Green Freighter

Reference Aircraft Hydrogen

Contents

Introduction - Green Freighter -

"The Green Freighter is seen as a vector to integrate innovative or revolutionary solutions coming from other concepts: advanced propeller engines, alternative fuels, one engine operations…

It is also the vector selected in ProGreen to challenge the certification regulation: no pilot operations, one engine aircraft…"

The purpose is to consider log term solutions for an ultra-green aircraft in term of noise and emissions. The freighter was identified as an appropriate vector because:

- **It is potentially more constrained for noise and emissions as it operates generally when passengers aircraft are less present (night operations)**
- **It is potentially less constrained in term of specifications for comfort and cruise speed. It gives the opportunity to look at innovative engine integration and energy."**

Assumed Top Level Aircraft Requirements

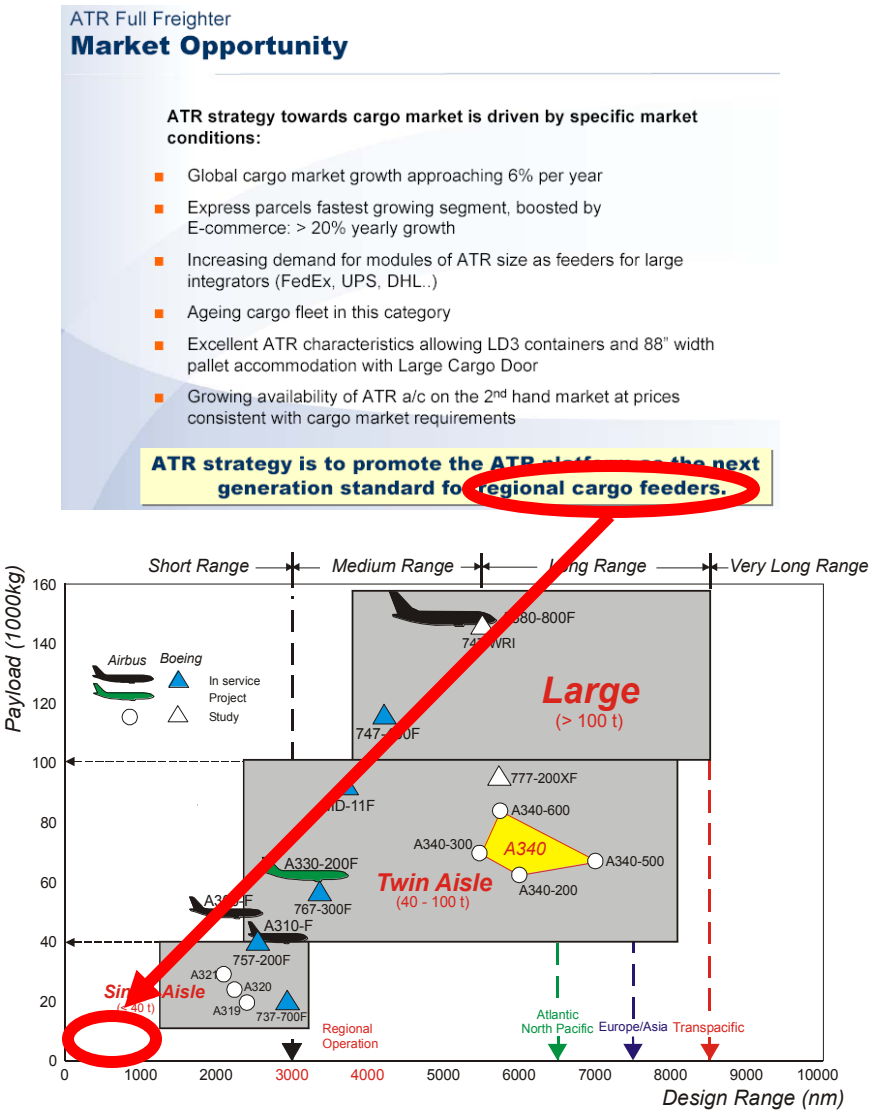
Aircraft		***Green Freighter***	***comment***
Range	*[nm]*	*1200*	*for express carrier hubs slivering (UPS, FedEx, DHL)*
Cargo payload	*[t]*	*8*	
Design Mach Number *Vmo/Mmo*	*[-]* *[kt/-]*	*0.53* *250/ 0.55*	*As Dash 8 (prop.)* *As ATR*
Initial Cruise Altitude Capability	*[ft]*	*≥ 17000*	*TO @MTOW, ISA+10*
Time To Climb to 17000ft	*[min]*	*≤ 10*	*ATR*
ACN (Flexible B)	*[-]*	*≤ 13*	*ATR*
Take-Off Field Length (MTOW, SL, ISA+15^{0}C)	*[ft]*	*≤ 4000*	*ATR*
Vapp (MLW, SL, ISA)	*[kt]*	*≤ 135*	
Typical turn around time	*[min]*	*45*	*As NSR*
Cabin Altitude	*[ft]*	*-*	*(un-pressurized fuselage)*

Why? Assumed Top Level Aircraft Requirements

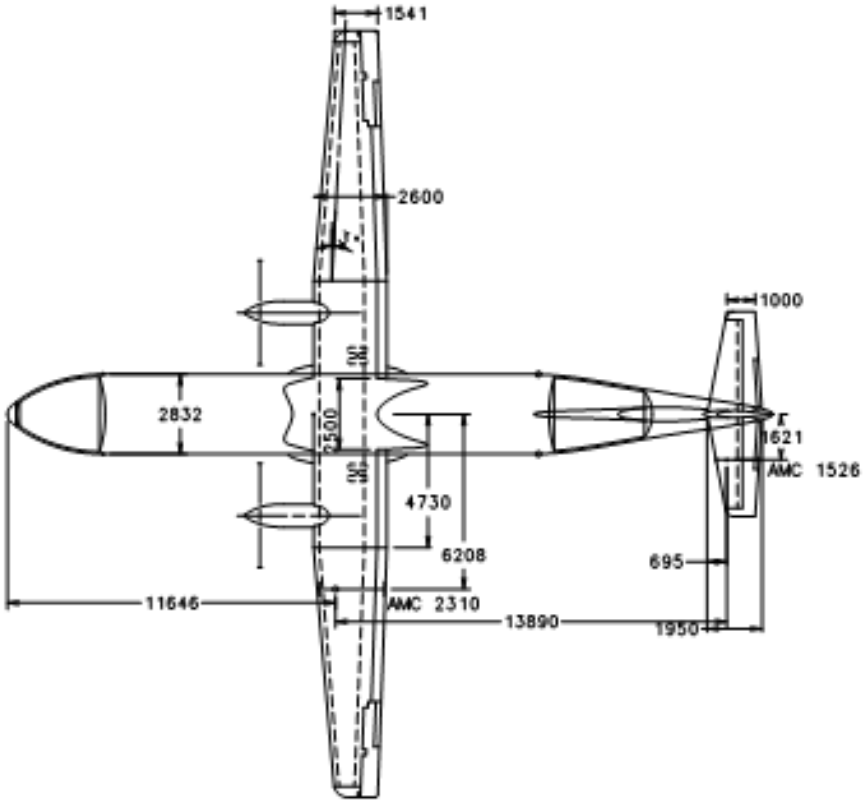
- The AC is just a platform for study purposes: no cockpit, alternative fuels...
- It can be every AC size
- Why are we working with a small cargo AC
- Hydrogene should be an alternative fuel
- It has an volume (drag) penalty
- The volume penalty is less
  - for small distances like 1200nm
- (to validate this the report is done for an LH2 and an kerosine version)
- waste water from hydrogene burning is harmfull for the atmosphere in high
- altitude → low cruise altitudes
- enabling operation of propeller engines leads to lower altitudes with less cruise speed
- un-pressurized fuselage is beneficial for unconventional configurations
- like VELA
- Low noise requirement leads to various possible studies for the universities
- but is not included in the ref. AC definition

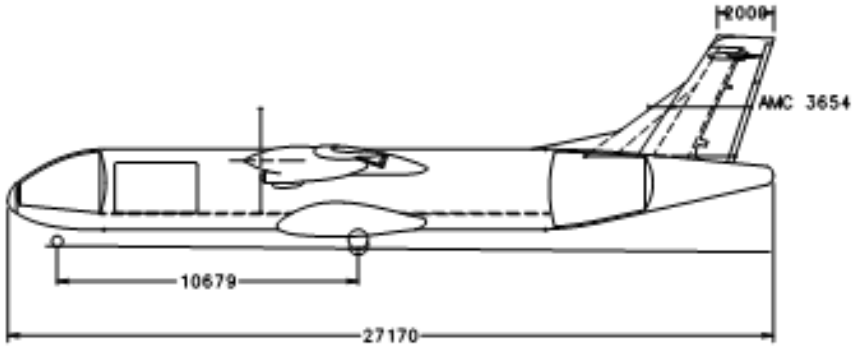
Why? Assumed Top Level Aircraft Requirements

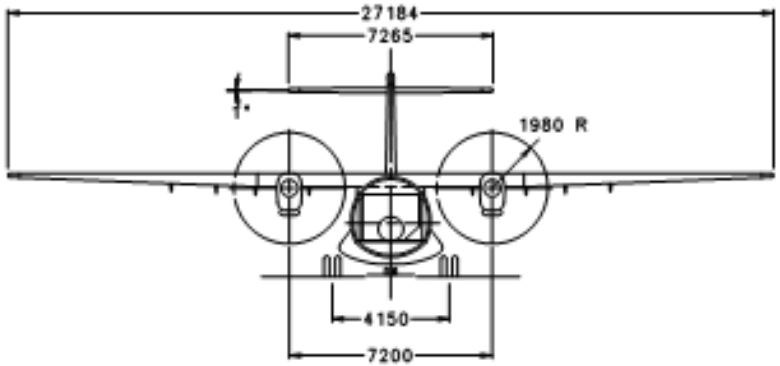
- Range: flexible regional feeders for bigger cargo AC leads to approx. 1200nm
- Payload: starting point for ref. AC is ATR 72 freighter with approx. 8 t cargo
- Mach number:
  ... less constrained in term of specifications for comfort and cruise speed. It gives the opportunity to look at innovative engine integration and energy."
- Next Points: more or less driven by ATR restrictions



ATR-H2 general arrangement

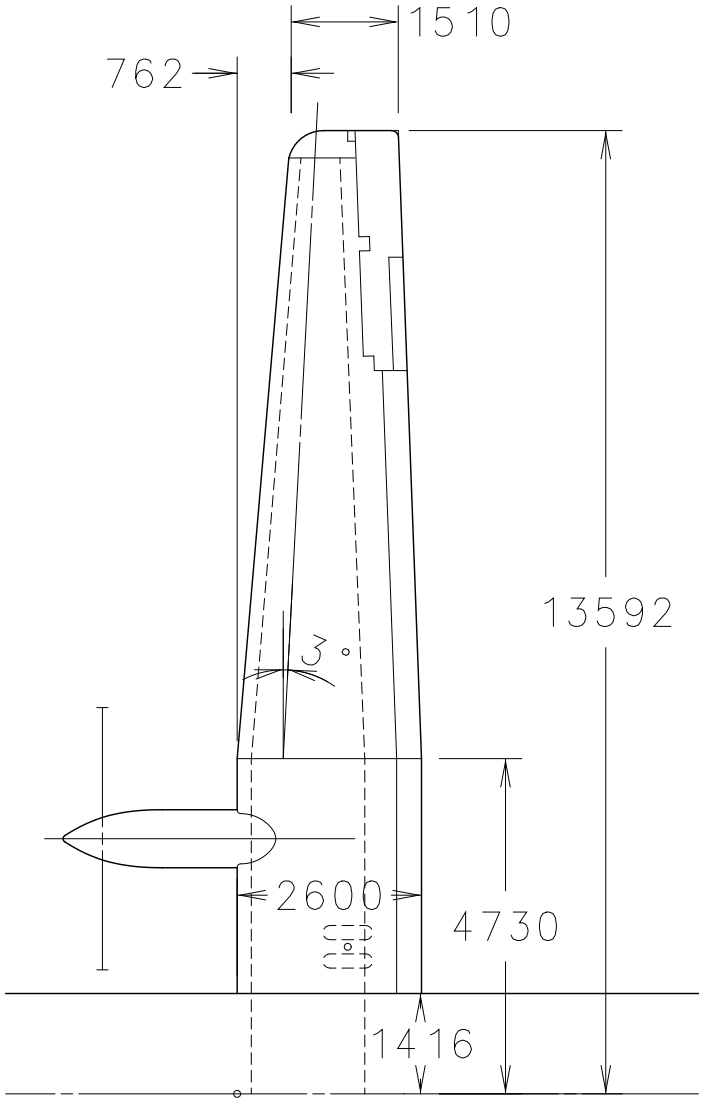






	WING	TAILPL.	FIN&RUDD
AREA m²	61	11.73	12.48
ASPECT RATIO	12	4.6	1.6
TAPER RATIO	0.618	0.61	0.6
1/4 CHORD SWP.	2.3°	6.32°	28.5°
T/C RATIO %	root 0.1784 tip 0.1353	0.12	0.12/0.15/0
VOL.COEFFIC.	-	-	-
Dihedral °	2.5°	0°	0°

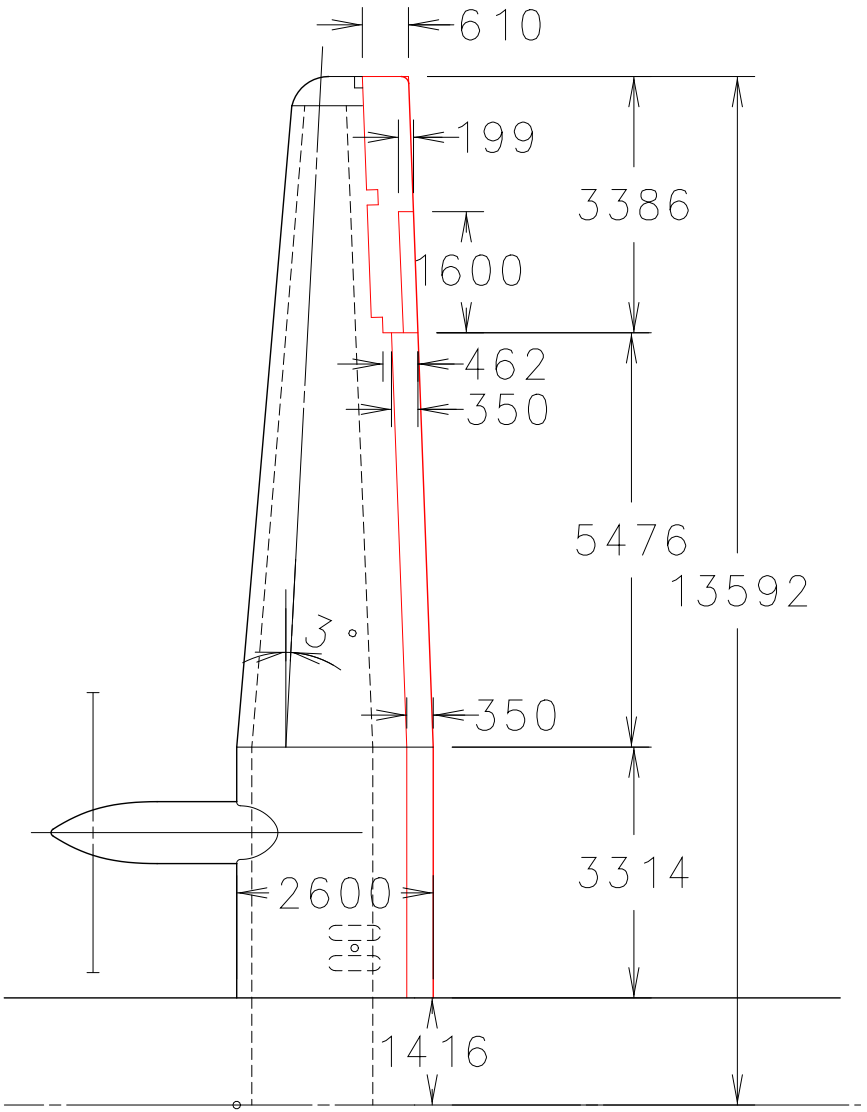
Wing arrangement



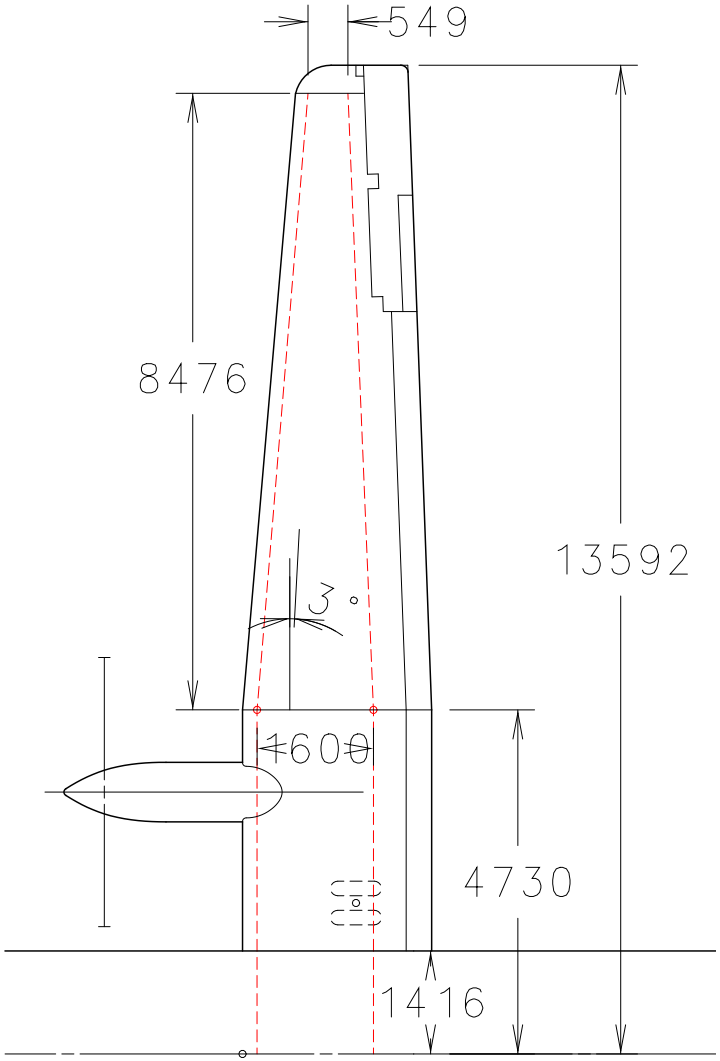
Thickness to chord ratios	
Eta	t/ c [%]
0.10	17.80
0.14	17.19
0.18	16.46
0.23	15.62
0.27	14.92
0.35	14.04
0.35	14.04
0.39	13.92
0.42	13.76
0.46	13.83
0.54	13.63
0.56	13.58
0.59	13.76
0.62	13.56
0.65	13.61
0.69	13.59
0.73	13.48
0.77	13.51
0.81	13.60
0.85	13.47
0.88	13.45
0.92	13.43
0.96	13.28
1.00	13.44

Wing main data		
wing reference area	61	m^2
aerodynamic mean chord	2.3	m
span	27.05	m
aspect ratio	11.99	-
taper ratio (tip / root)	0.62	-
root chord	2.57	m
tip chord	1.59	m
sweep angle (25%)	2.3	deg
leading edge sweep	4.9	deg
trailing edge sweep	2.1	deg
dihedral upper surface	2.5	deg

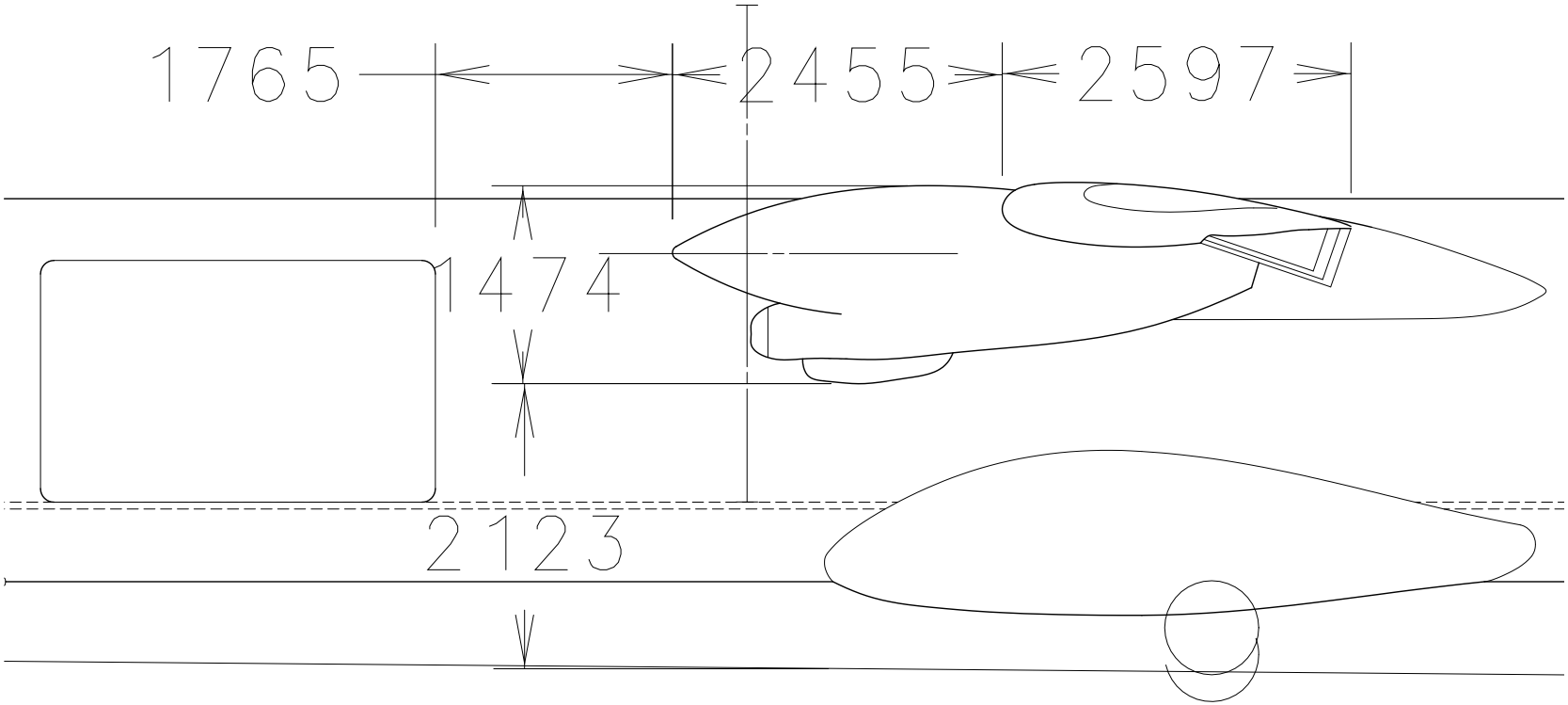
Wing movables arrangement



Wing structural arrangement

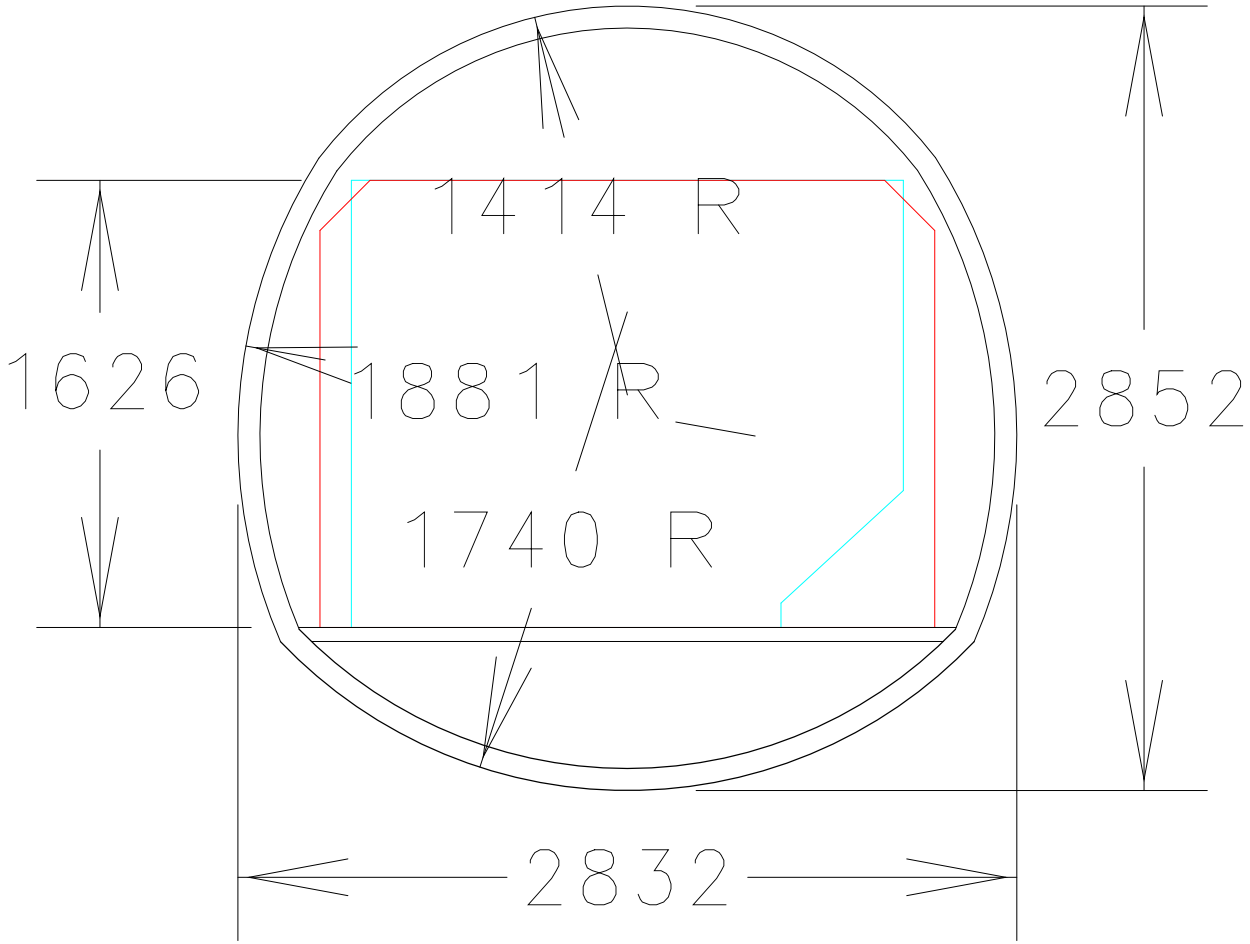


Engine integration



Engine: PW 127

Fuselage cross section



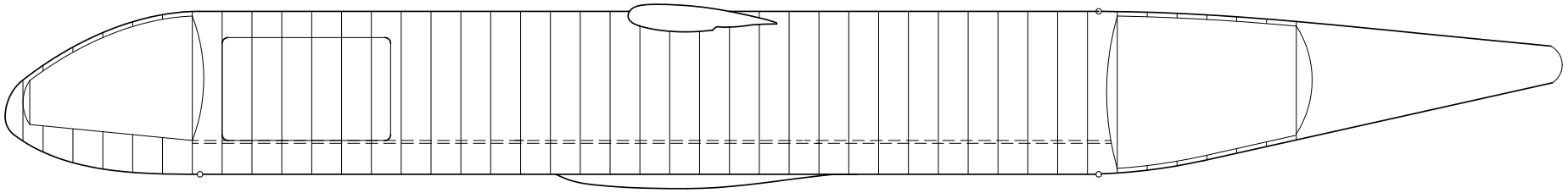
Perimeter 9.1 m

Cross Section Area

outer 6.52 m²

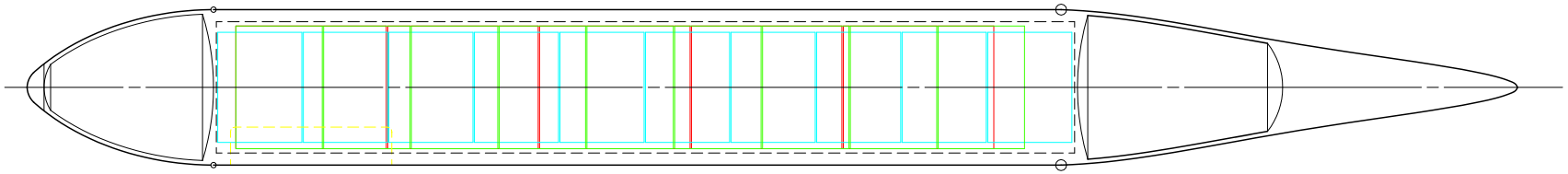
inner 5.81 m²

Fuselage arrangement



20.5“ frame pitch

Cargo arrangement



pallet: 88"x108"xH64"

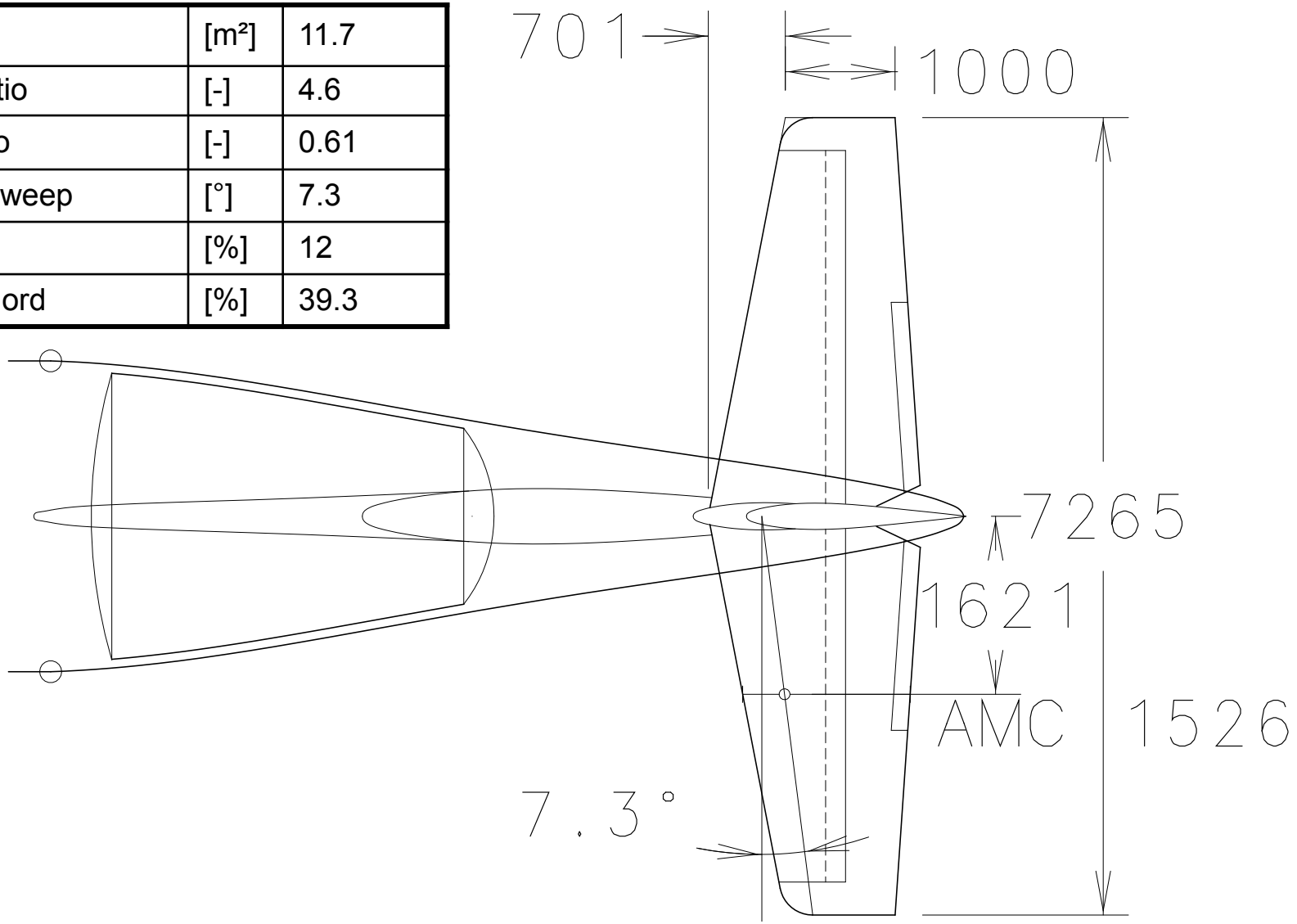
pallet: 88"x62"xH64"

LD3

Cargo options: - 5x pallet (88“x 108“ x 64“)
- 10x LD3
- 9x pallet (88“x 62“x 64“)

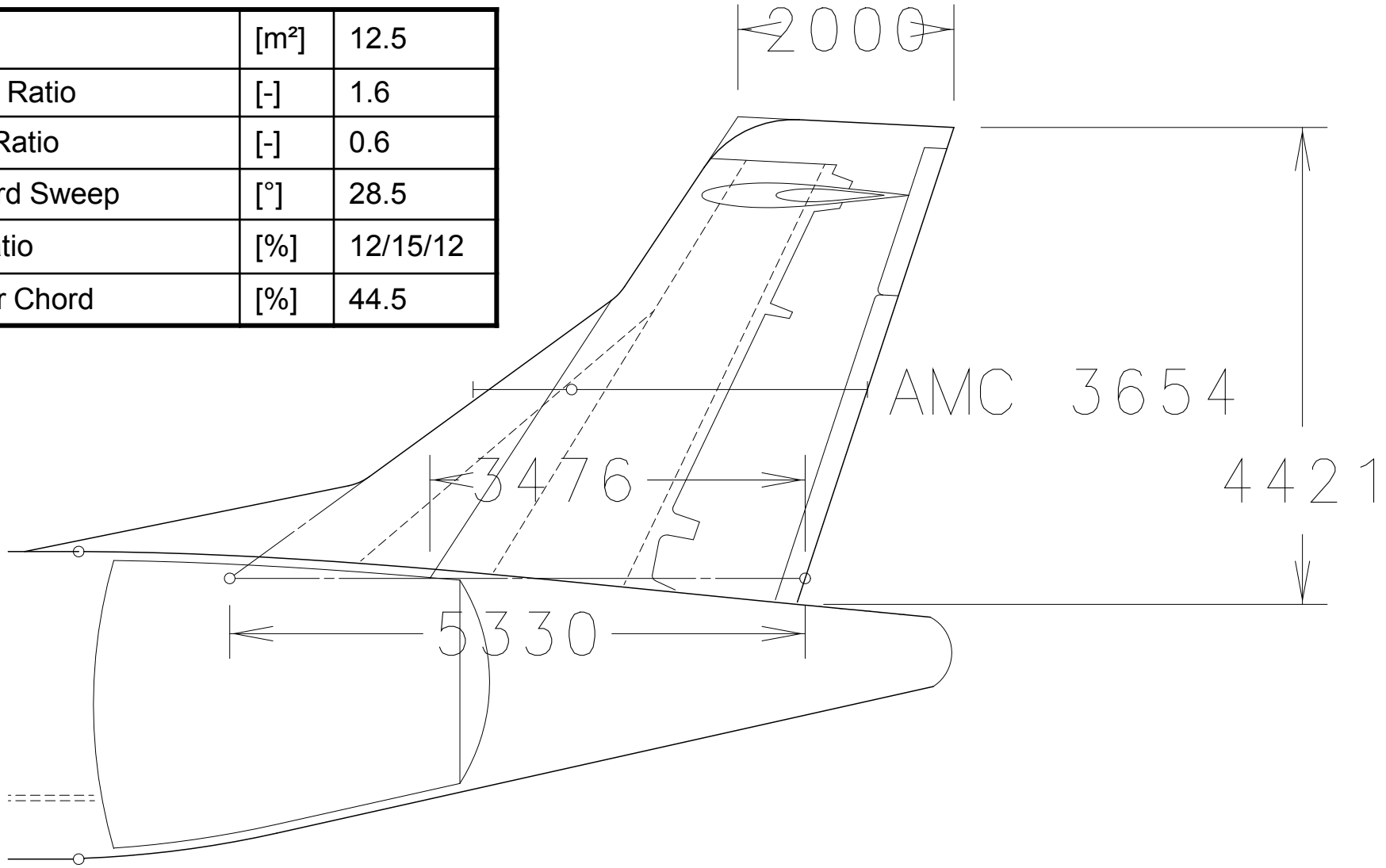
Horizontal tailplane

Area	[m²]	11.7
Aspect Ratio	[-]	4.6
Taper Ratio	[-]	0.61
¼ Chord Sweep	[°]	7.3
T/C Ratio	[%]	12
Rudder Chord	[%]	39.3

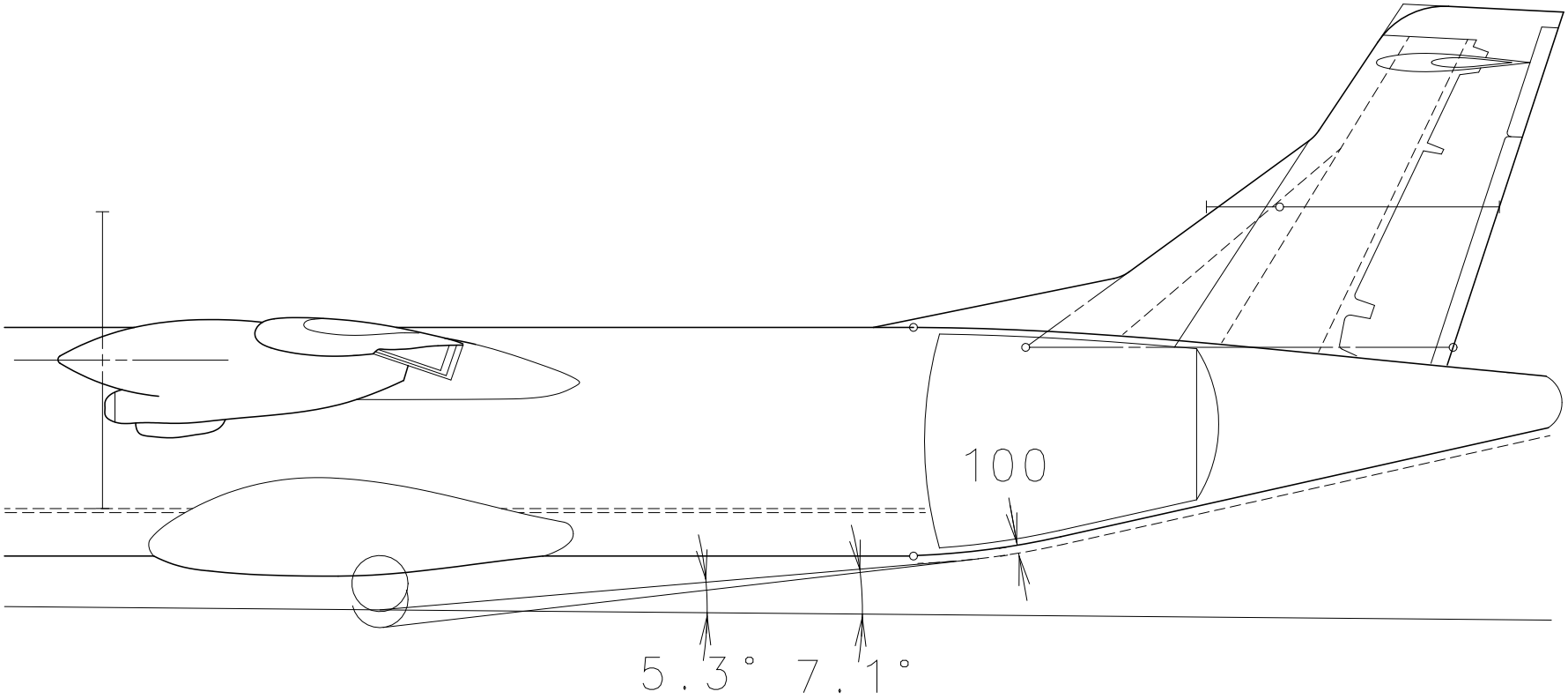


Fin & rudder

Area	[m²]	12.5
Aspect Ratio	[-]	1.6
Taper Ratio	[-]	0.6
¼ Chord Sweep	[°]	28.5
T/C Ratio	[%]	12/15/12
Rudder Chord	[%]	44.5



Rotation angle



Rotation angle includes 100mm clearance to fuselage loft