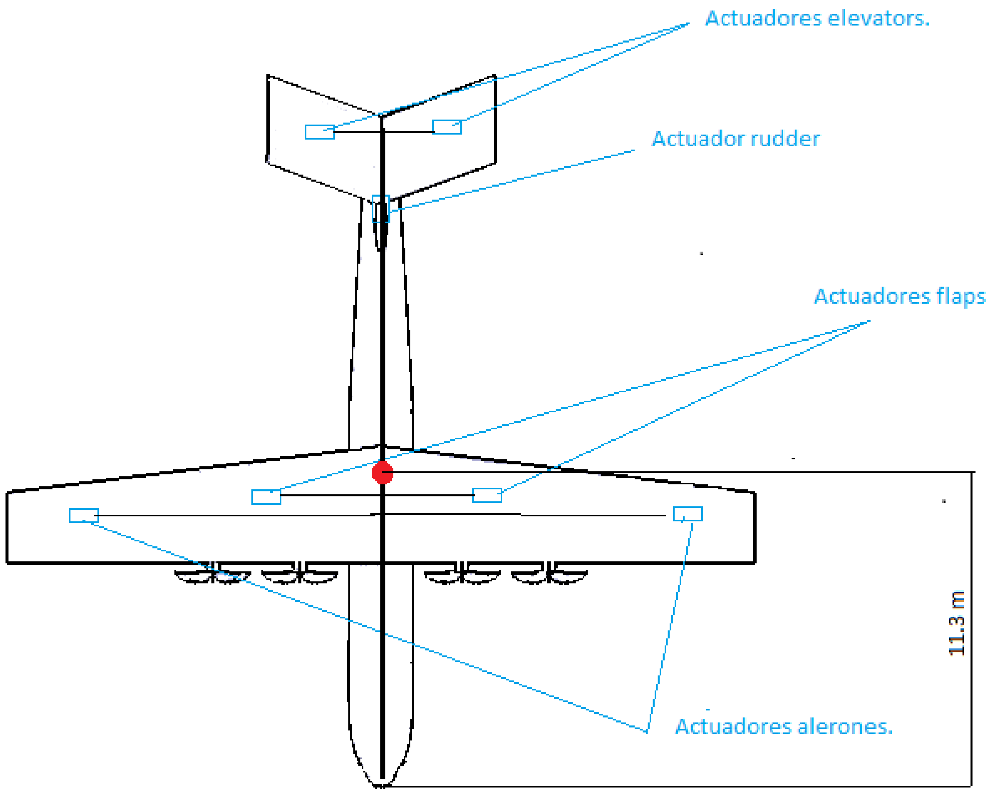
S. Hidráulico



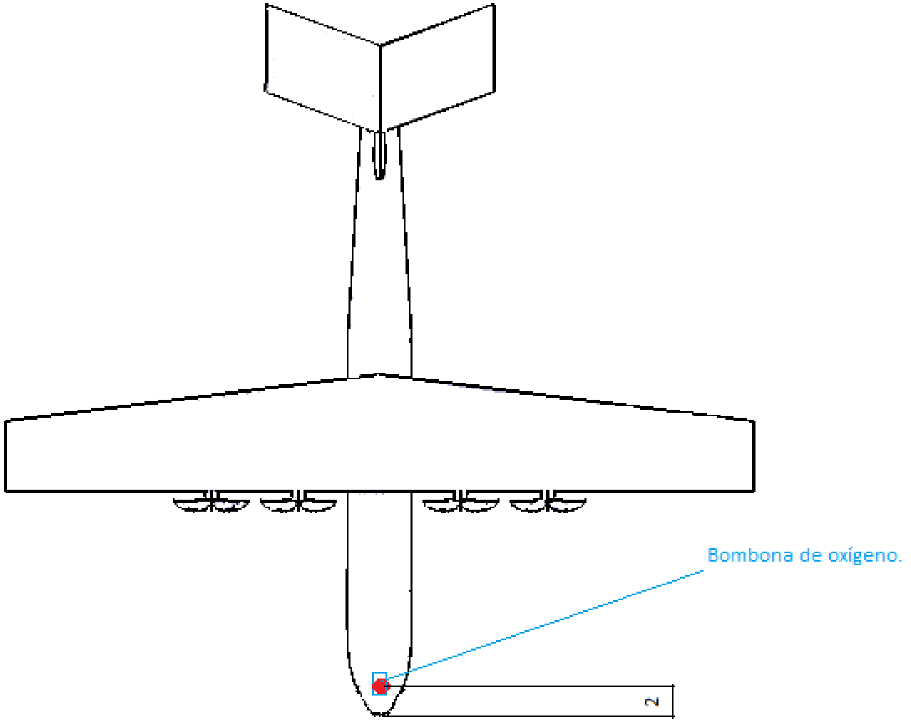
S. Presurización



FCS


Actuadores elevators.
Actuador rudder
Actuadores flaps
11.3 m
Actuadores alerones.

S. Oxígeno



Instrumentación

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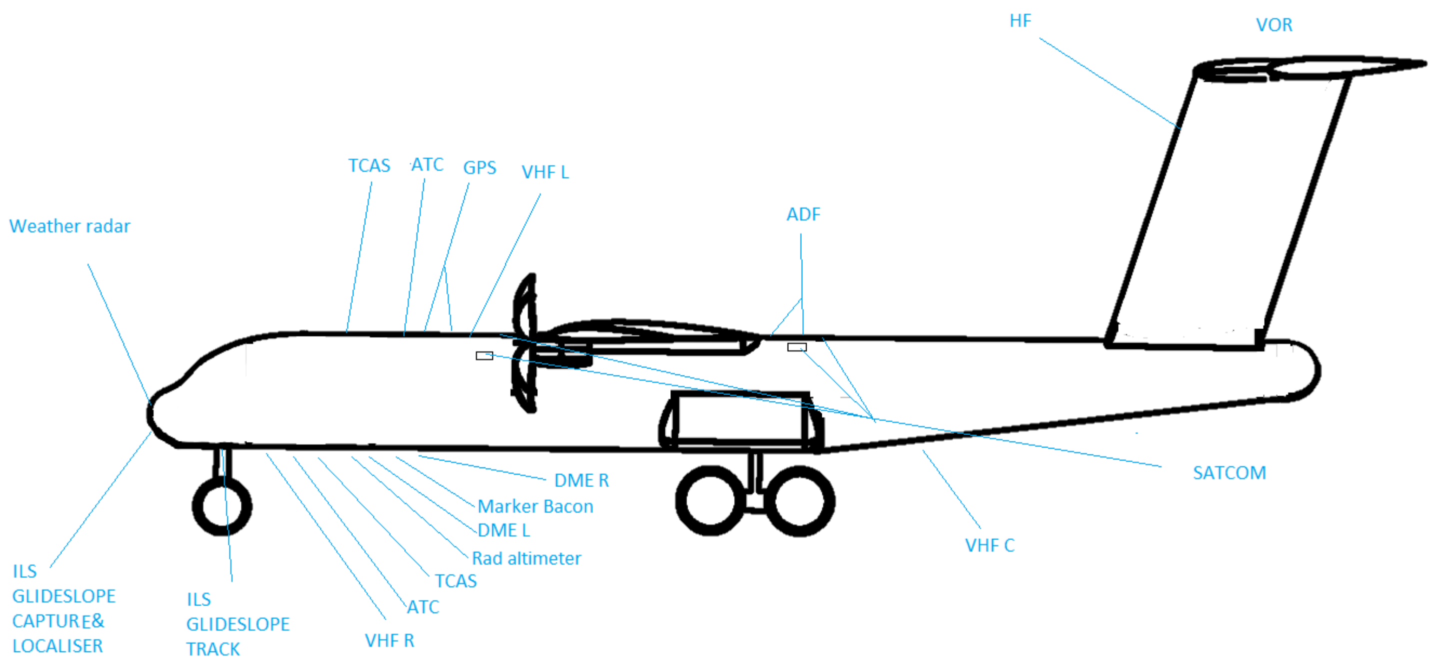

Lucha contra incendios I

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* Comunicación
* Capacidad
* Ataque eficaz
* Rapidez

Lucha contra incendios II

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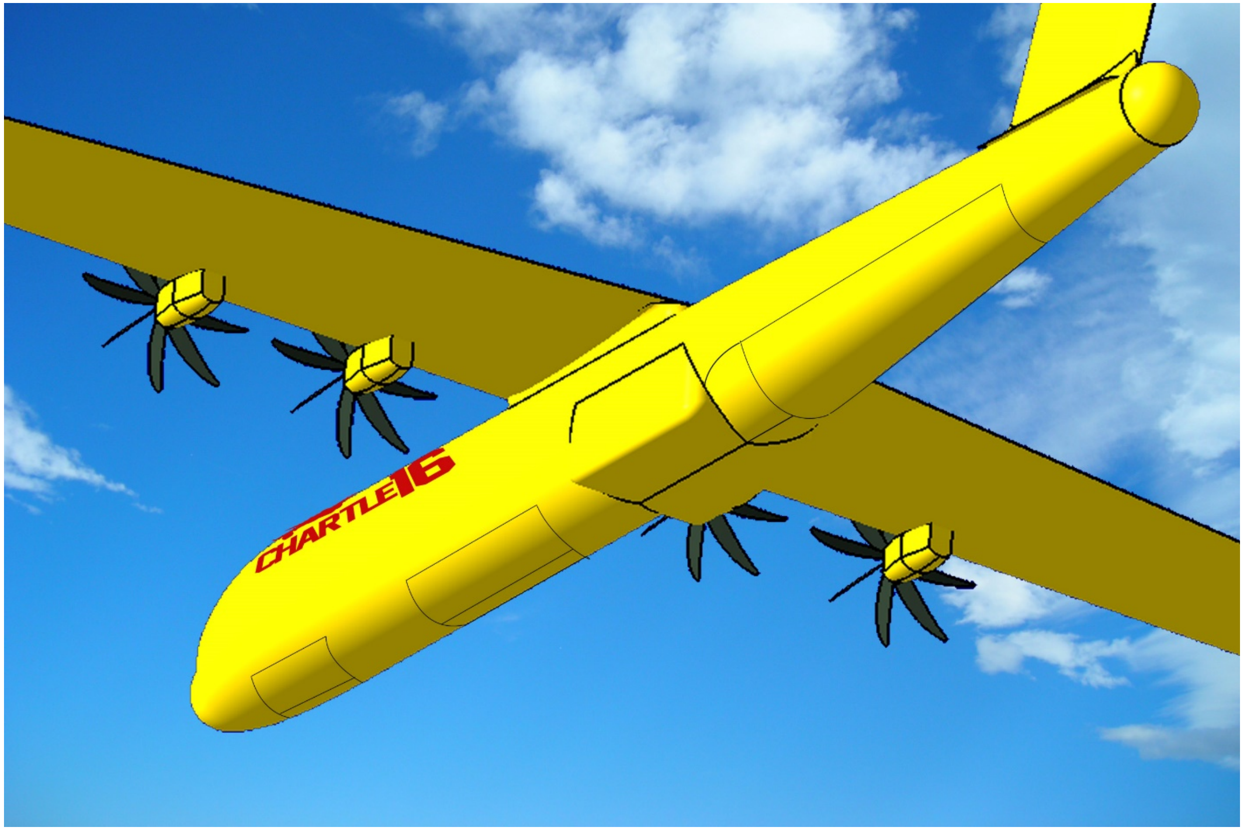
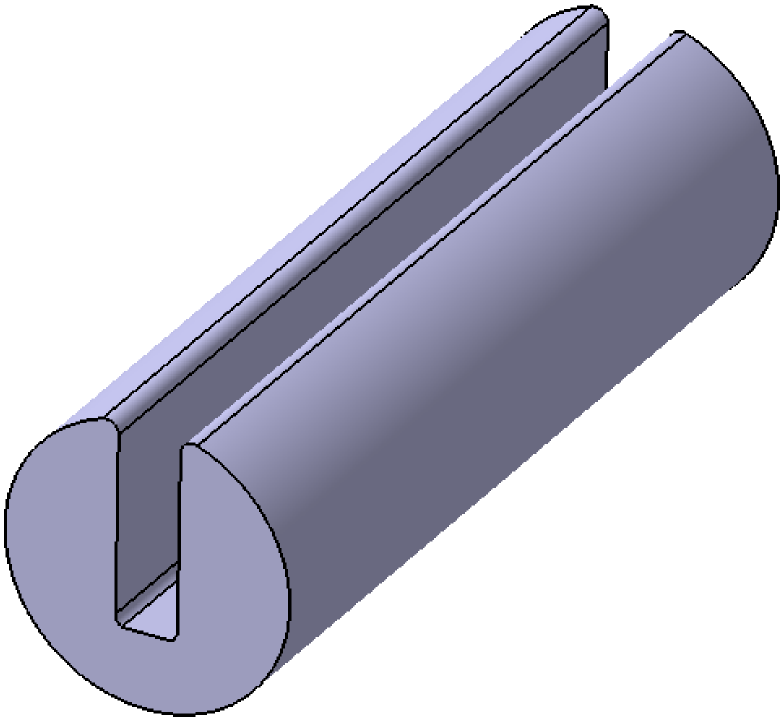


Lucha contra incendios III



DEPARTAMENTO DE AERODINÁMICA

AFF AIRCRAFTS

CHARTLE16

Objetivos

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SUSTENTACIÓN MÁXIMA + RESISTENCIA MÍNIMA

CONDICIONES DE VUELO ÓPTIMAS

Elección Del Perfil

AFF AIRCRAFTS

NACA 2418

¿QUÉ PERFIL VAMOS A UTILIZAR?

NACA 23012

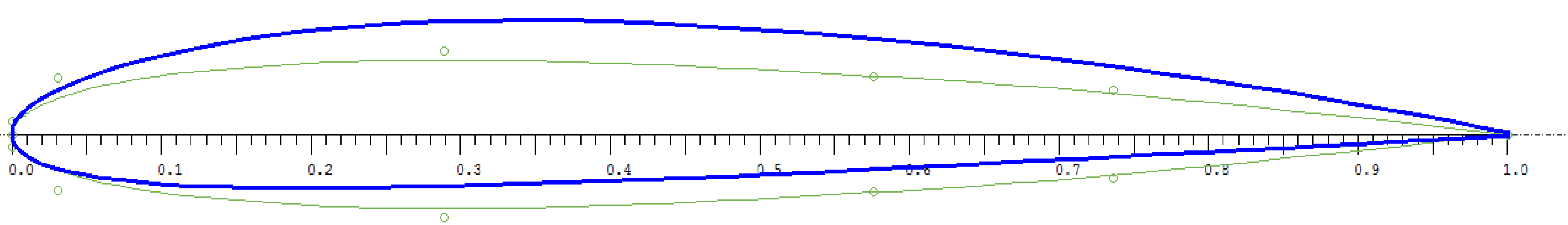
NACA 2412

NACA 23015

NACA 2415

NACA 2410

NACA 23018



Geometría Del Ala

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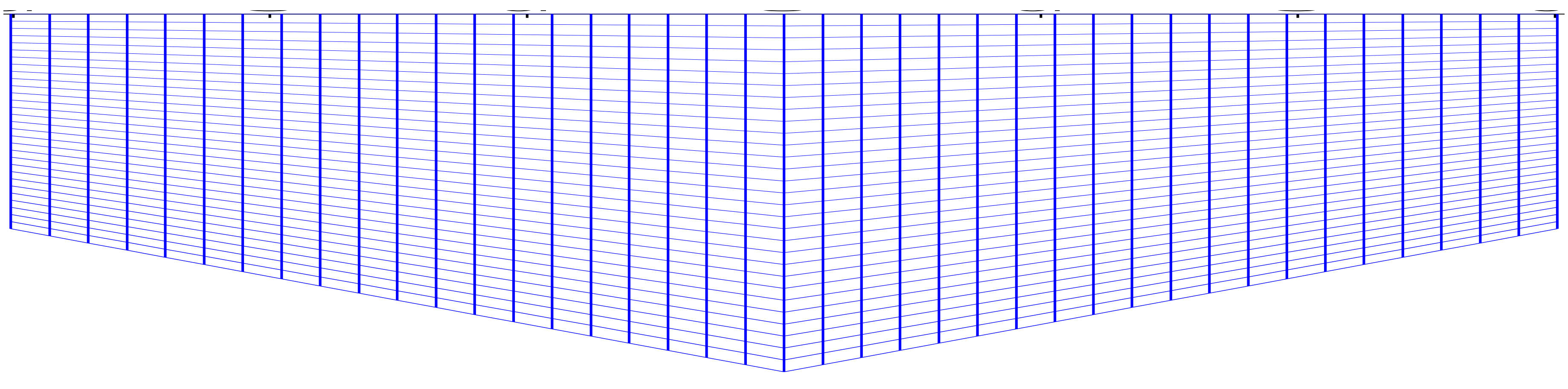
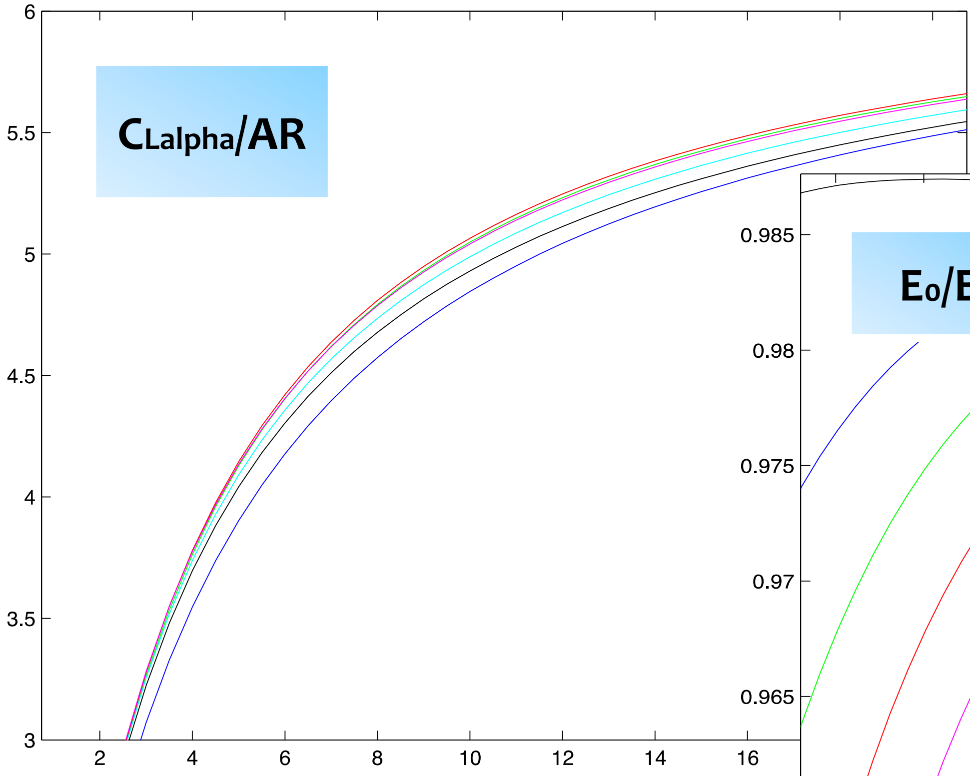
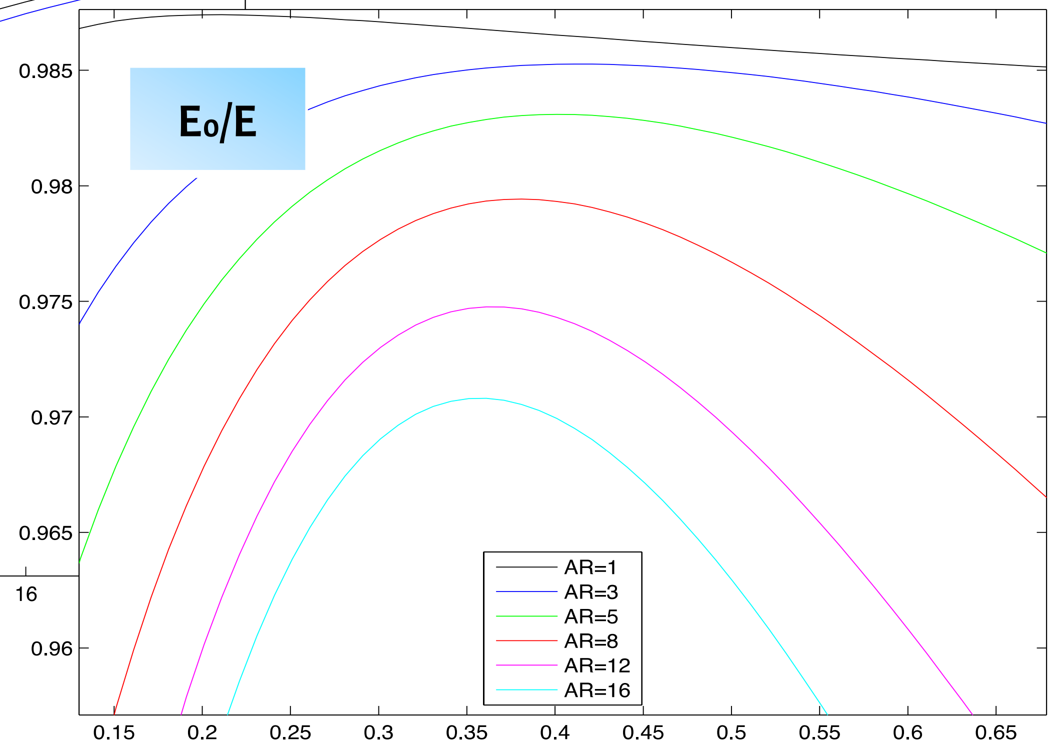
S=113,15	AR=8



Flecha=-1,79	Torsión=1	E=0,6	$I_w=1,5°$

Alargamiento Y Estrechamiento





Torsión

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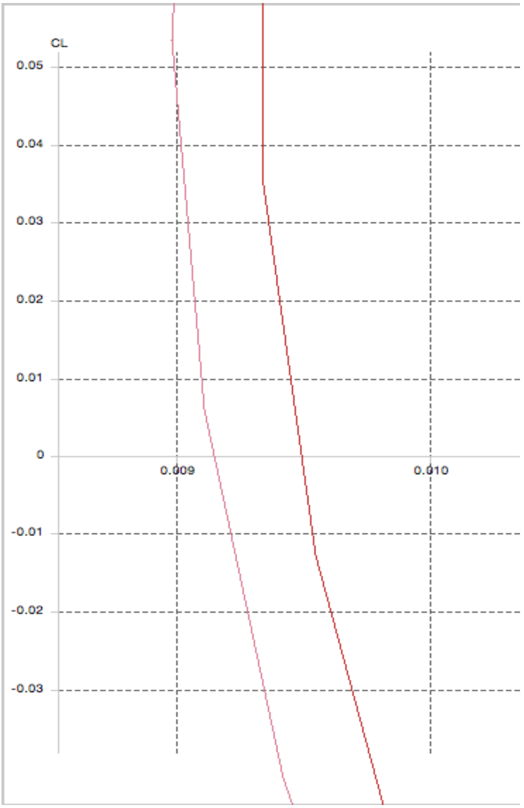
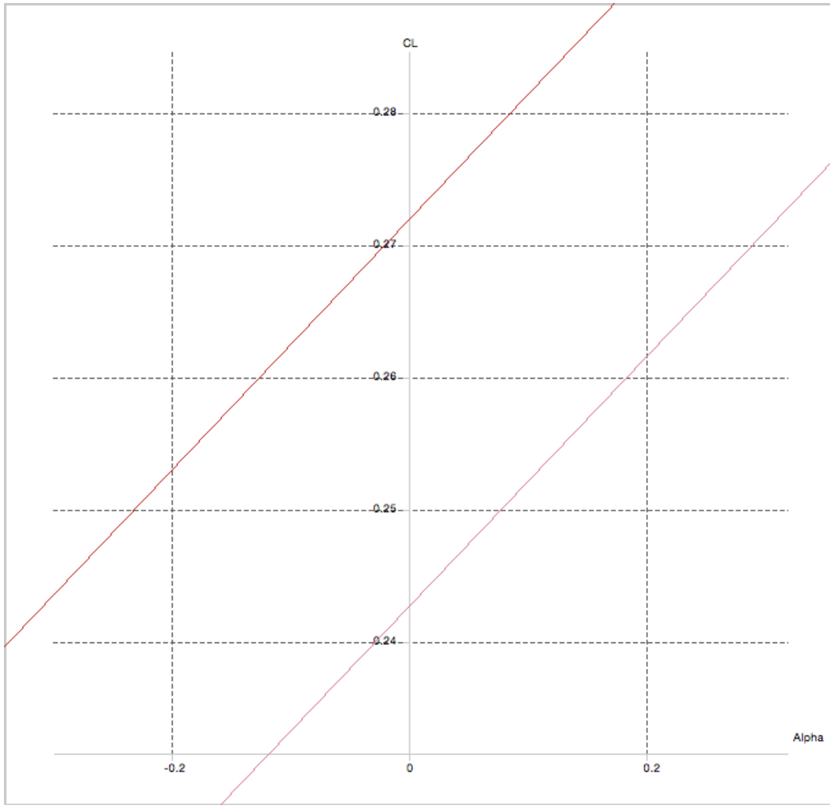
CL/CD

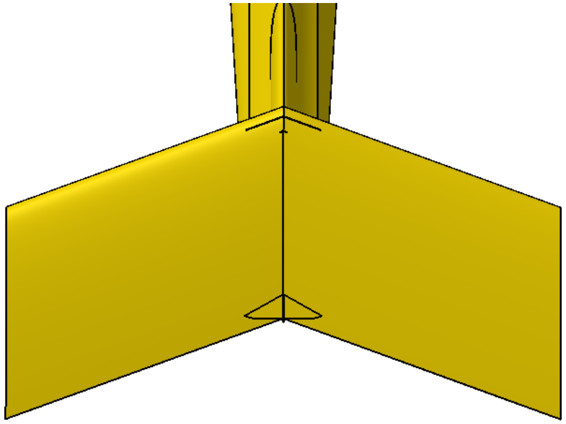


CL/Alpha



Estabilizadores

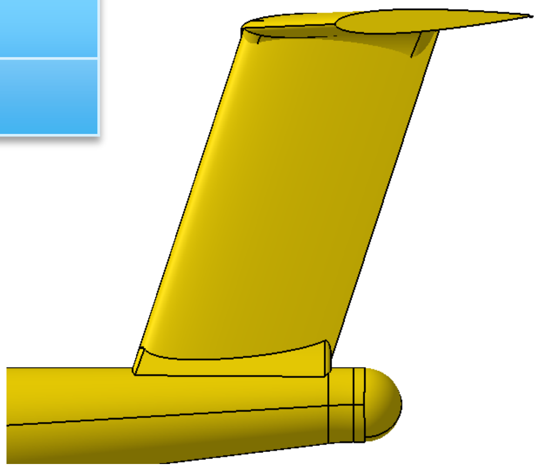
HORIZONTAL



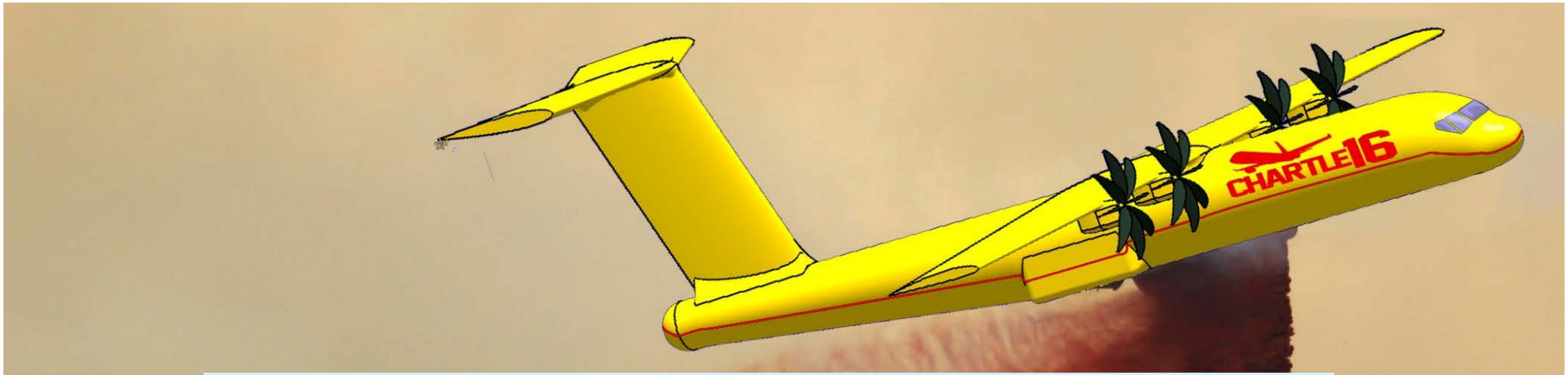
CLalpha	0,0503
CLmax	0,8

VERTICAL

CLalpha	0,0035
CLmax	0,62



Polar Del Avión Limpia



C_{Do}	$C_{Do,f}$	$C_{Do.S}$	$C_{Do,LG}$	$C_{Do,Misc}$	k_1	k_2	C_{lmax}
0.0170	0.0550	0.0095	0.0000	0.0110	-0.0048	0.0440	1,92

Dispositivos Hipersustentadores

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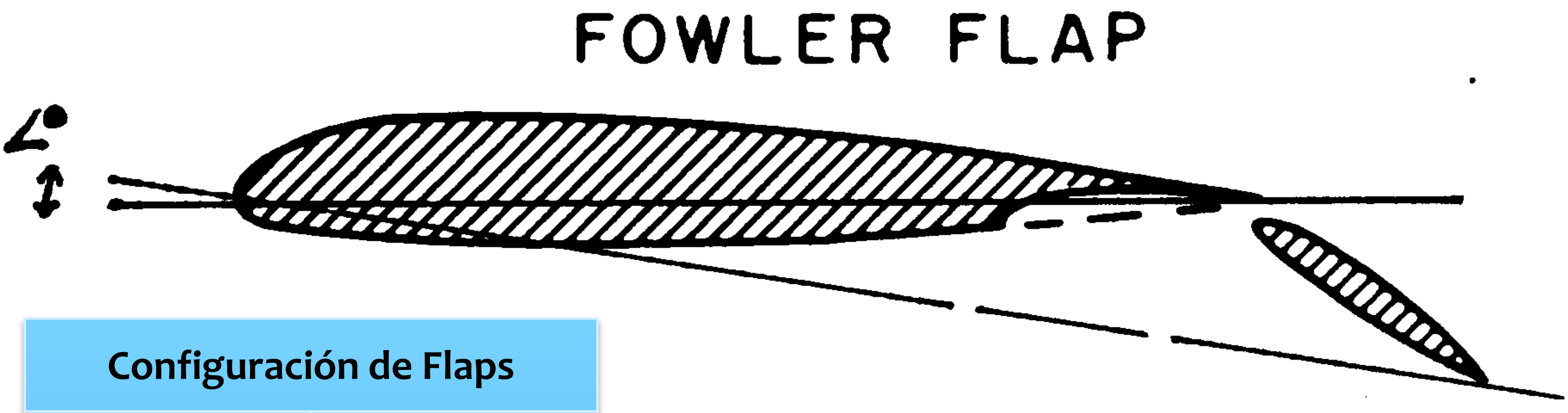
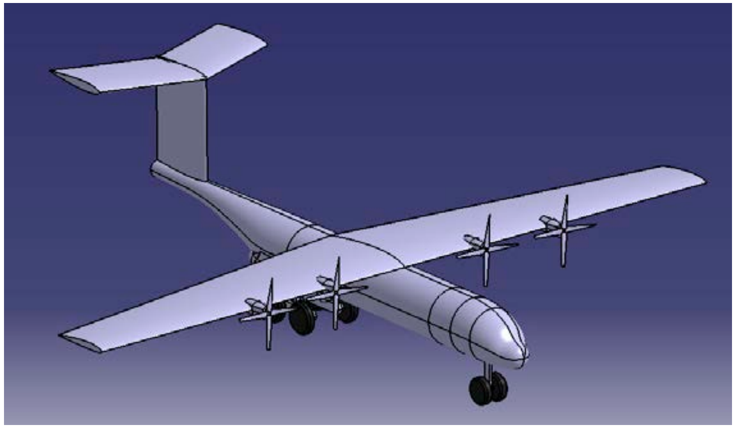


Configuración de Flaps	
Cuerda	30%
Deflexión	40°
Envergadura	46%

Configuración con Flaps			
ΔCDo	+0,0273	CDo	0.0499
ΔCl	+1,04	Clmax	2,96

Polar Del Avión Sucia

Configuración de Despegue						
C_{Do}	$C_{Do,f}$	$C_{Do.S}$	$C_{Do,LG}$	$C_{Do,Misc}$	k_1	k_2
0.0509	0.0063	0.0340	0.0041	0.0011	-0.0051	0.0449



Configuración de Aterrizaje						
C_{Do}	$C_{Do,f}$	$C_{Do.S}$	$C_{Do,LG}$	$C_{Do,Misc}$	k_1	k_2
0.0506	0.0061	0.0339	0.0041	0.0011	-0.0050	0.0446

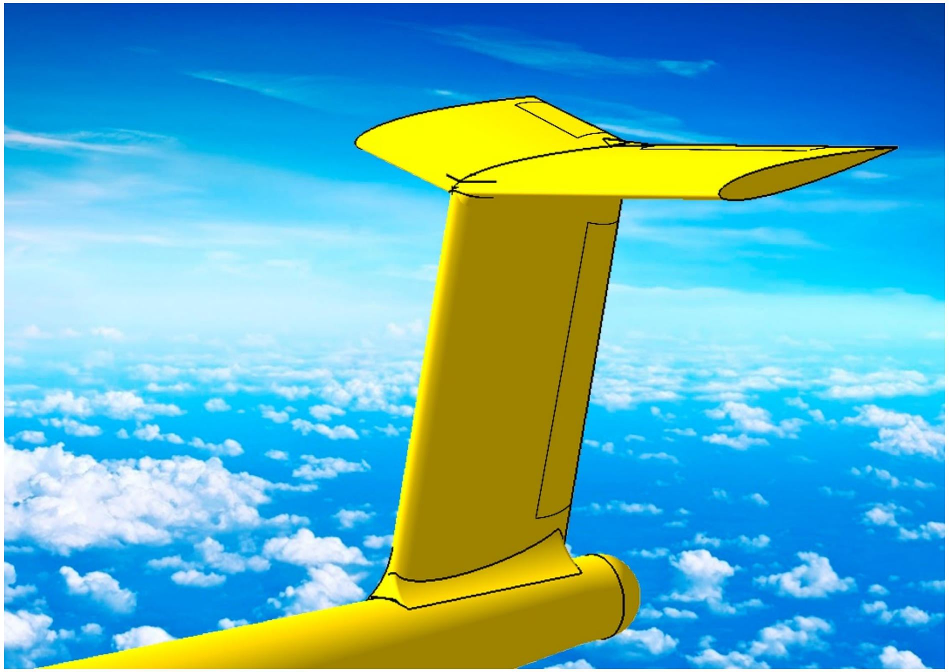
DEPARTAMENTO DE ESTABILIDAD Y CONTROL

AFF AIRCRAFTS

CHARTLE16

Objetivos

* Análisis Longitudinal
  * Dimensionado HTP e incidencias
  * Centro de gravedad
  * Margen Estático
  * Trimado Longitudinal

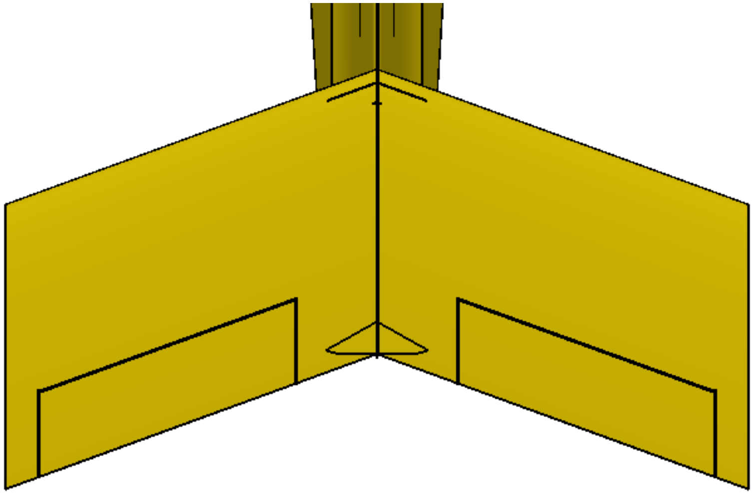


* Análisis lateral-direccional
  * Dimensionado VTP
  * Dimensionado alerones
  * Análisis de Fallo de Motor
  * Viento cruzado

* Estabilidad Dinámica
  * Longitudinal
  * Lateral-direccional

Análisis Longitudinal

HTP



S_h = 32 m^2	S_e=8.50 m^2
iw = 1.50°	Ih = -1°

Análisis longitudinal

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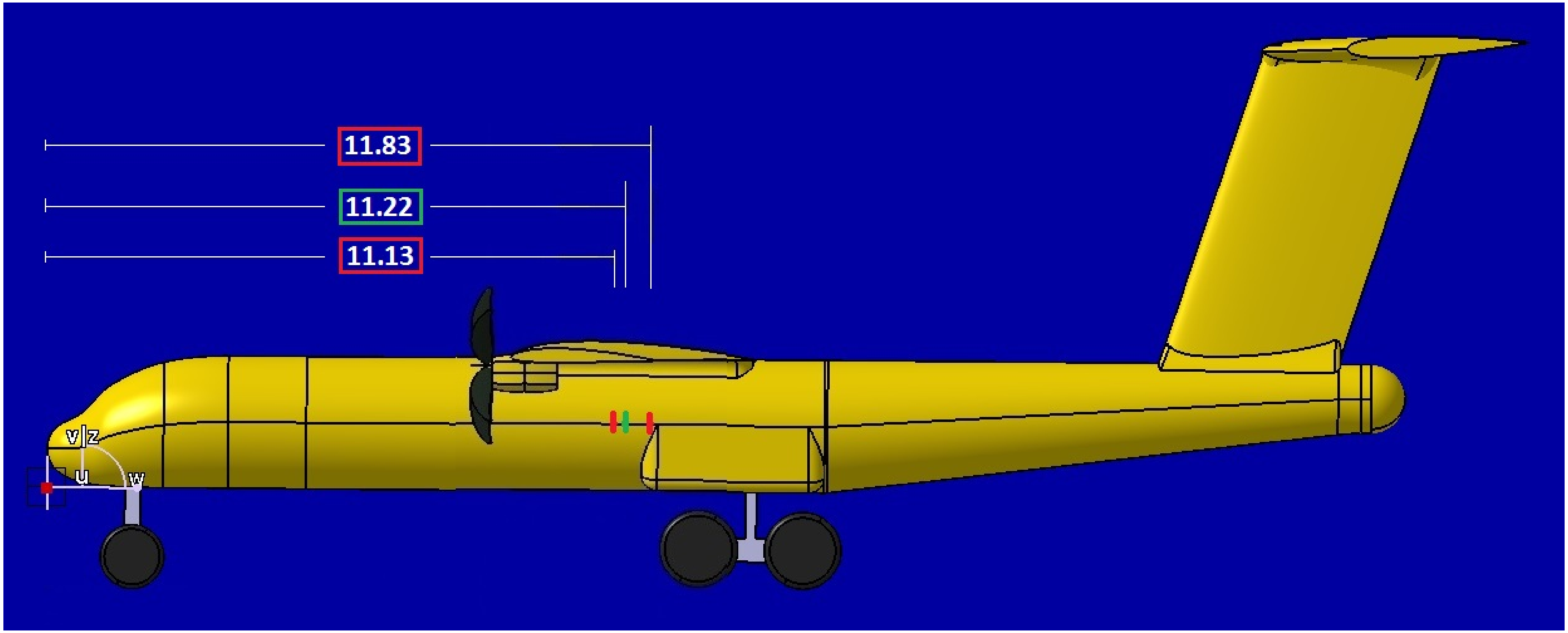
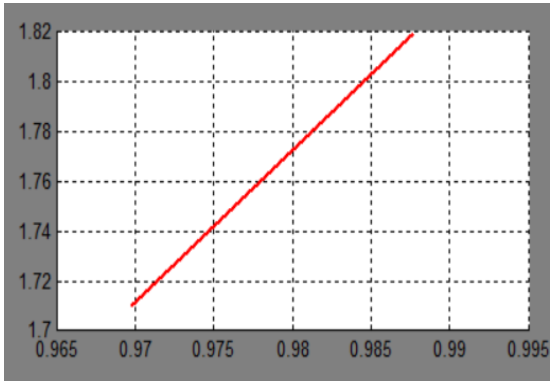


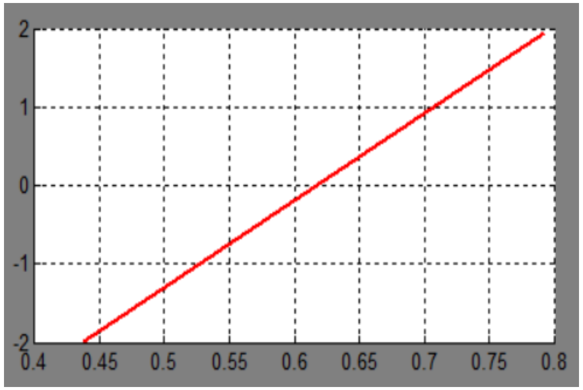
$SM_{PL\text{-}f}$: 18.6%	$SM_{PL\text{-}Nf}$: 17.9%	$SM_{NPL\text{-}f}$: 18.6%	$SM_{NPL\text{-}Nf}$: 16.5%

Análisis Longitudinal

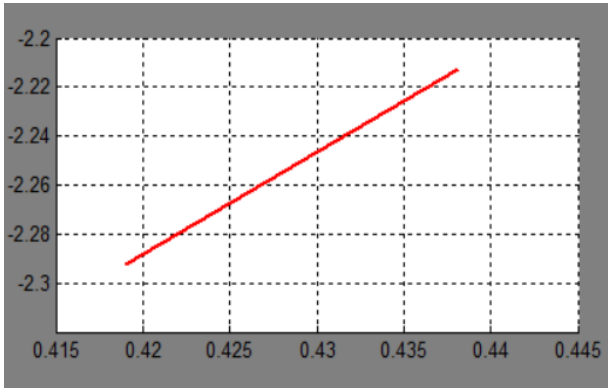
Antes de la descarga



Durante la descarga



Después de la descarga



αmax=1.82°	**αmin=-2.29°**

Análisis Longitudinal

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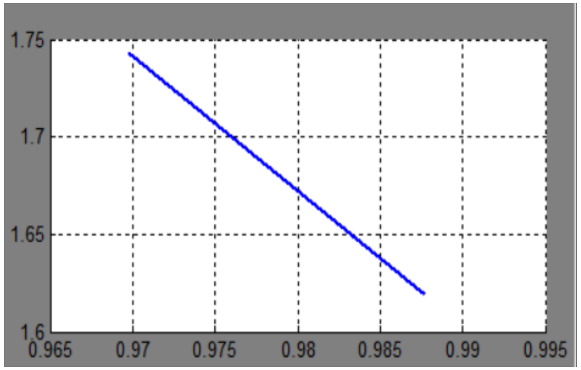
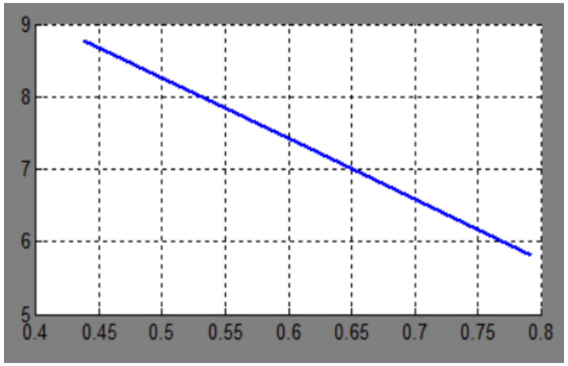
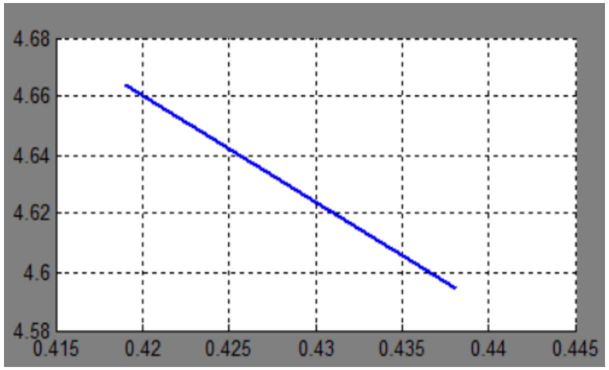
Antes de la descarga	Durante la descarga	Después de la descarga
		

$\delta_{e,min}$=1.62°	$\delta_{e,max}$=8.7°

Análisis Lateral - Direccional

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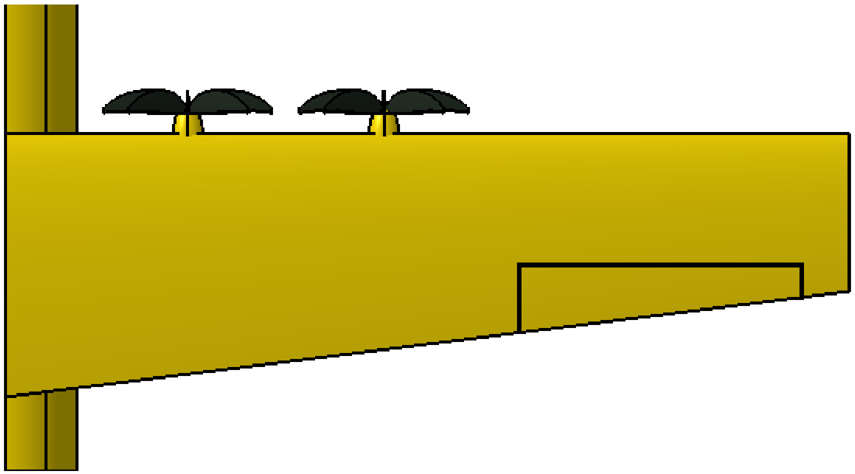
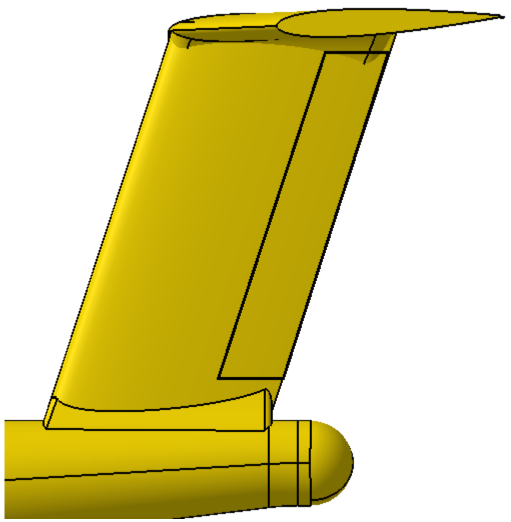
ALERONES



VTP



y_1=10.08 m	y_2=14.75 m	c_a/c=0.30
S_a=8.82 m²	S_a/S_{ala}=0.08	

y_1=0.30 m	y_2=5.40 m	c_r/c=0.40
S_r=7.14 m²	S_r/S_{VTP}=0.34	

Fallo de motor y viento cruzado

AIRCRAFTS

$C_{Y\beta} = -0.3564$	$C_{Y\delta a} = 0$	$C_{Y\delta r} = 0.2873$
$C_{l\beta} = -0.0543$	$C_{l\delta a} = 0.2321$	$C_{l\delta r} = 0.0234$
$C_{n\beta} = 0.1127$	$C_{n\delta a} = -0.0459$	$C_{n\delta r} = -0.1163$

OEI
$\phi=-2.478^\circ$
$\delta_a=-1.664^\circ$
$\delta_{er}=16.488^\circ$

$\beta=15^\circ$
$\phi=0.505^\circ$
$\delta_a=2.131^\circ$
$\delta_{er}=13.692^\circ$

Estabilidad dinámica longitudinal

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Corto periodo
$\lambda = -2.5372 \pm 3.8062i$
$\omega = 4.574$ rad/s
$\xi = 0.554$
$T = 1.651$ s

Fugoide
$\lambda = -0.033 \pm 0.0941i$
$\omega = 0.099$ rad/s
$\xi = 0.331$
$T = 66.758$ s

Estabilidad dinámica lateral-direccional

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Balanceo holandés
λ = -0.549±2.955i
ω = 3.006 rad/s
ξ = 0.183
T = 2.126 s

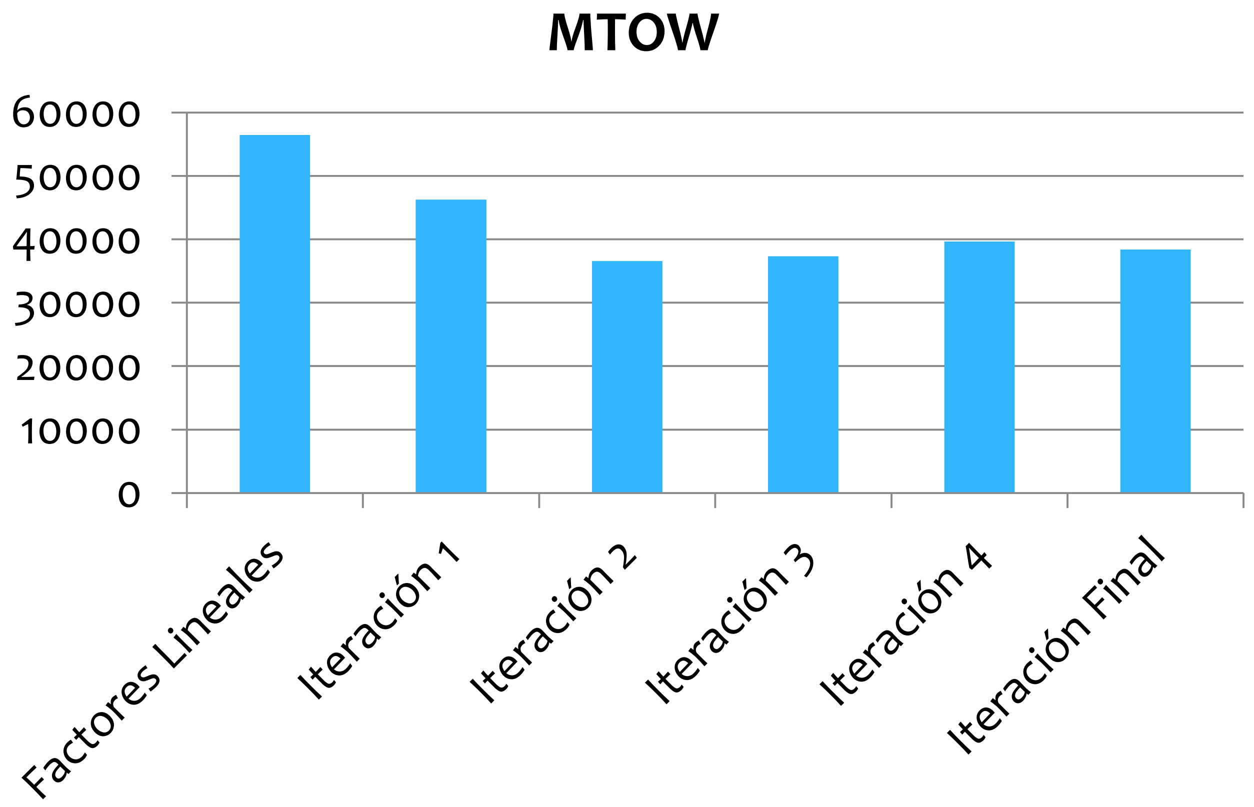
Espiral
λ = -0.00217
t_{half} = 319.022 s

Convergencia en balance
λ = -3.773
t_{half} = 0.187 s

DEPARTAMENTO DE ESTRUCTURAS

Histórico de Resultados

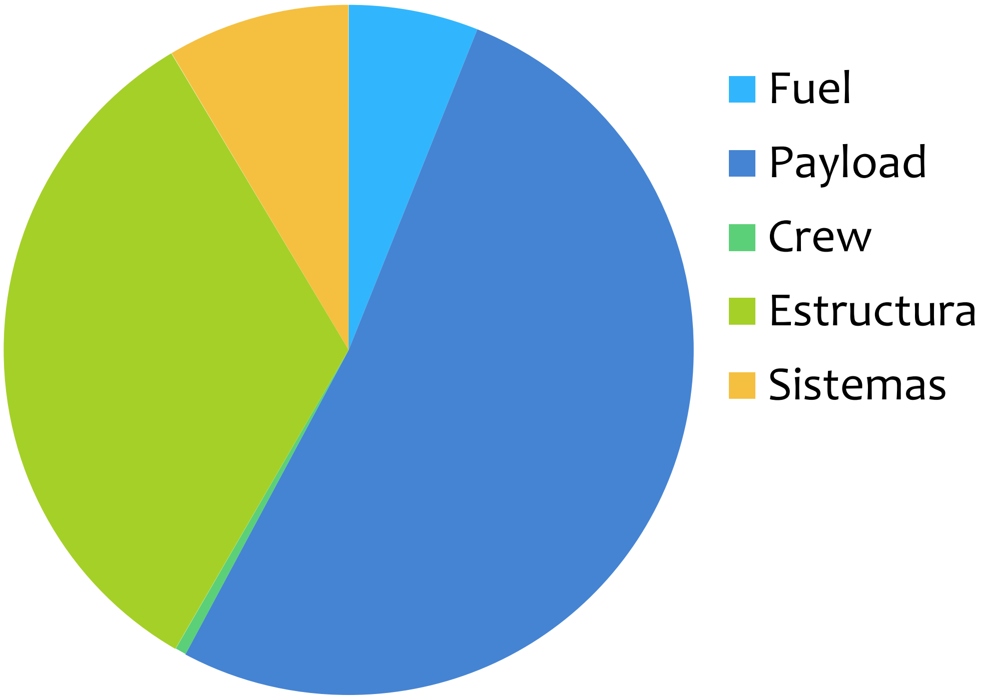
	MTOW (kg)
Factores Lineales	56424
Iteración 1	46243
Iteración 2	36575.4
Iteración 3	37340.2
Iteración 4	39644.4
Iteración Final	***38404.16***



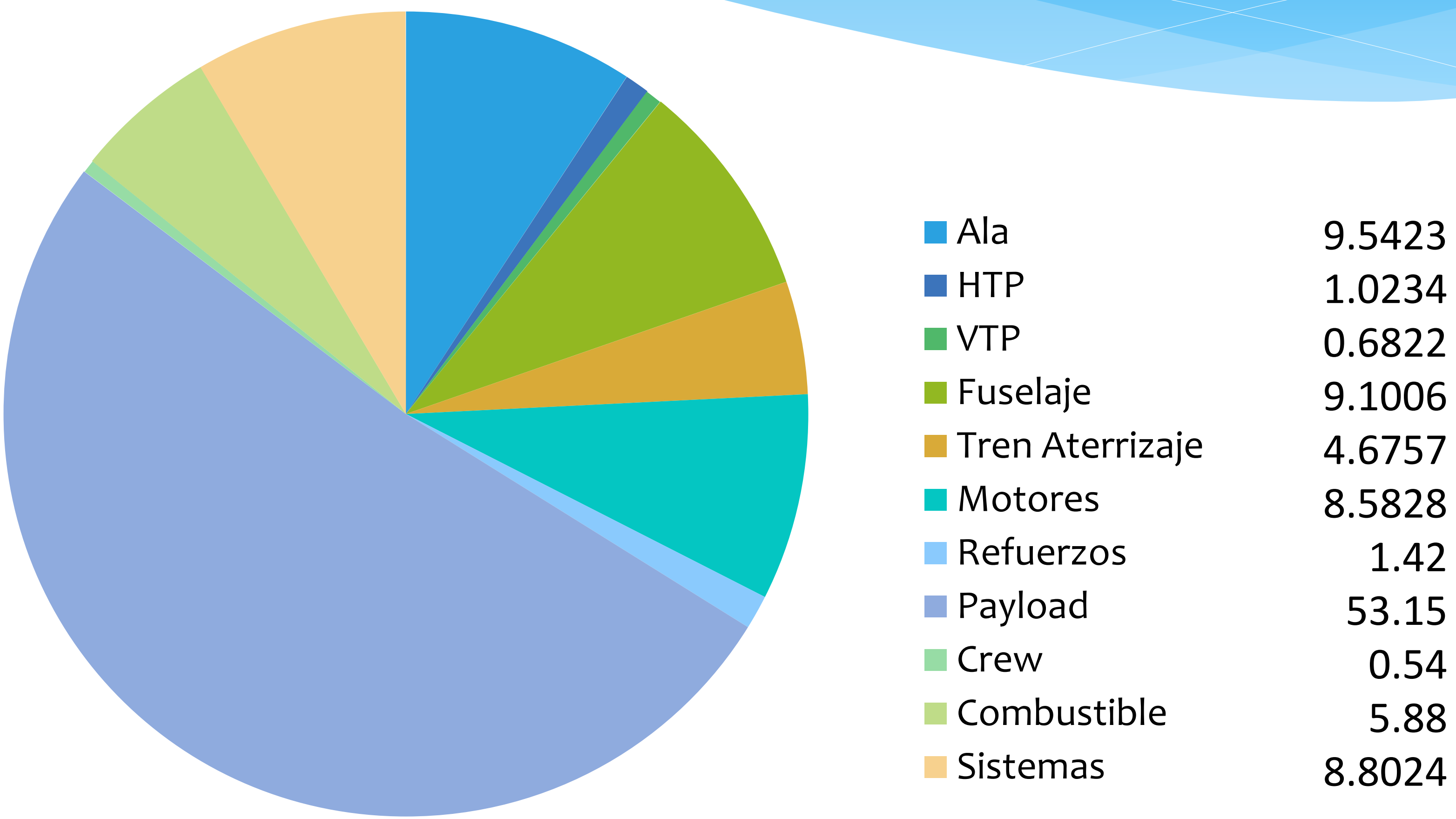
Resultados

- **Carga Alar:** W/S= 346.4 kg/m2

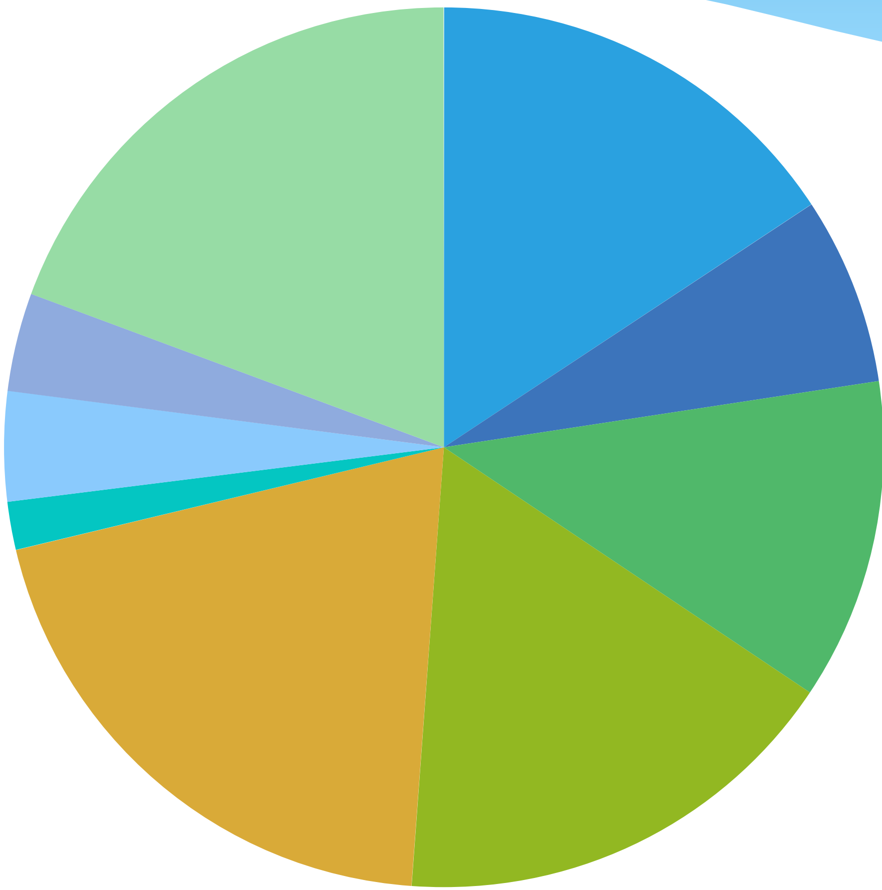
	Peso (kg)
MTOW	*38404.158*
Fuel + Reserva	*2393.14*
Payload	*20412*
Crew	*205.93*
Estructura*	*13041.3*
Sistemas	*3380.5*



%MTOW


Ala 9.5423
HTP 1.0234
VTP 0.6822
Fuselaje 9.1006
Tren Aterrizaje 4.6757
Motores 8.5828
Refuerzos 1.42
Payload 53.15
Crew 0.54
Combustible 5.88
Sistemas 8.8024

% W Sistemas



Fly Control System	15.7007
Sistema Hidráulico	6.8829
Instrumentación	11.8048
Electricidad	16.7812
API	20.0761
Oxígeno	1.7878
APU	4.0150
Op. Item	3.6059
Depósito	19.3463

Comparación: Lockheed C-130 Hércules

AFF AIRCRAFTS

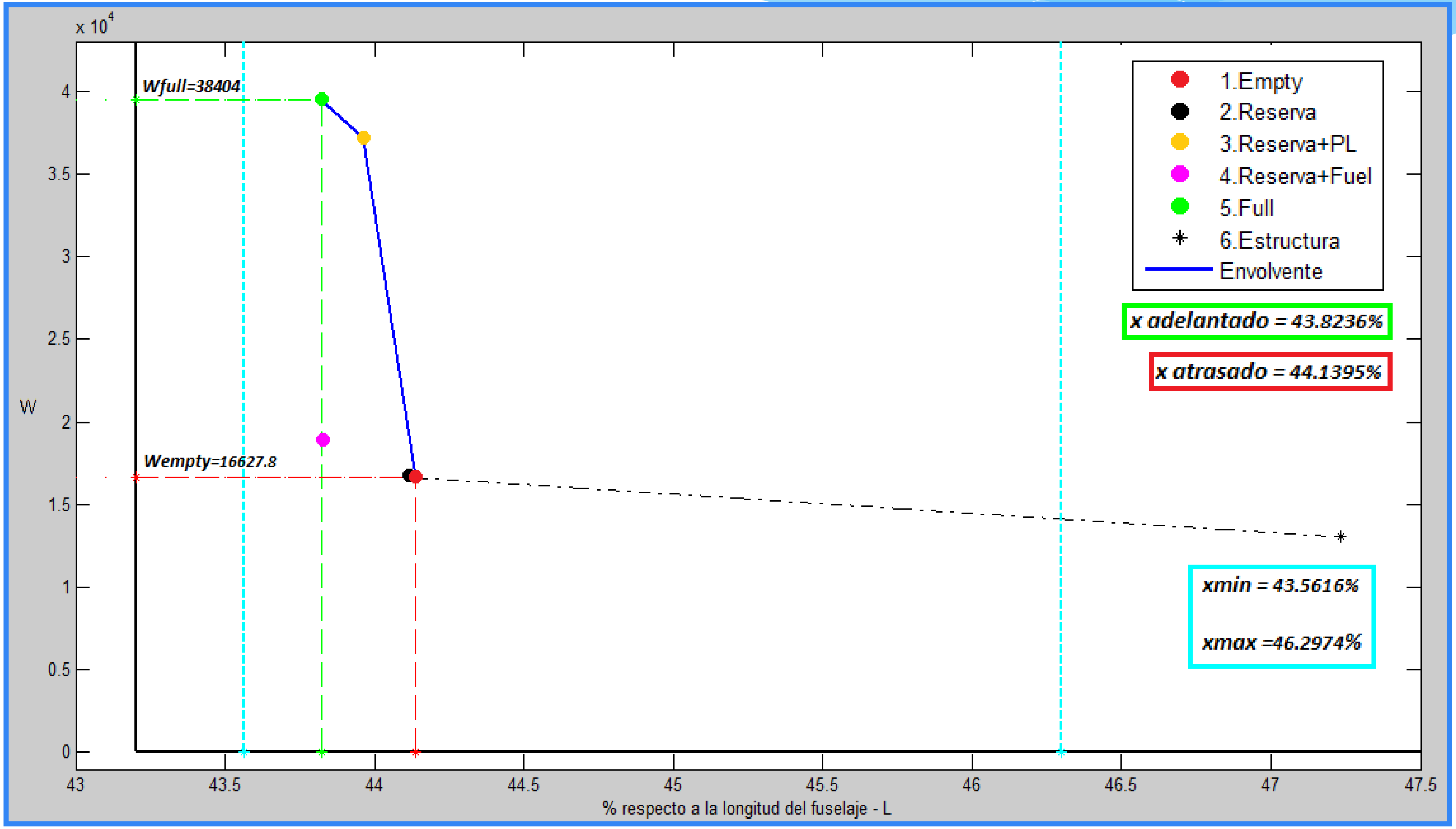
Chartle 16

	%MTOW
Ala	9.54
HTP	1.02
VTP	0.68
Fuselaje	9.10
Tren Aterrizaje	4.68
Motores	8.58
Estructura	33.96
Sistemas	8.80

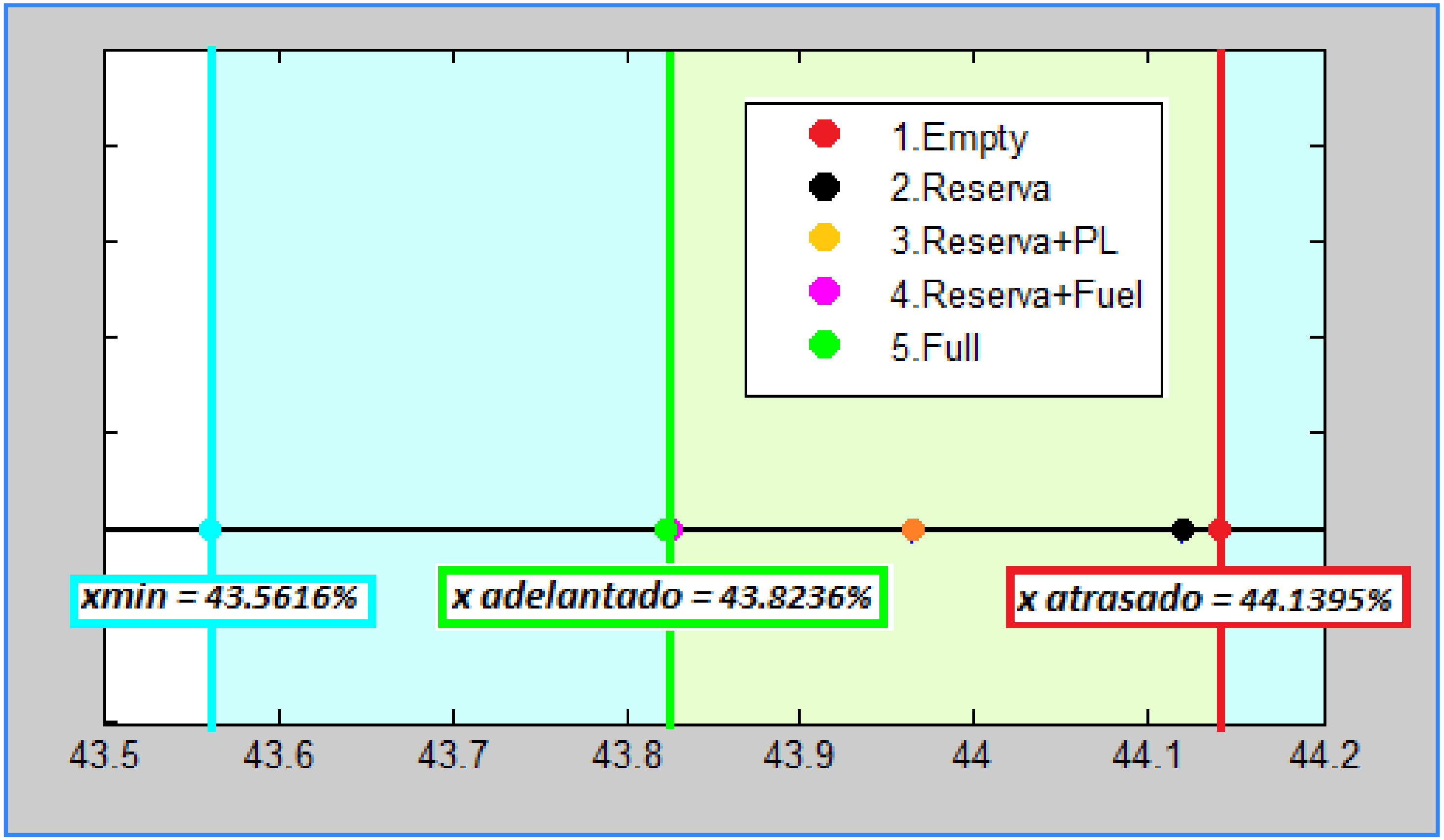
Lockheed C-130

%MTOW
9
2.2
9,5
3,4
10,9
25,9
10

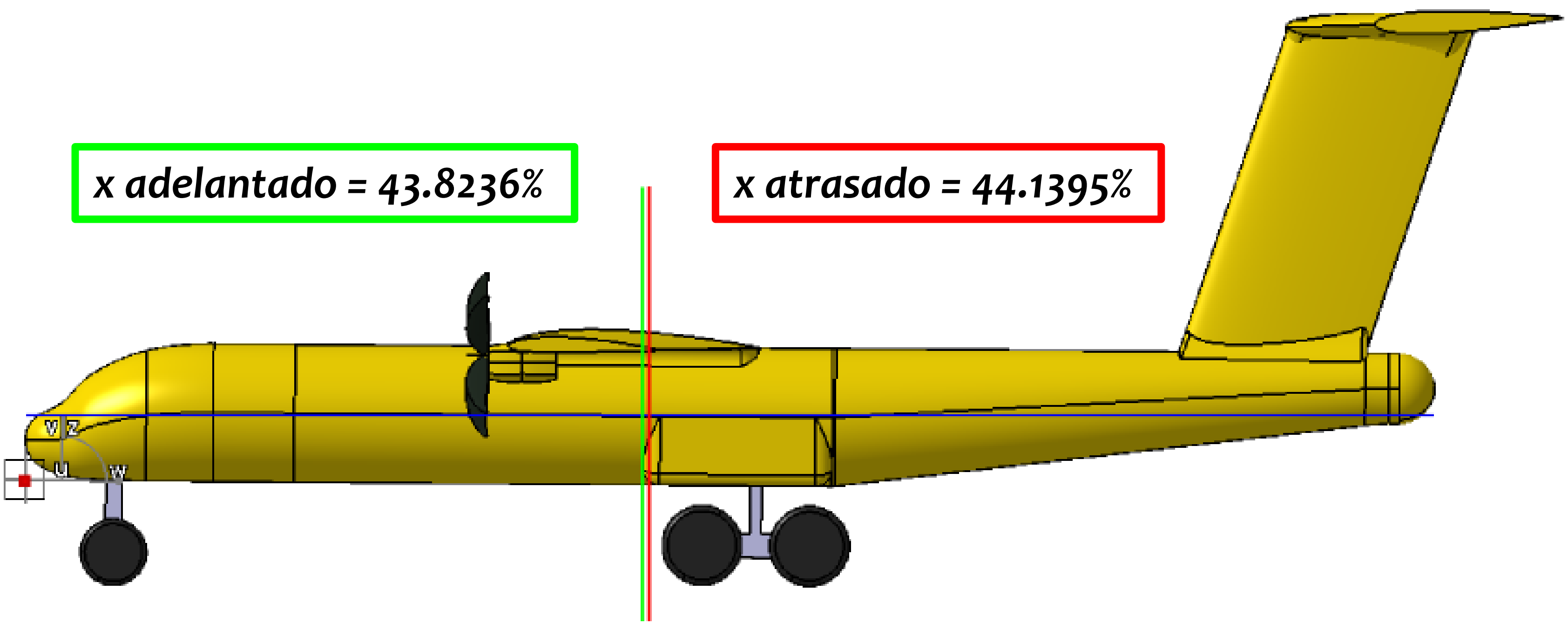
Envolvente del Centro de Gravedad



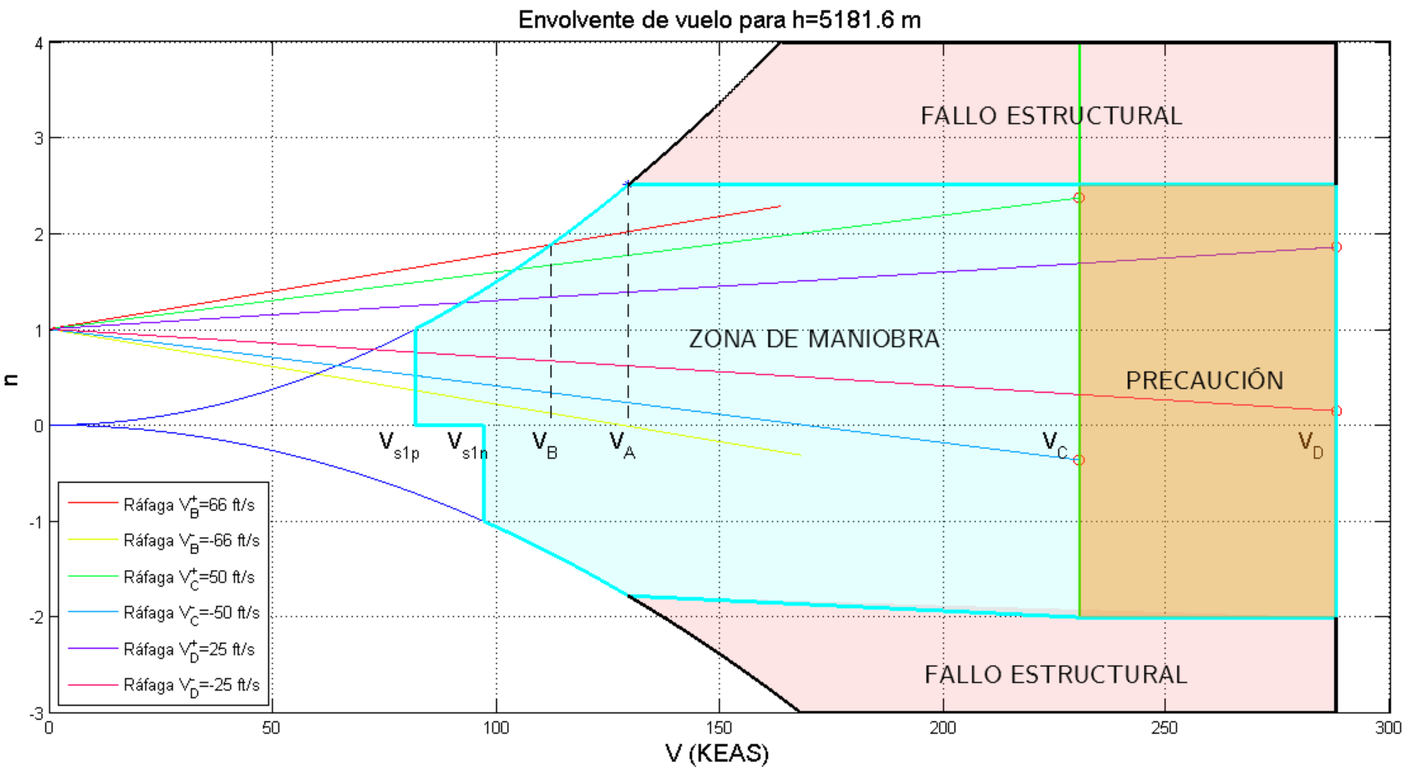
Envolvente del Centro de Gravedad



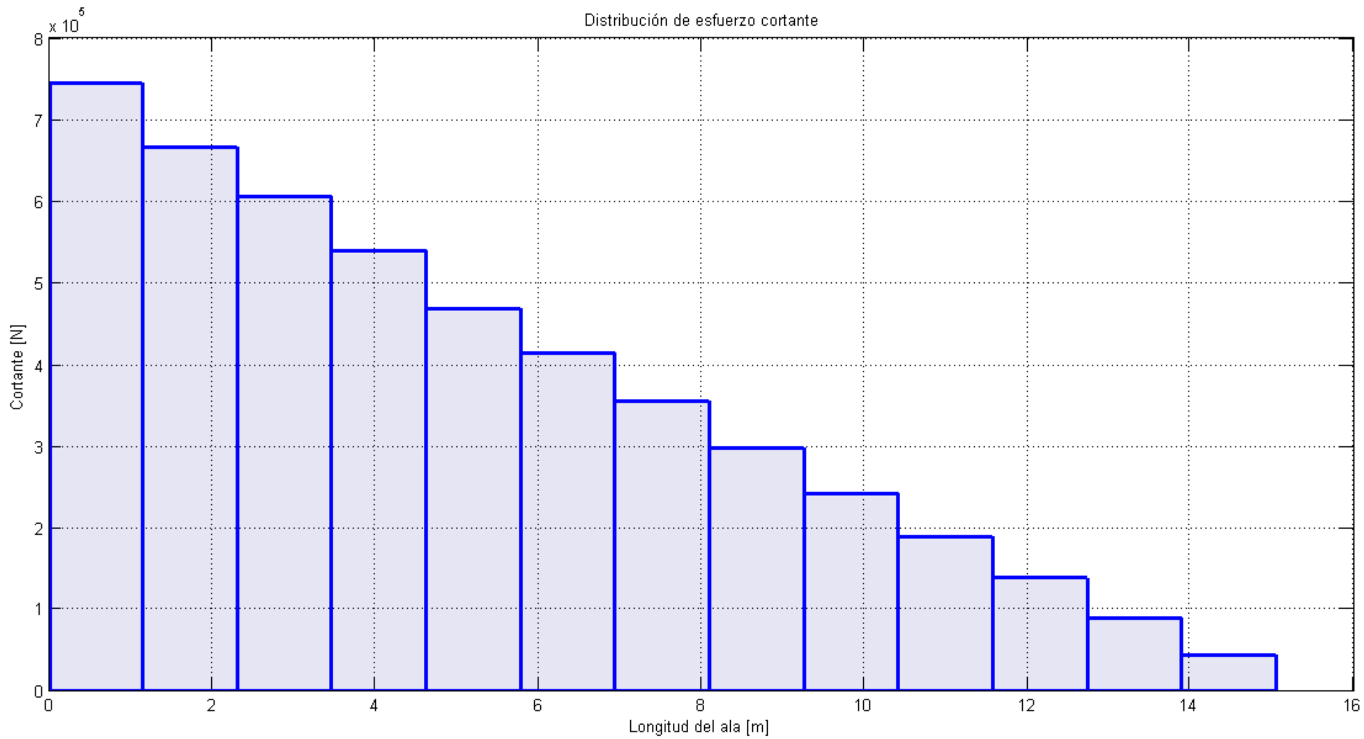
Envolvente del Centro de Gravedad



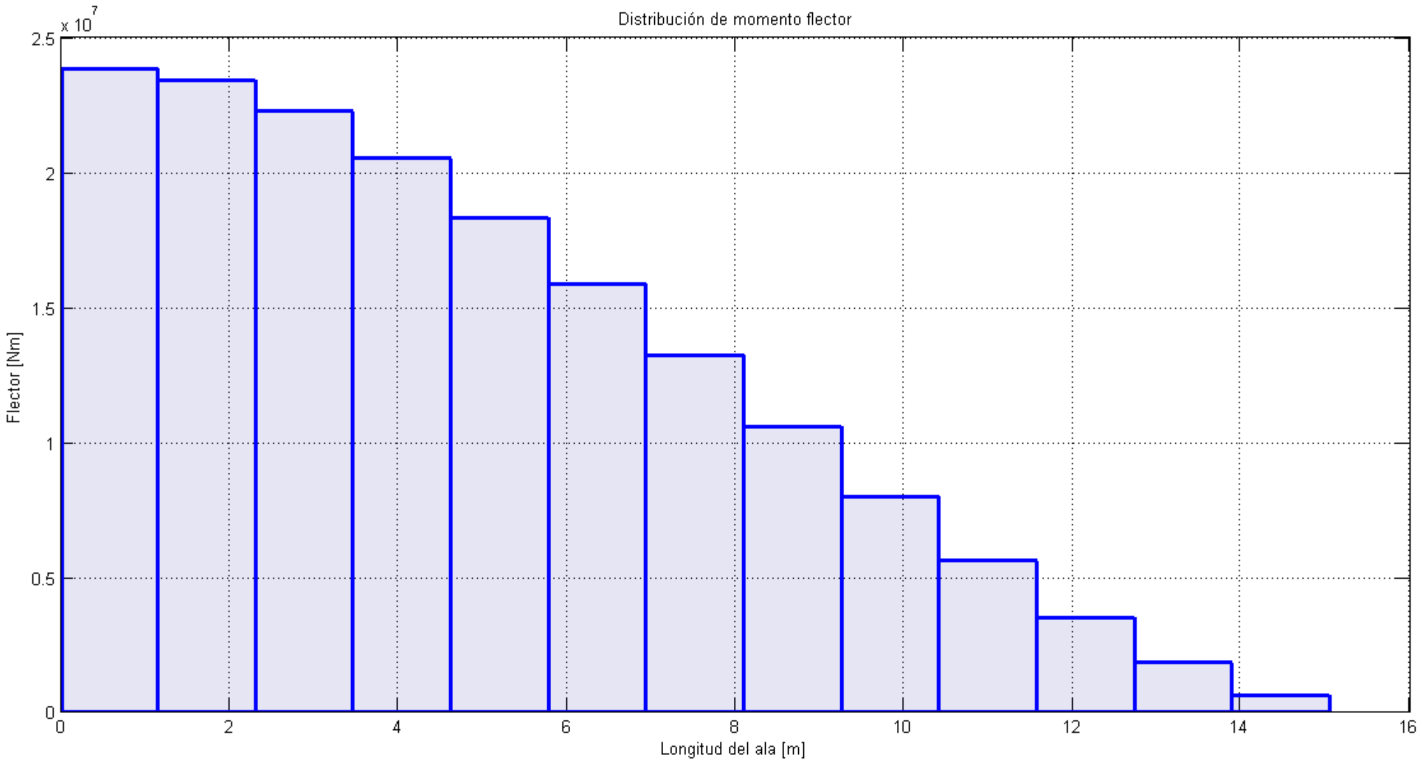
Envolvente de Vuelo



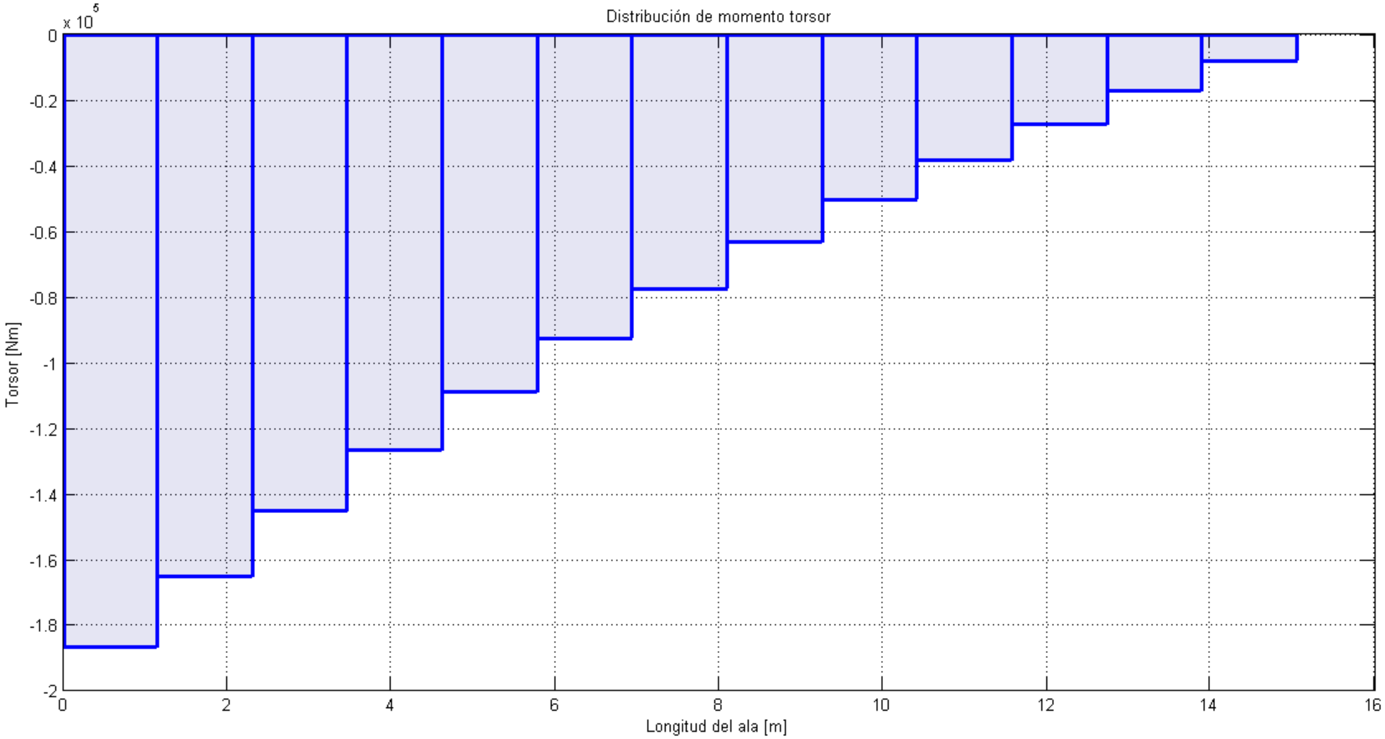
Esfuerzos del Ala: Cortante



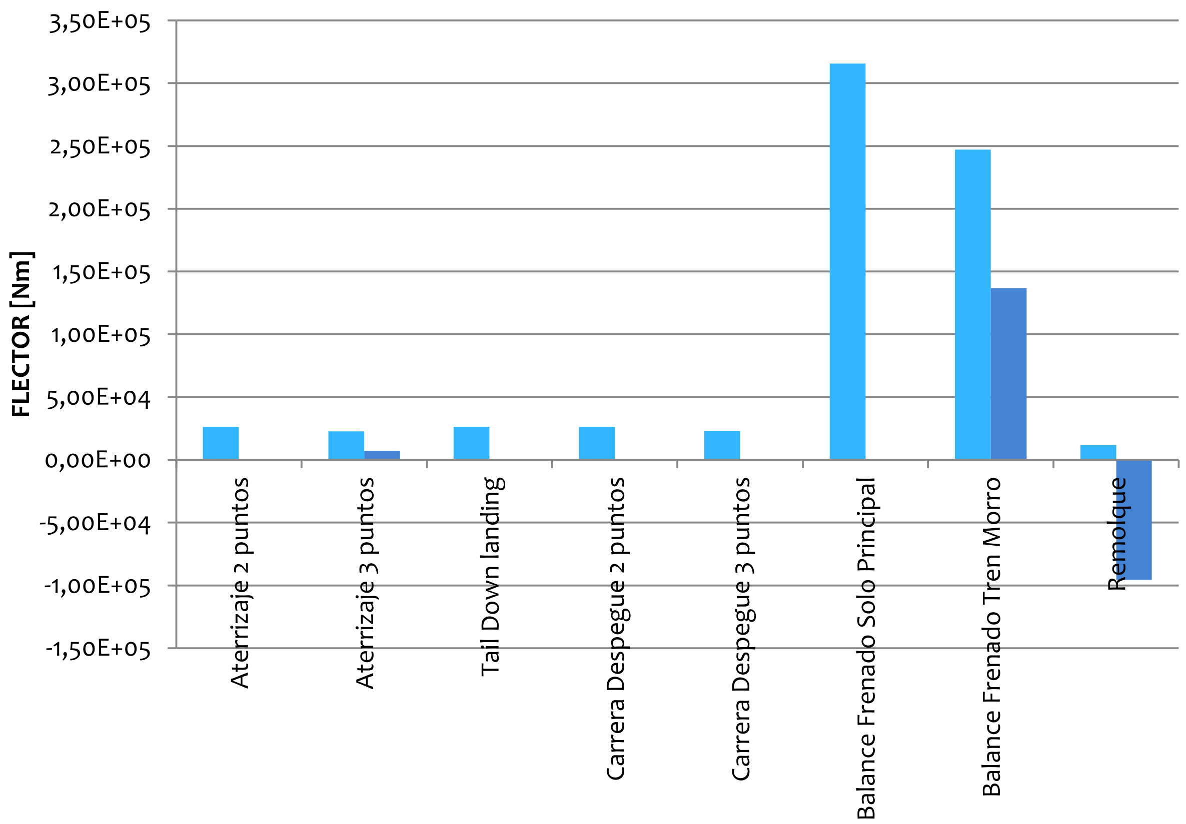
Esfuerzos del Ala: Momento Flector



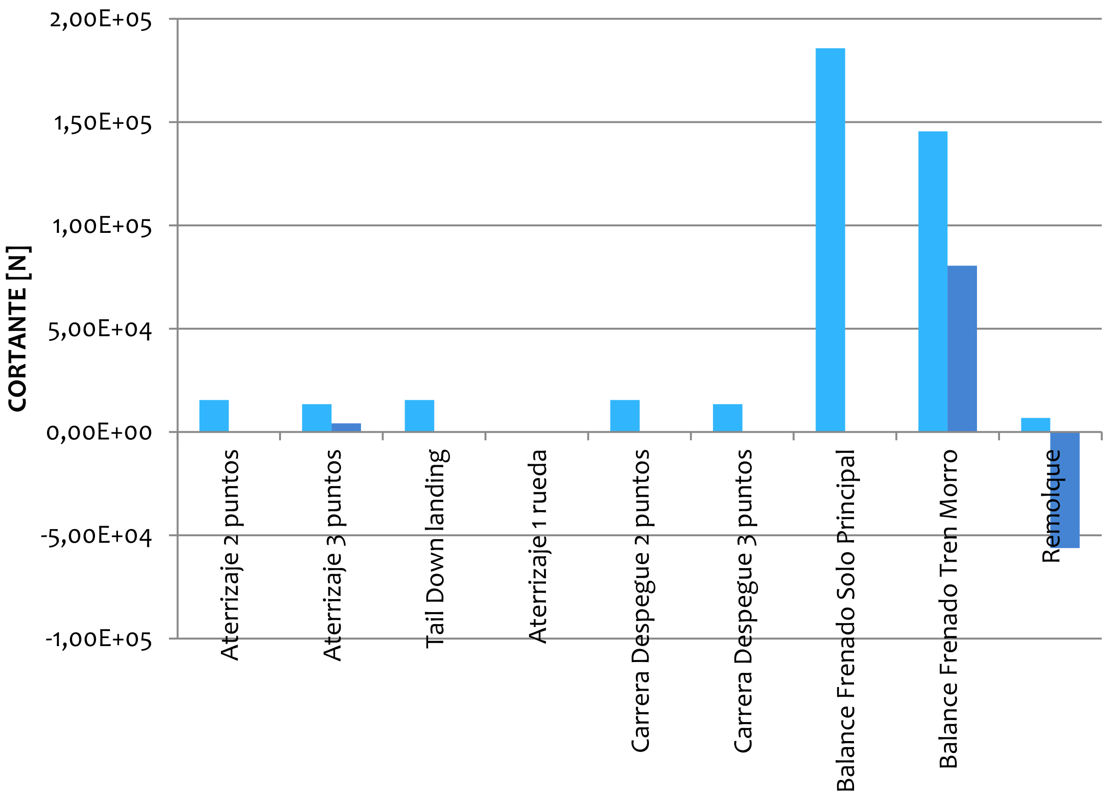
Esfuerzos del Ala: Momento Torsor



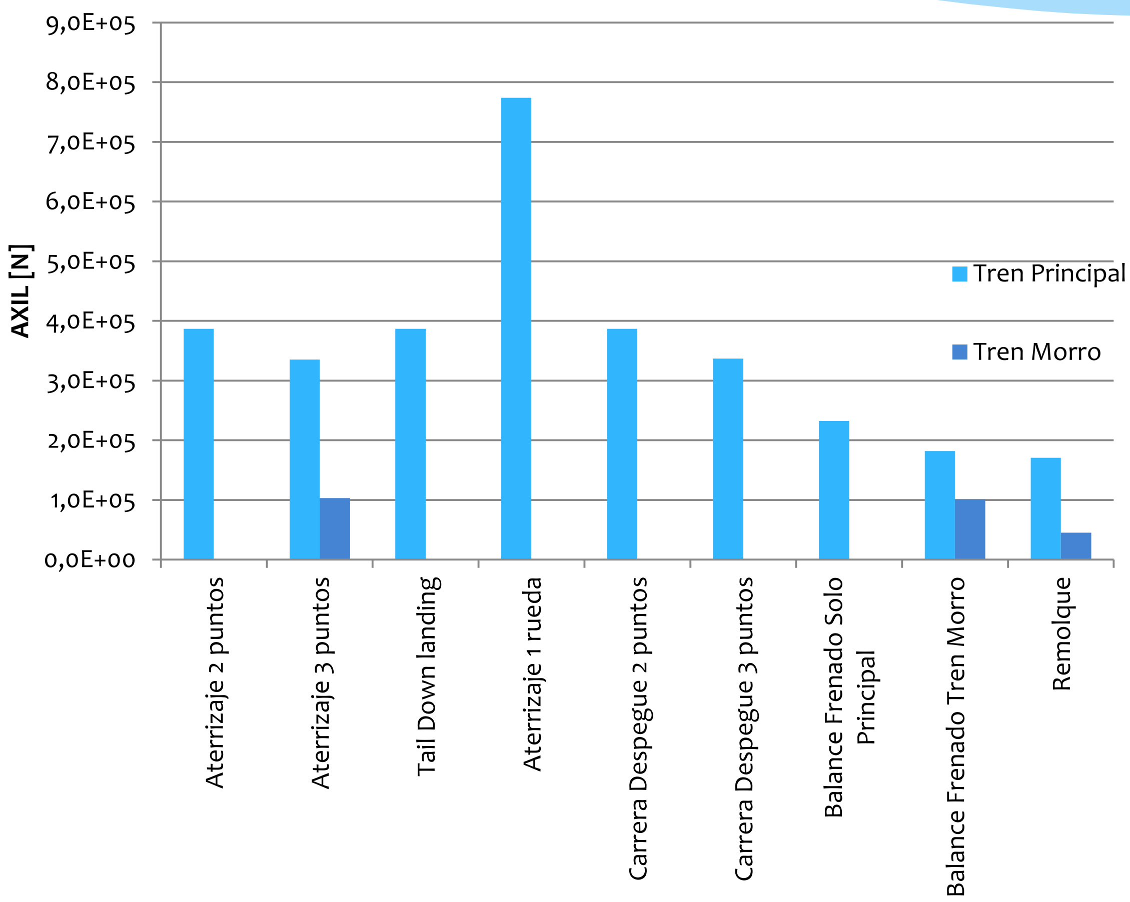
Esfuerzos en el Tren de Aterrizaje



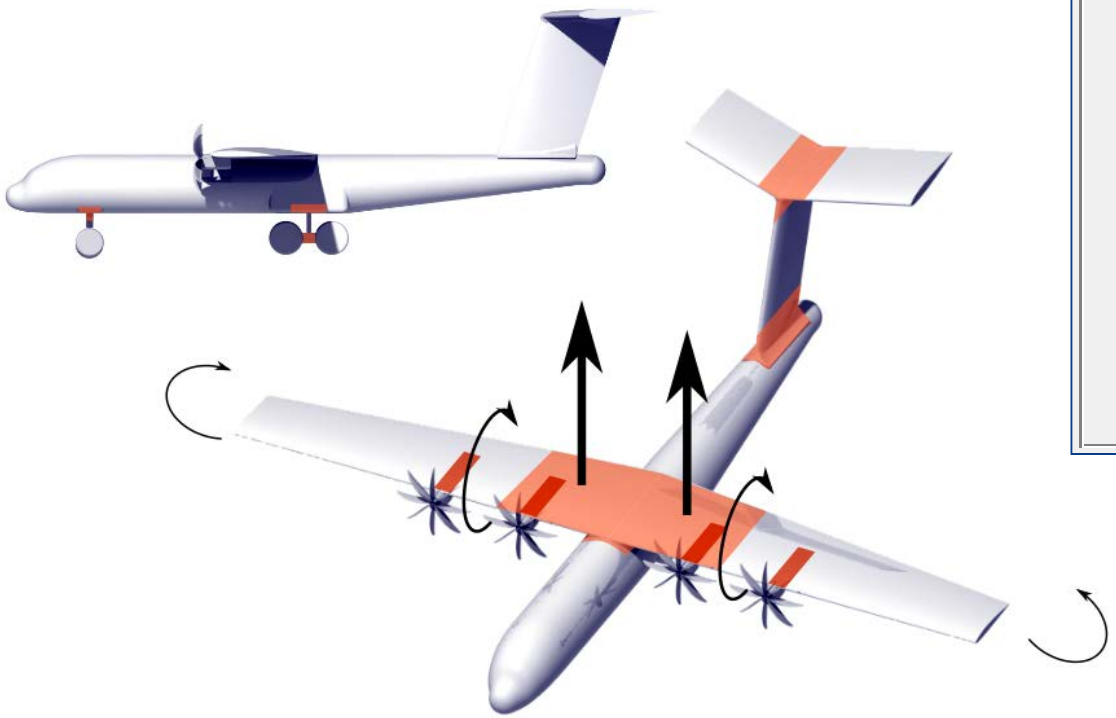
Esfuerzos en el Tren de Aterrizaje



Esfuerzos en el Tren de Aterrizaje



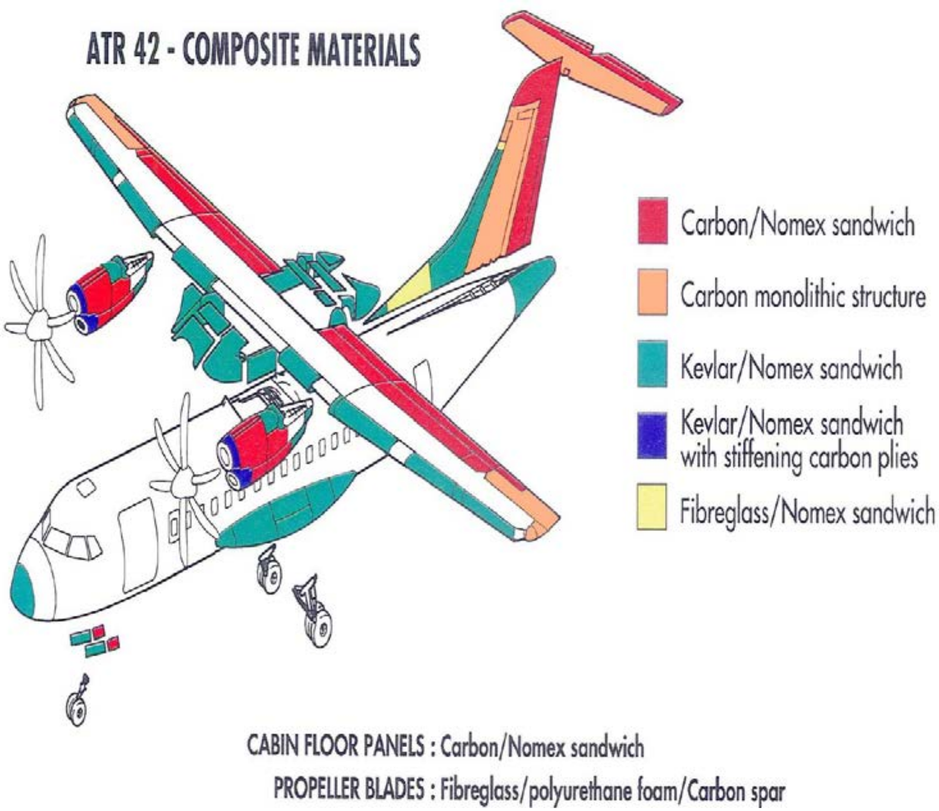
Refuerzos



incremento por refuerzos

	factor de incremento	% reforzado	
Ala	1.2	25	%
Htp	1.2	15	%
Vtp	1.2	15	%
Fuselaje	1.2	20	%
Tren de aterrizaje	1.2	25	%
Motores	1.2	20	%

Elección de Materiales



Reducción por material

	% de reducción	
Ala	10	%
Htp	18	%
Vtp	18	%
Fuselaje	10	%
Tren de aterrizaje	2	%
Motores	5	%

DEPARTAMENTO DE PROPULSIÓN Y ACTUACIONES

AFF AIRCRAFTS

CHARTLE16

Planta propulsora

AFF AIRCRAFTS

Rolls Royce Turbomeca RTM 322-01/09 (2430 shp)

- Motor de helicóptero adaptado para uso como Turboprop
- Escalado del 90,53 %
- Características:
  W_e = 230 kg (12,5 % de PGB)
  Longitud = 1,14 m
  Diámetro = 0,64 m
  C_{bhp} = 0,42 lb / (shp h)
  P/W = 4,87 shp / lb

Hélice

- Material : Composite
- Peso = 65 kg
- Número de palas = 8
- Diámetro = 3 m

Planta de potencia

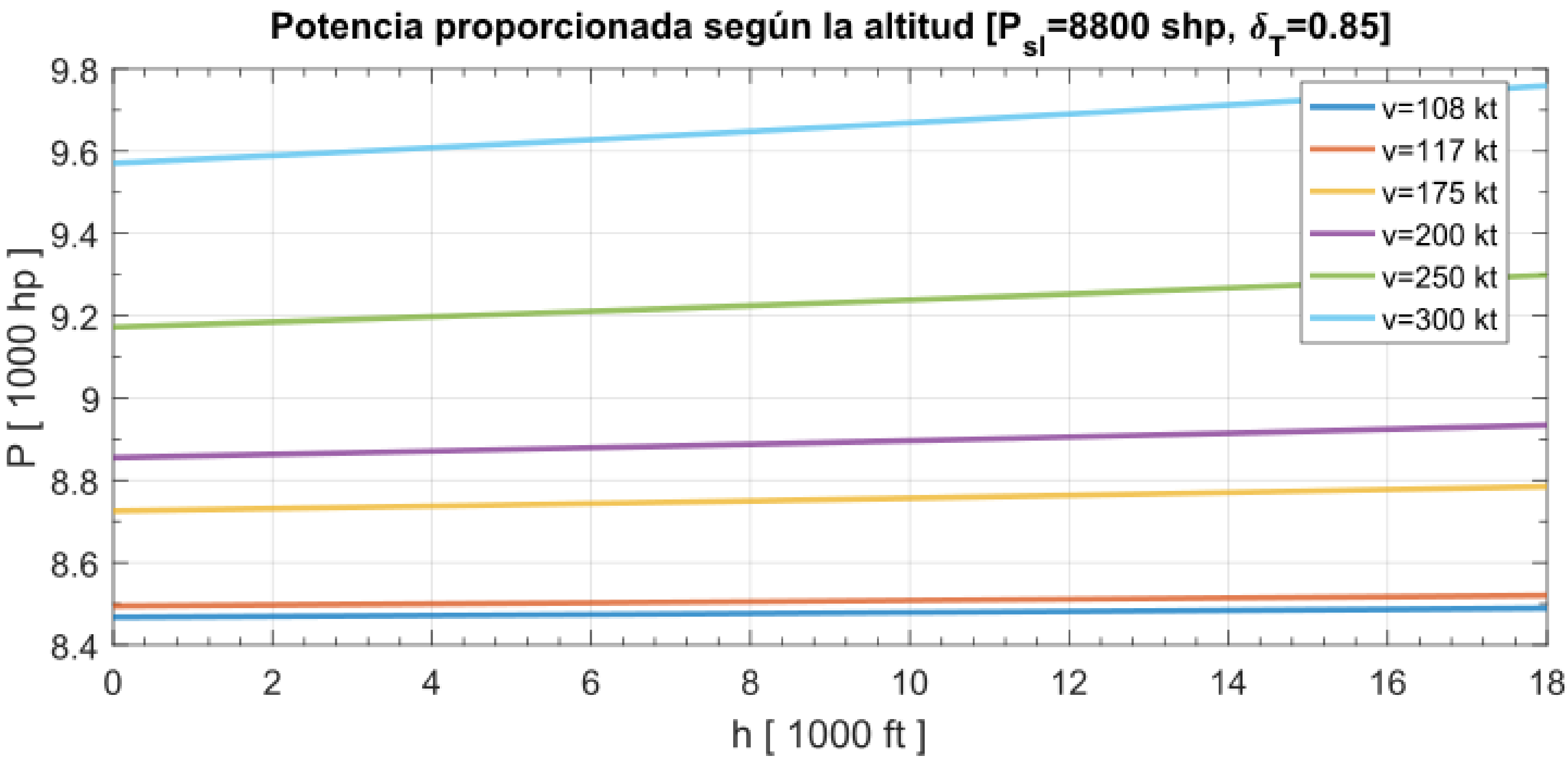
- 4 motores
- P = 8800 shp
- $W_{e,T}$ = 295 kg

✓ **Compacto**

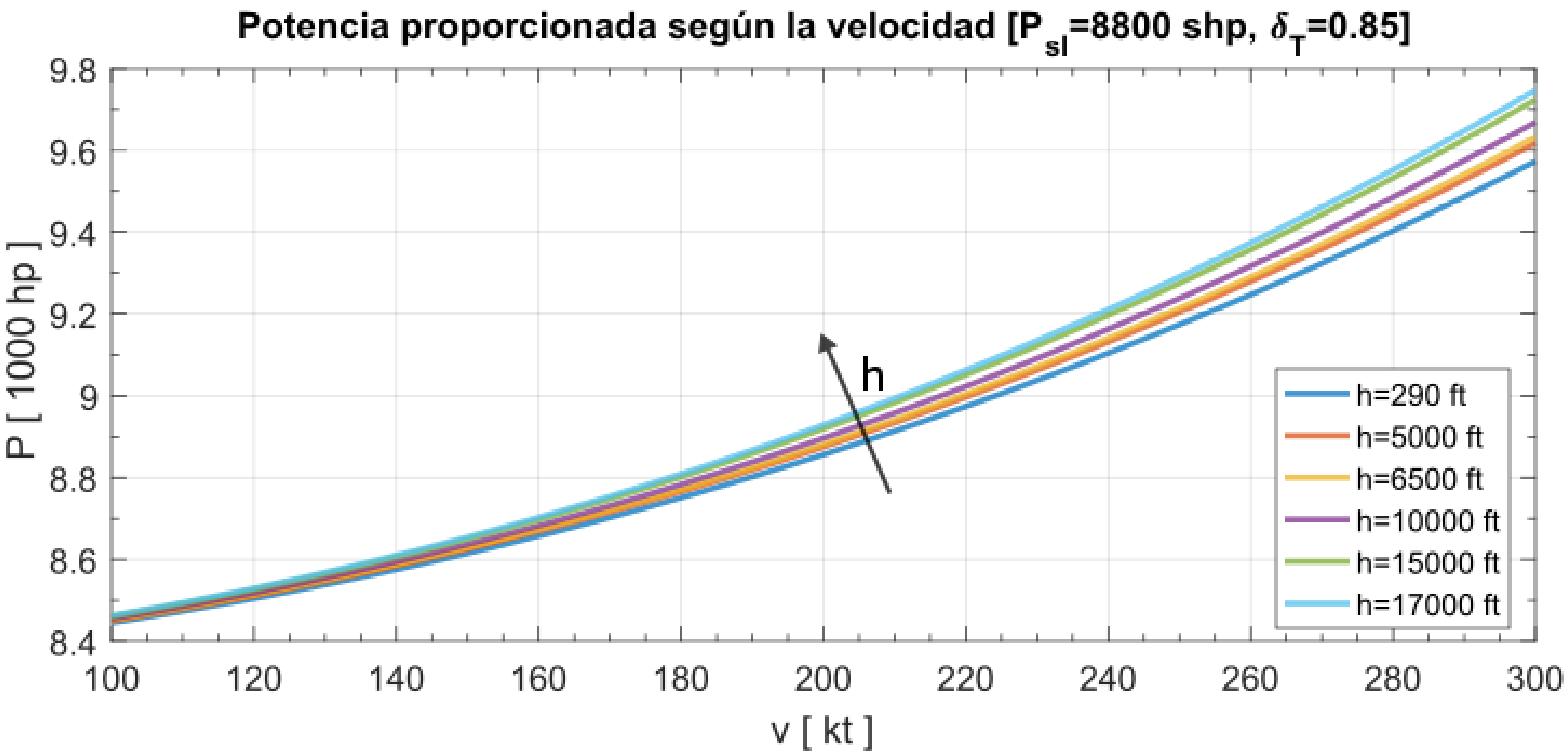
✓ **Ligero**

✓ **Eficiente**

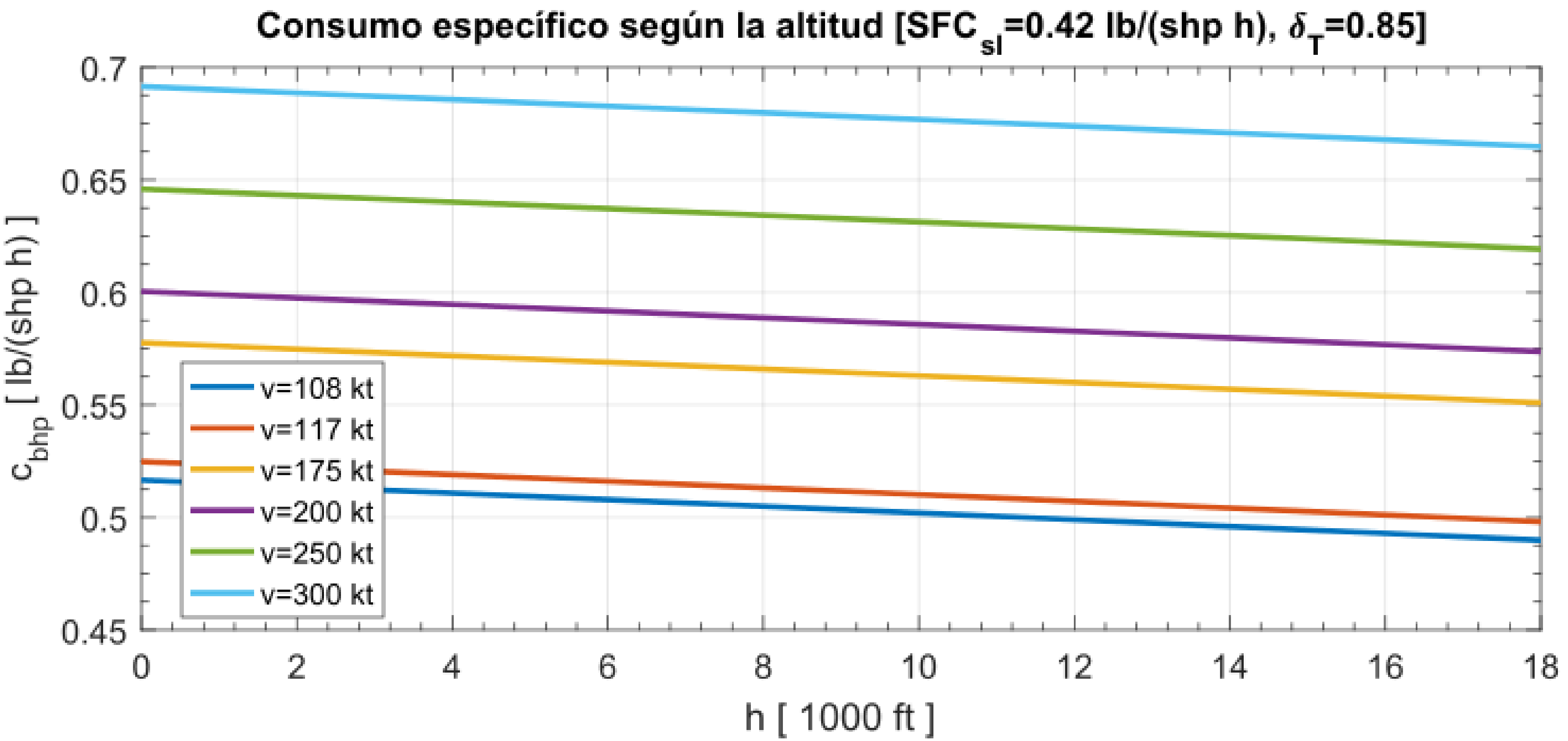
Potencia vs altitud



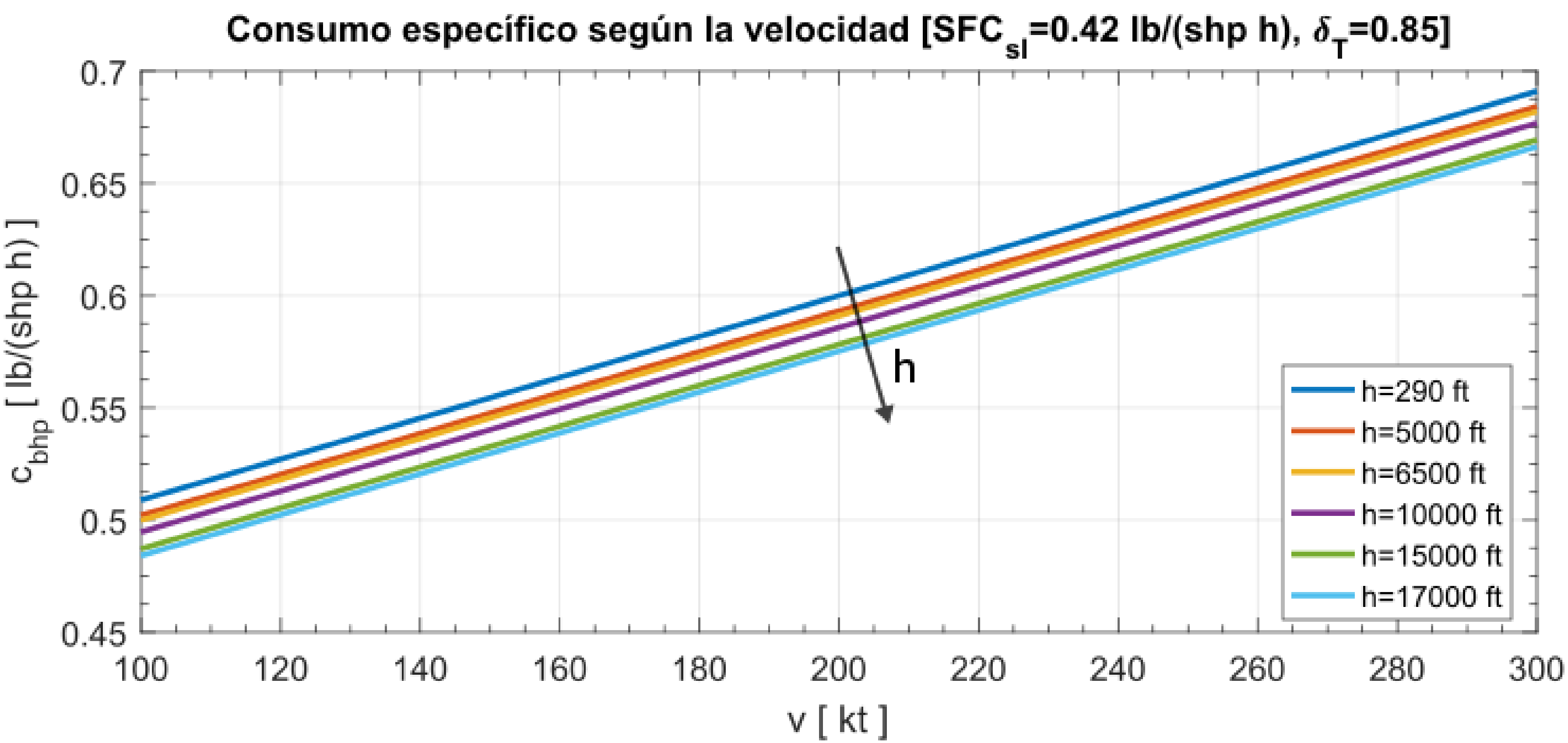
Potencia vs velocidad



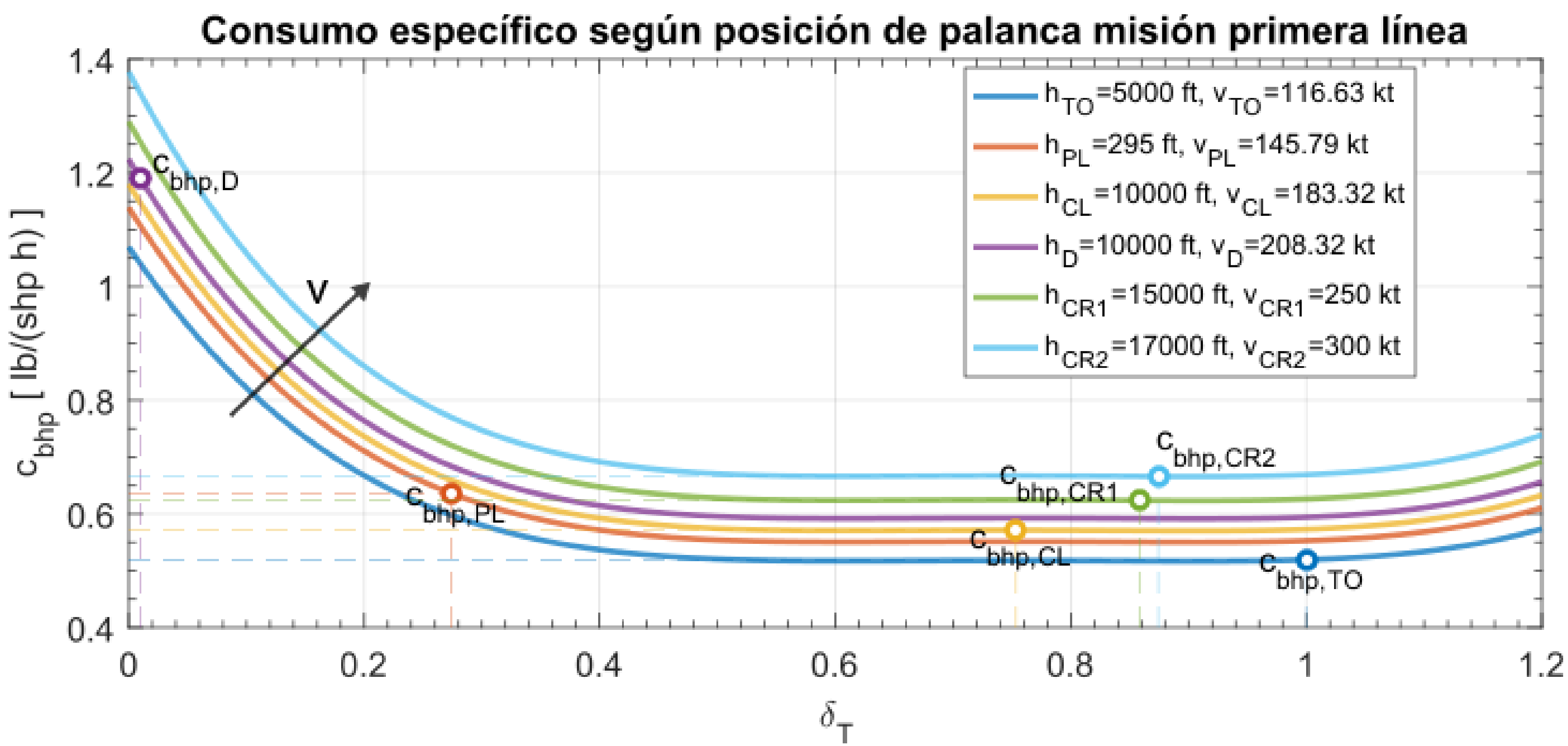
C_{bhp} vs altitud



C_{bhp} vs velocidad

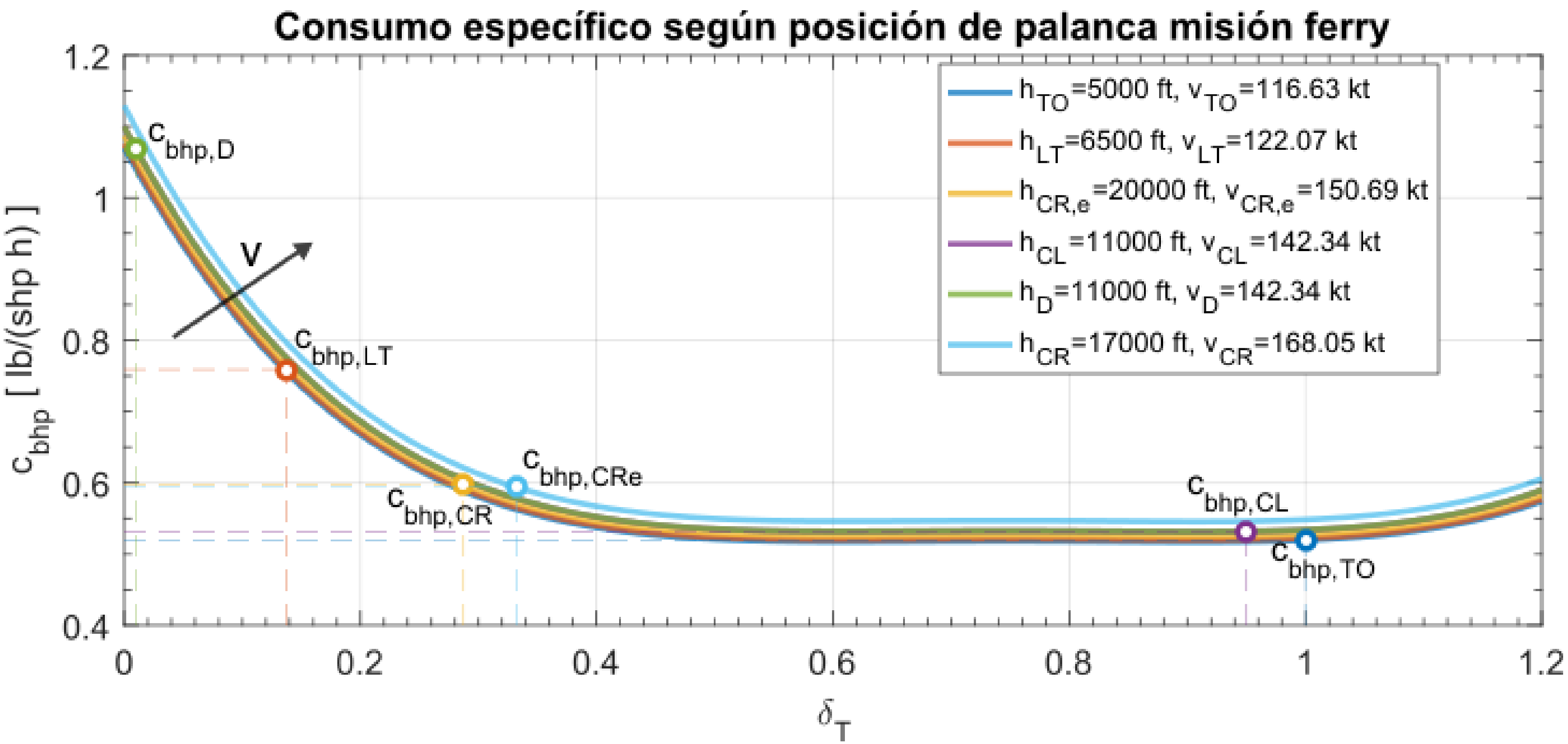


C_{bhp} vs δ_T primera línea



C_{bhp} vs δ_T ferry

AFF AIRCRAFTS

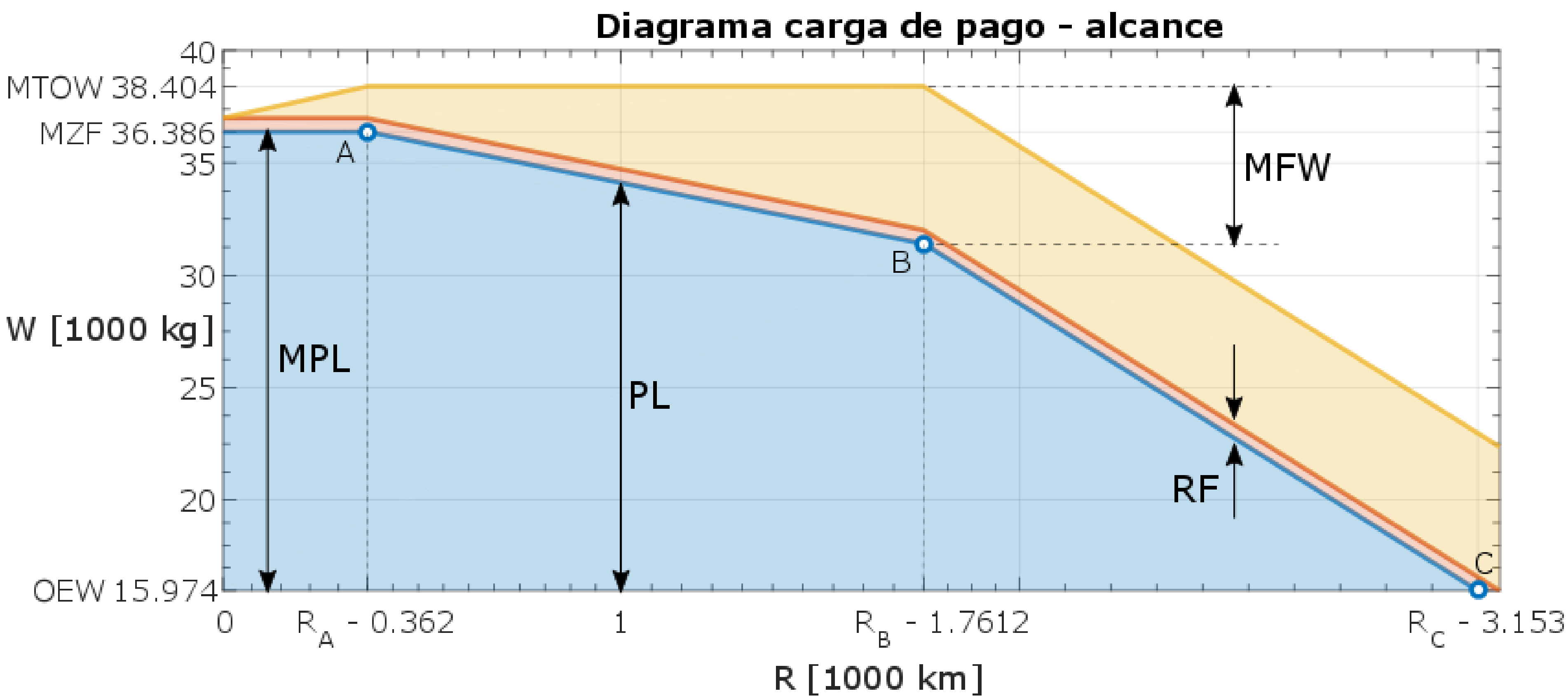


Radio de operación

McCall Municipal Airport , Idaho

Altitud: 5024 ft   Pista máxima: 6108 ft

Diagrama carga de pago - alcance



Primera línea Alternativas

AFF AIRCRAFTS

Subida

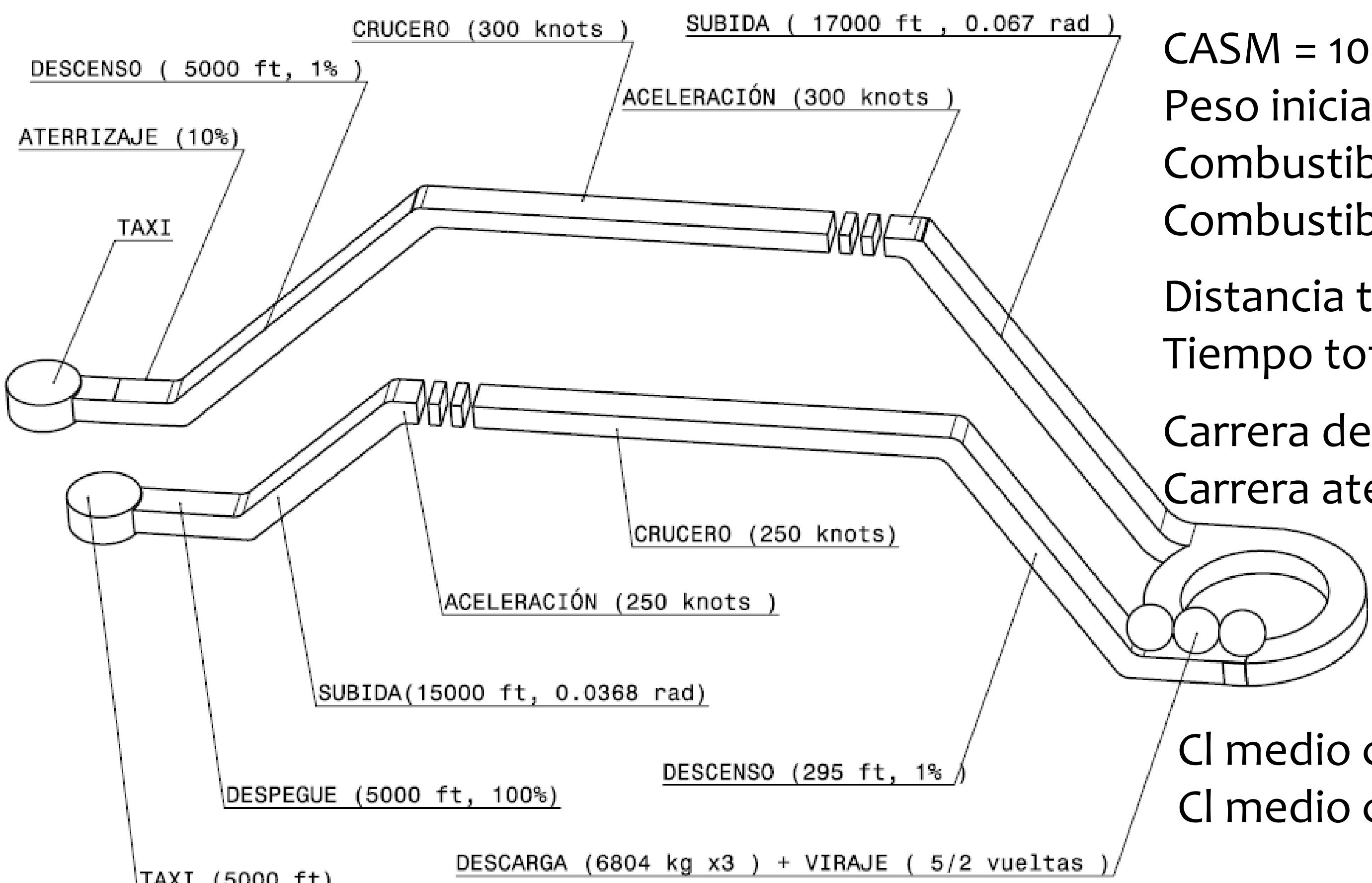
Tramos / palanca	∇	Comb.
10000 ft + 15000 ft 80 % / 95 %	< 3,2%	715 kg
10000 ft + 15000 ft Crucero	< 3,2%	557 kg
5035 ft + 15000 ft Crucero	0,0368 rad	395 kg 88,5 kg
295 ft + 17000 ft crucero vuelta	0,0638 rad	173,2 kg 45,1 kg

Crucero

Altura/velocidad	δ	CASM / t	Comb.
15000 ft 250 kt Vuelta	85 % 56,2 %	8,78 1788 s	662 kg 438 kg
15000 ft 300 kt Vuelta	110 % 85,6 %	8,45 1490 s	827 kg 625 kg
17000 ft 250 kt Vuelta	91,2 % 58,1 %	8,9 1788 s	652 kg 416 kg
17000 ft 300 kt vuelta	115 % 87 %	8,45 1490 s	826 kg 589kg

Distancia = 124,1 nmi

Primera línea



CASM = 10, 1499 cént. $
Peso inicial = 38404, 1584 kg
Combustible consumido= 1900,29 kg
Combustible reserva = 6 %

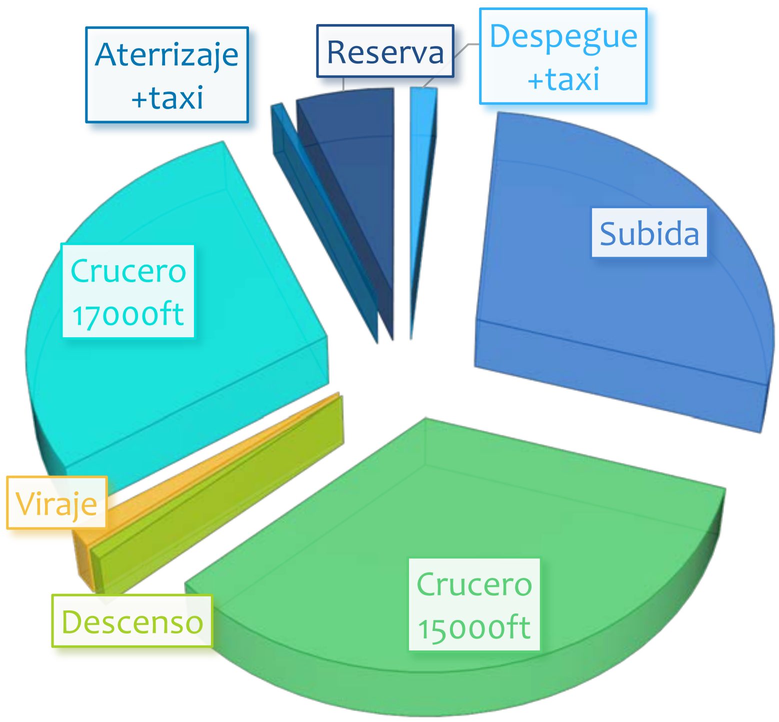
Distancia total = 741,715 m = 449 nmi
Tiempo total = 1 h 50,89 min

Carrera de despegue = 451,93 m
Carrera aterrizaje = 213,47 m

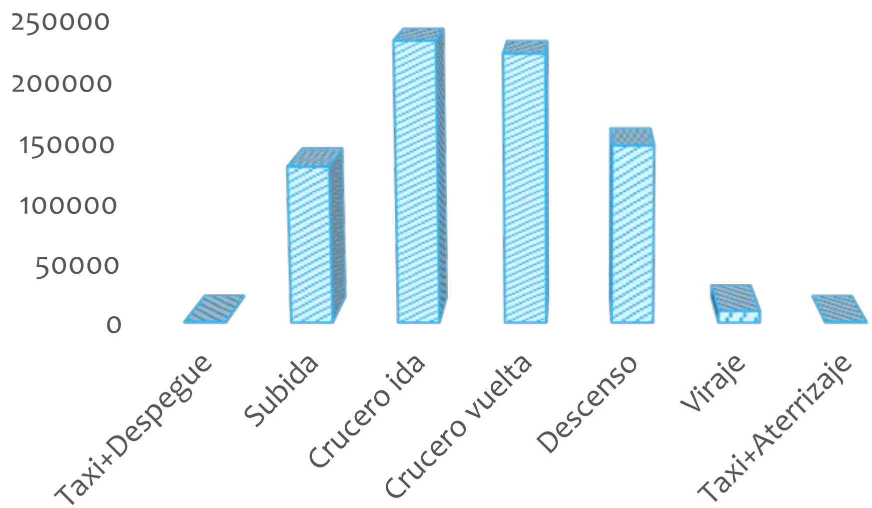
Cl medio crucero ida = 0,511
Cl medio crucero vuelta = 0,165

Primera línea Consumo/Distancia

CONSUMO



DISTANCIA



Ferry Alternativas

Subida

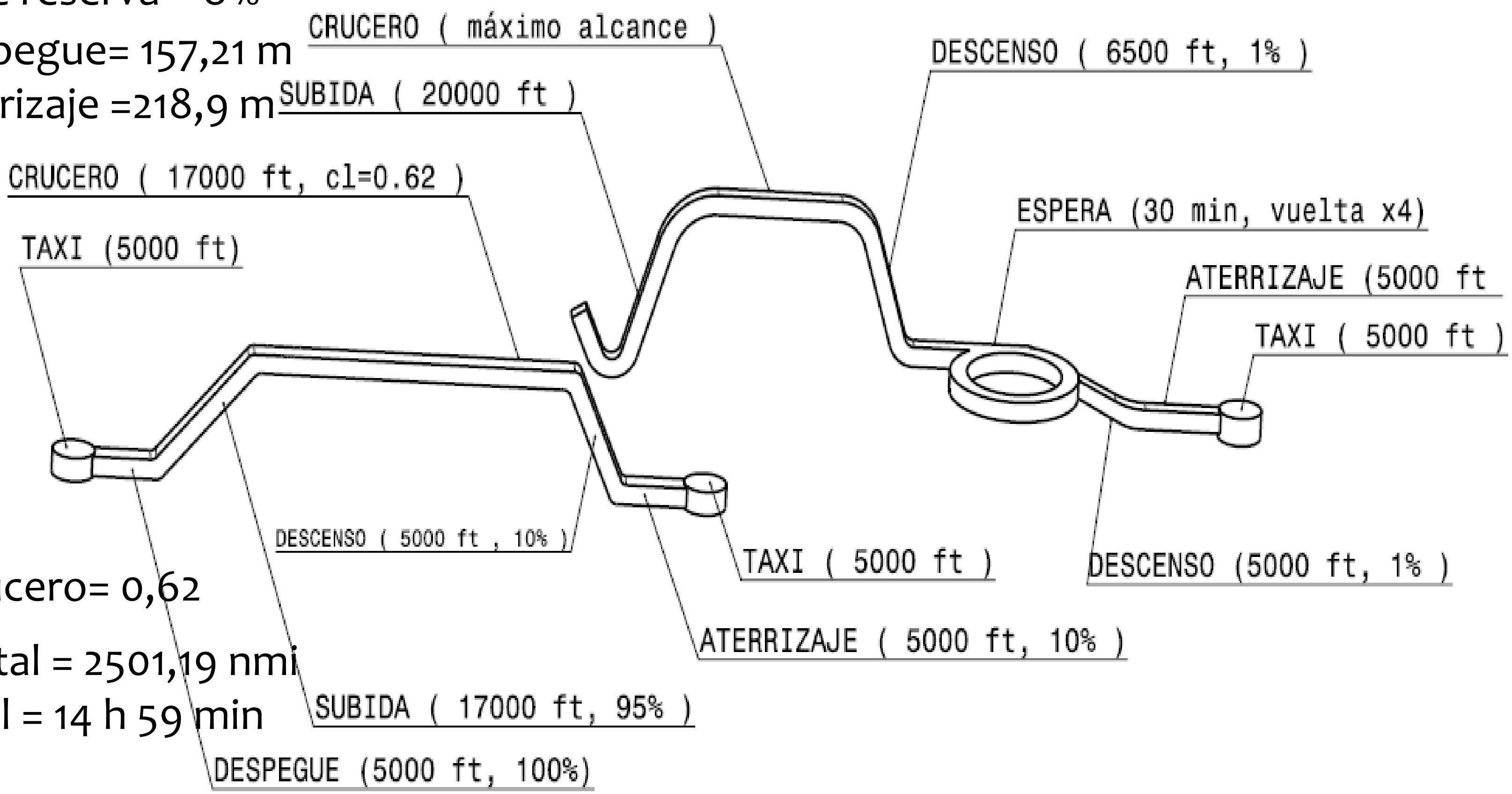
Tramos	δ
5035ft+17000ft	95 %

Crucero

Altura/velocidad	δ	**Comb.**	**Tiempo**
15000 ft cl=0,6	29,73 %	5911 kg 4450 km	52720 s
17000 ft cl=0,62	31,7 %	5709 kg 4450 km	52270 s
17000 ft 250 knots	62,4 %	8646 kg 4450 km	34598 s

Ferry

Peso inicial = 22634,33 kg
Combustible consumido= 6132,27 kg
Combustible reserva = 8 %
Carrera despegue= 157,21 m
Carrera aterrizaje =218,9 m



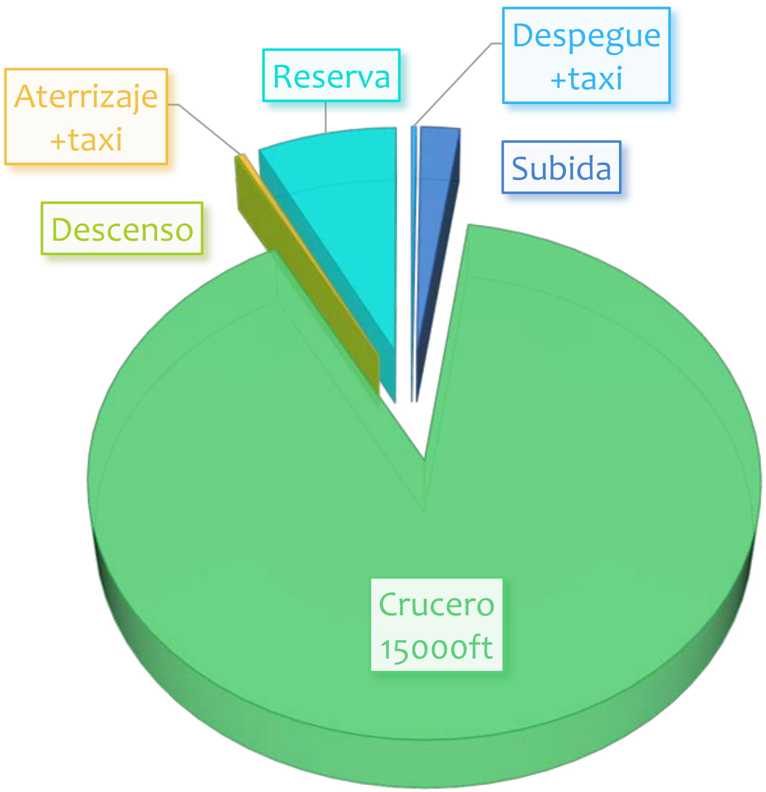
Cl medio crucero= 0,62

Distancia total = 2501,19 nmi
Tiempo total = 14 h 59 min

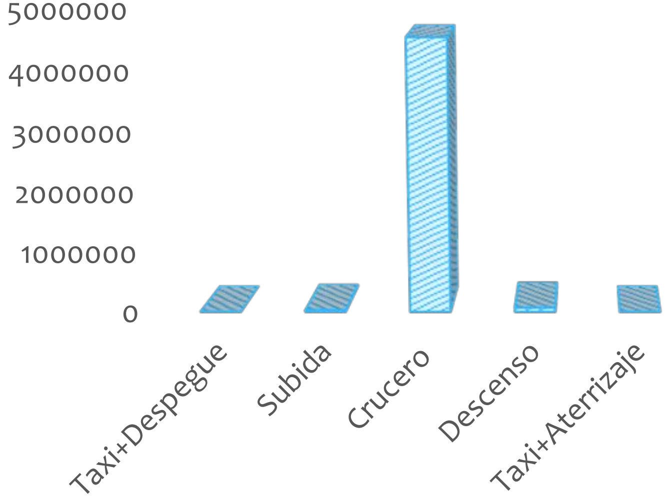
Ferry Consumo/Distancia

AFF AIRCRAFTS

CONSUMO



DISTANCIA



Segmentos emergencia

- Motor inoperativo en despegue

- Aterrizaje con 90% MWTO

Despegue 3 motores	Distancia ground	Distancia transicción	Distancia climb	Ángulo de subida tramos definidos
Línea	566,7 m	145,7 m	39,5 m	0,042 rad/0,029 rad
Ferry	200 m	65,7 m	0 m	0,042 rad/0,029 rad

Aterrizaje 90% MTWO	Distancia acercamiento	Distancia flare	Distancia ground
Línea	110,7975 m	140 m	301,6 m
Ferry	139,59 m	86 m	158,1 m

Mejoras

En un futuro análisis por parte de un equipo de diseño, se llevarán a cabo las siguientes mejoras:

- Mejor optimización tramos de subida: menor combustible
- Aprovechamiento longitud de pista, disminuyendo el incremento de flaps necesarios y el % de superficies hipersustentadoras
- Disminución de potencia necesaria
- Reducción de CASM
- Búsqueda de plantas de potencia más actuales y eficientes