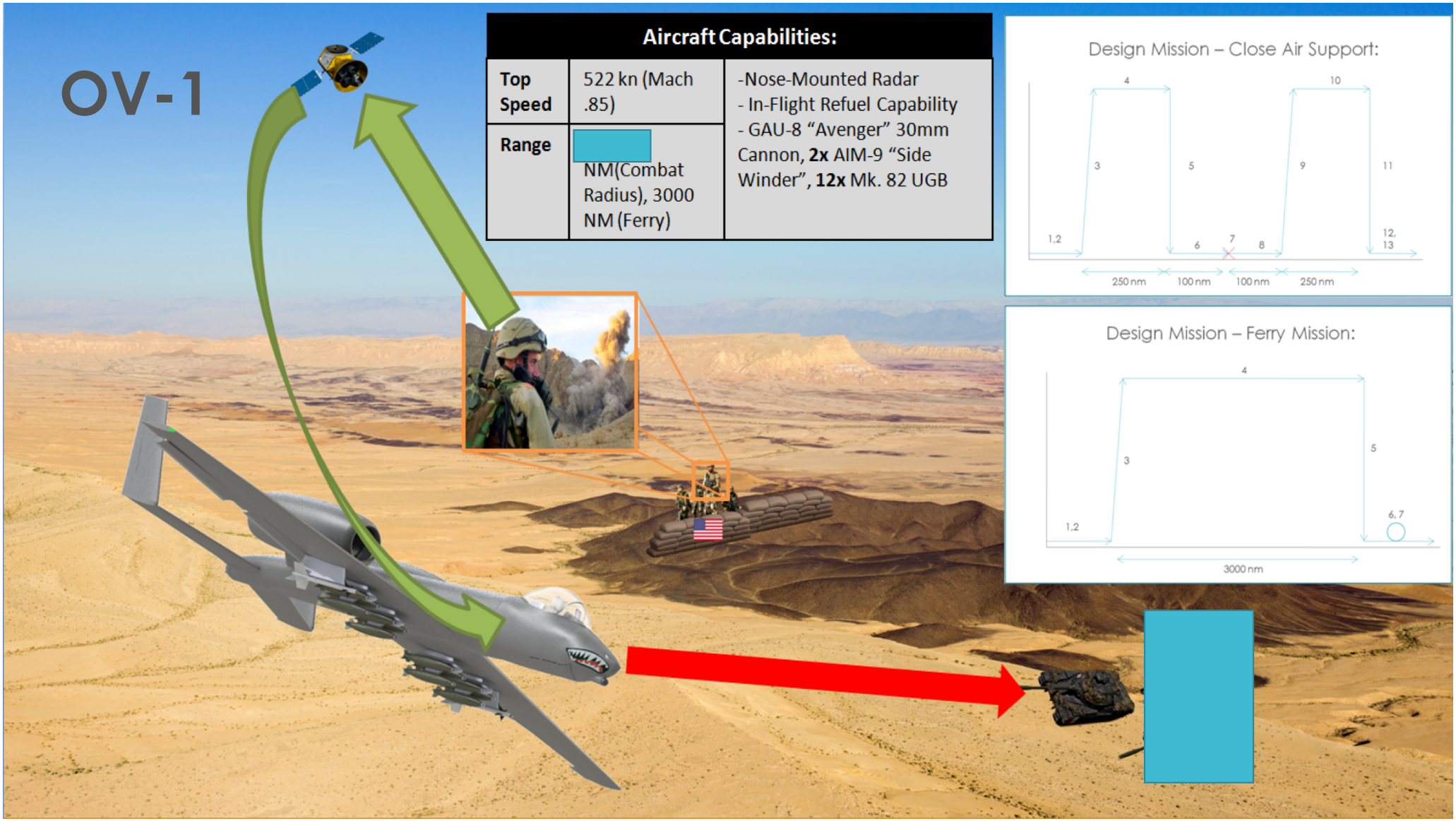
PRELIMINARY DESIGN REVIEW

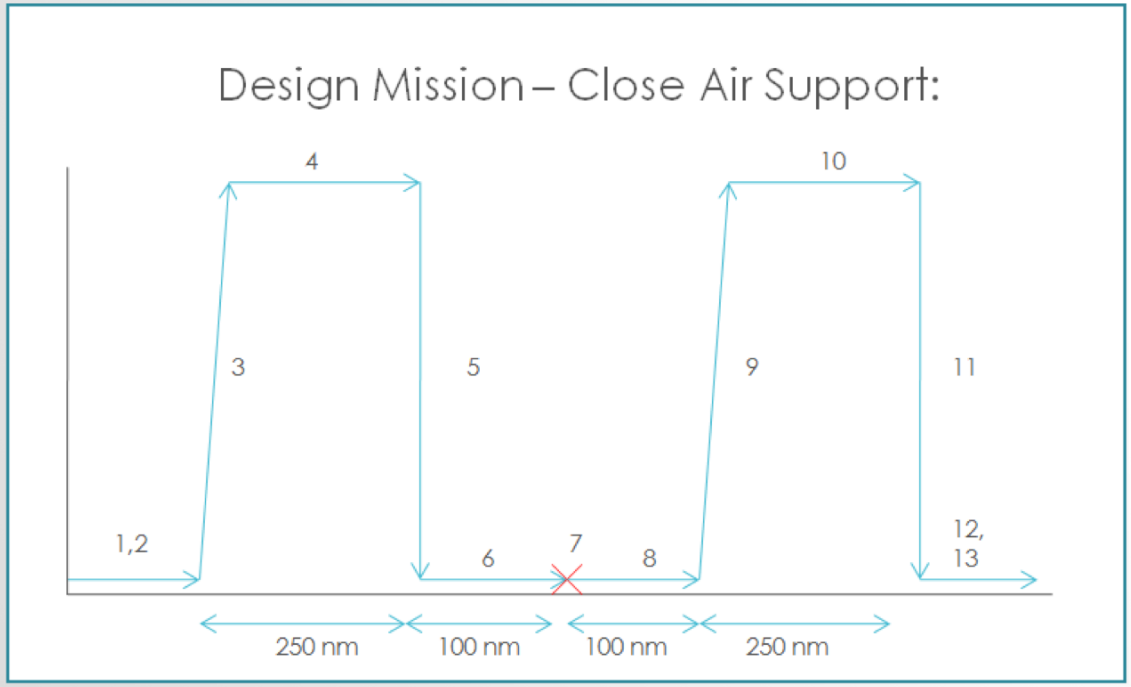
SPECTRE A-X “GHOSTBUSTER”

OV-1

Aircraft Capabilities:		
Top Speed	522 kn (Mach .85)	-Nose-Mounted Radar - In-Flight Refuel Capability - GAU-8 “Avenger” 30mm Cannon, **2x** AIM-9 “Side Winder”, **12x** Mk. 82 UGB
Range	[redacted] NM(Combat Radius), 3000 NM (Ferry)	

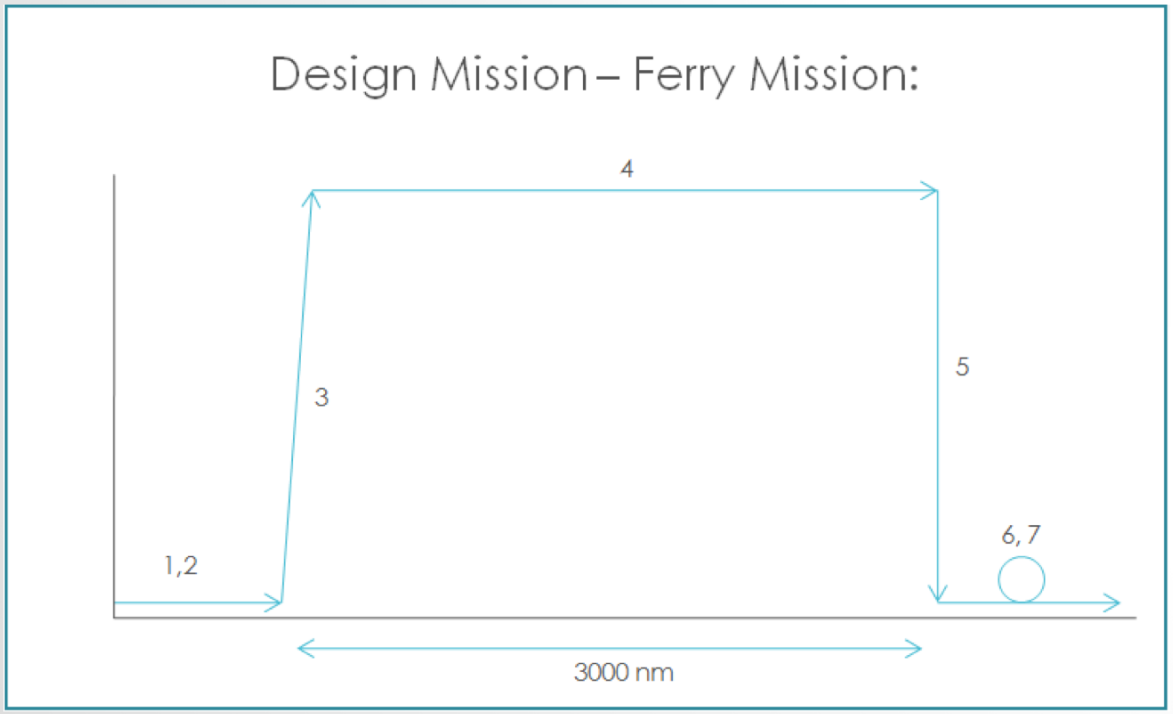


MISSION PROFILE



Mission		Fuel (gal)
1,2	Startup/taxi, Takeoff	
3	Climb	
4	Cruise	
5	Descend	
6	Dash (knots)	
7	Combat (10 min)	
8	Dash (500 knots)	
9	Climb	
10	Cruise	
11	Descend	
12,13	Loiter (20 min) & Land	
Required Fuel Remaining		33.11

MISSION PROFILE



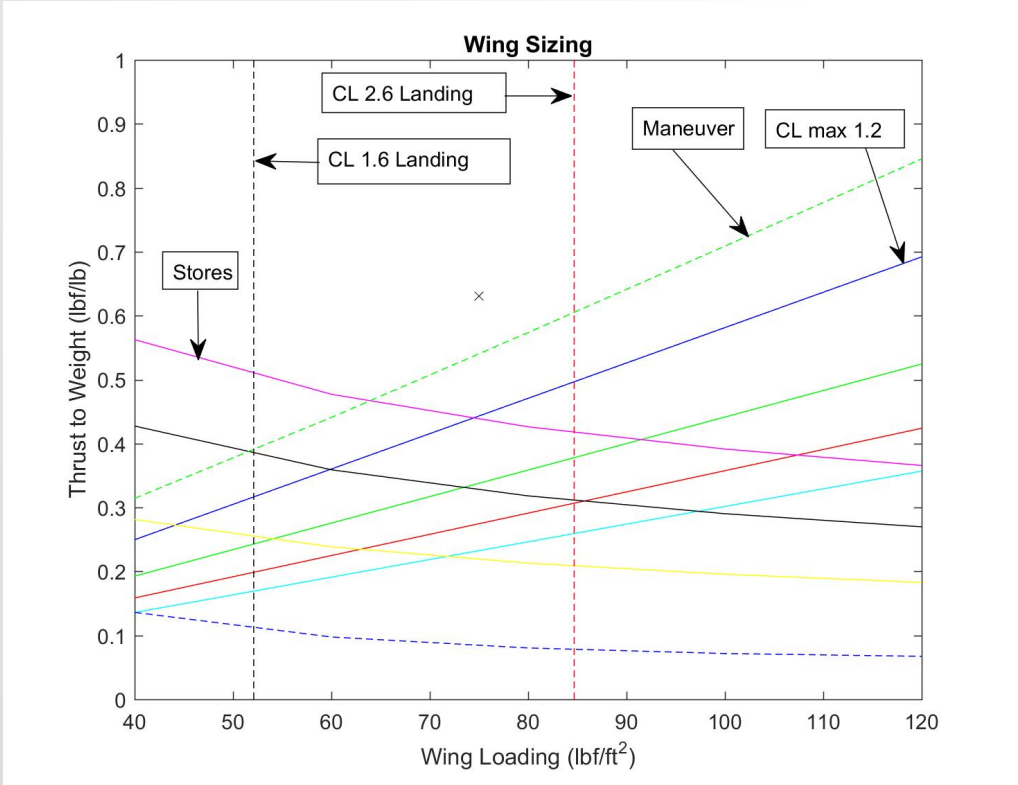
Mission		Fuel (gal)
1,2	Start up/Taxi, Takeoff	
3	Climb	
4	Cruise	
5	Descend	
6,7	Loiter (20 min) & Land	
Required Fuel Remaining		14.7

Mission Configuration: Three external, 600 gallon, fuel tanks

AIRCRAFT COMPARISON

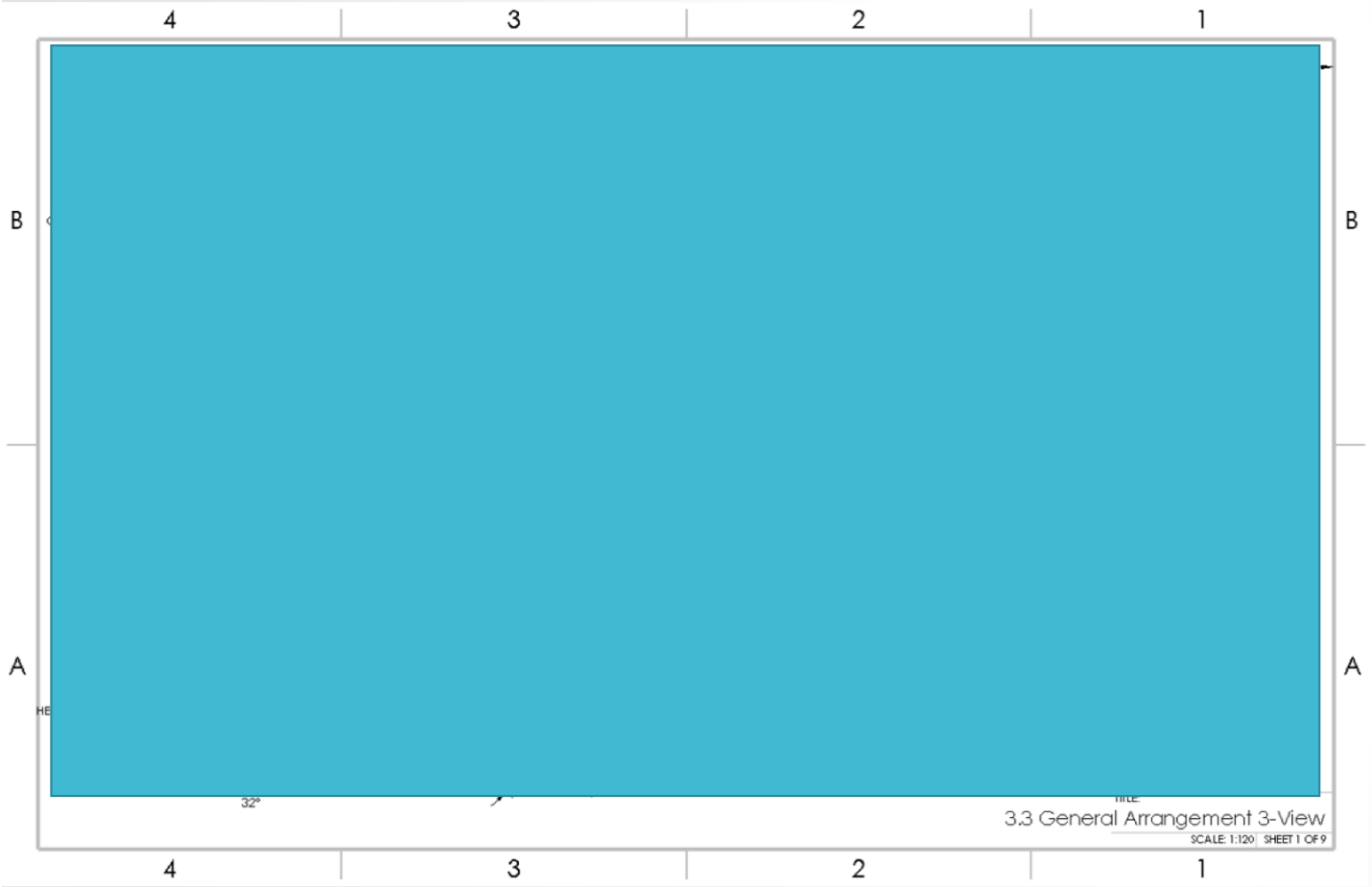
Details	Sukhoi SU - 25	Fairchild Republic A-10	Spectre
Weight (lbs)	31,645	51,000	
Wing Span (ft)	47.1	57.6	
Wing Area (ft^2)	324	506	
Ceiling (ft)	23,000	45,000	
Maximum Speed (kts)	540	381	
Maximum Thrust (lb_f)	19,840	18,130	

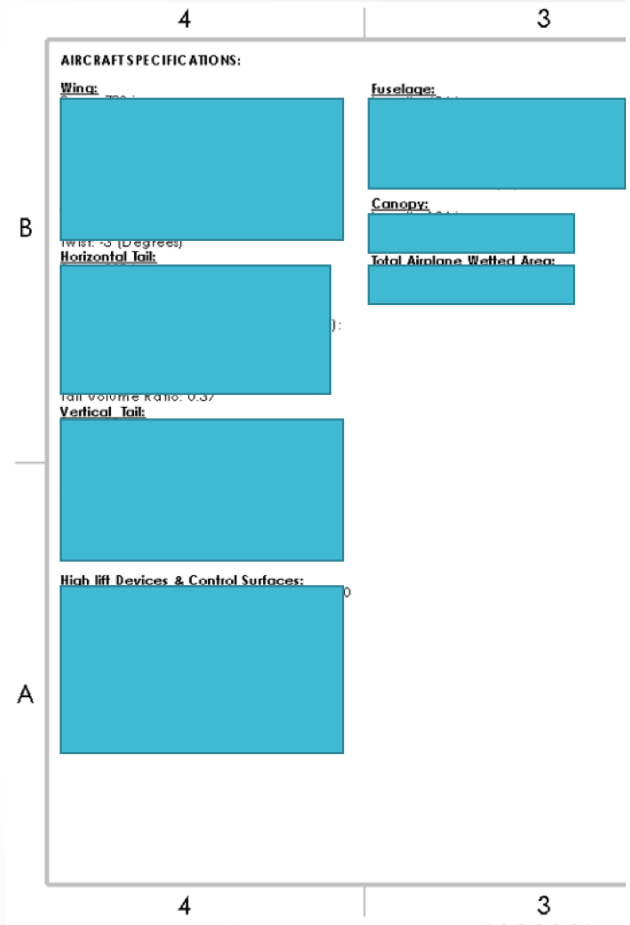
WING SIZING

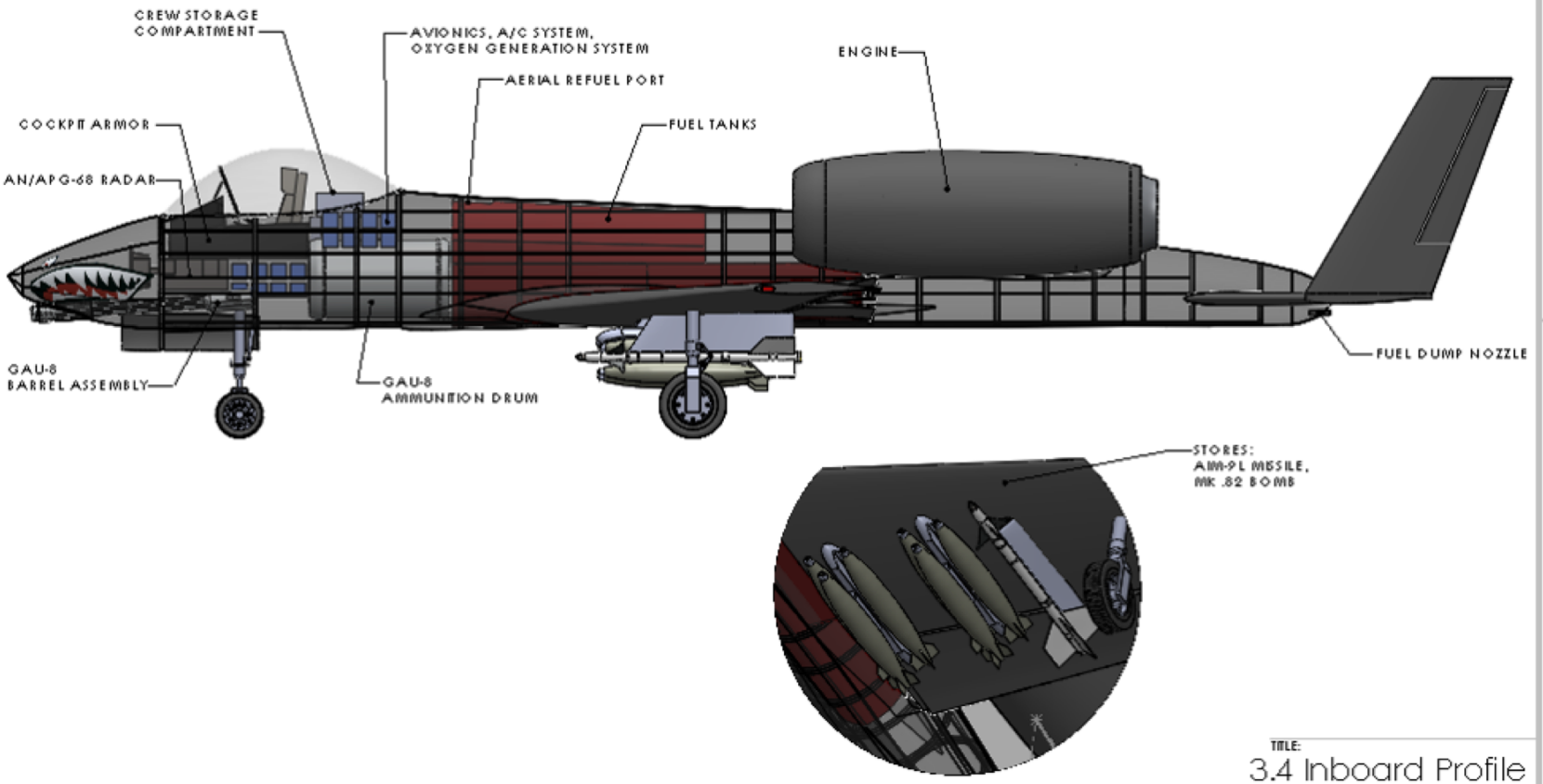


Properties	Values
T/W	
W/S (lb/ft^2)	
b (ft)	
S_{ref} (ft^2)	

AIRCRAFT 3-VIEW

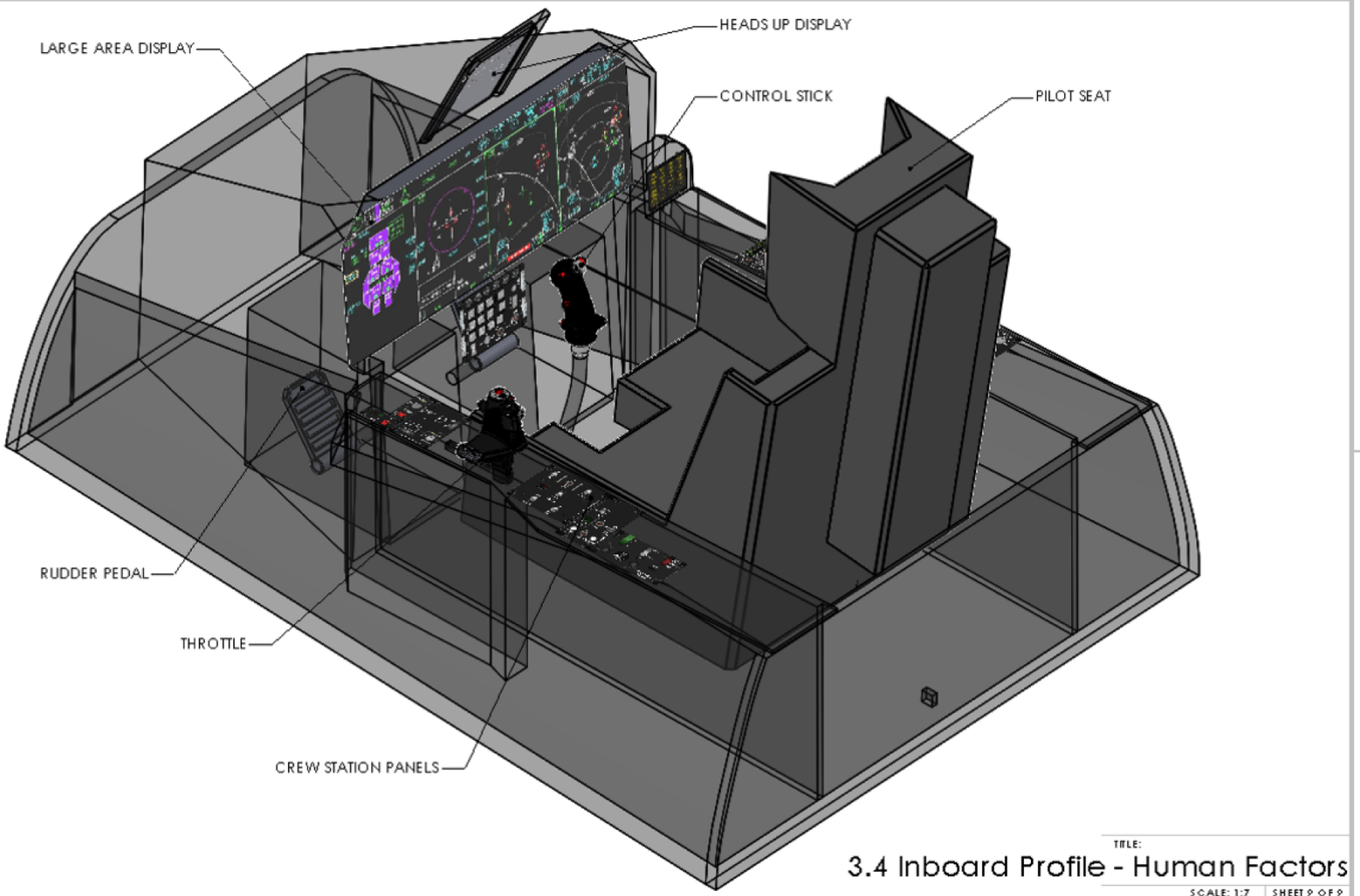






TITLE:
3.4 Inboard Profile

SCALE 1:46 | SHEET 3 OF 9

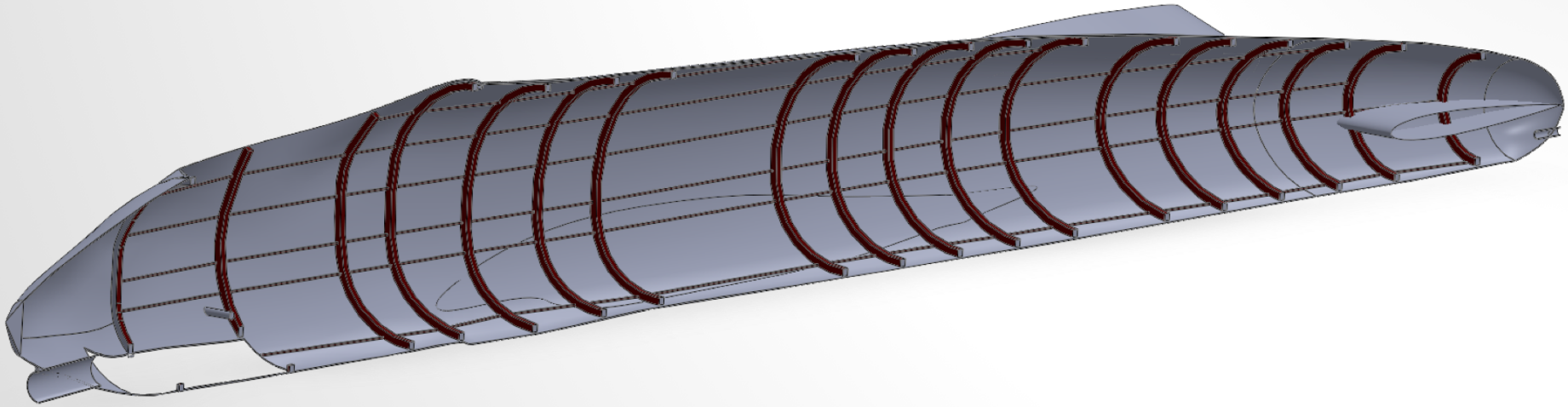


TITLE:

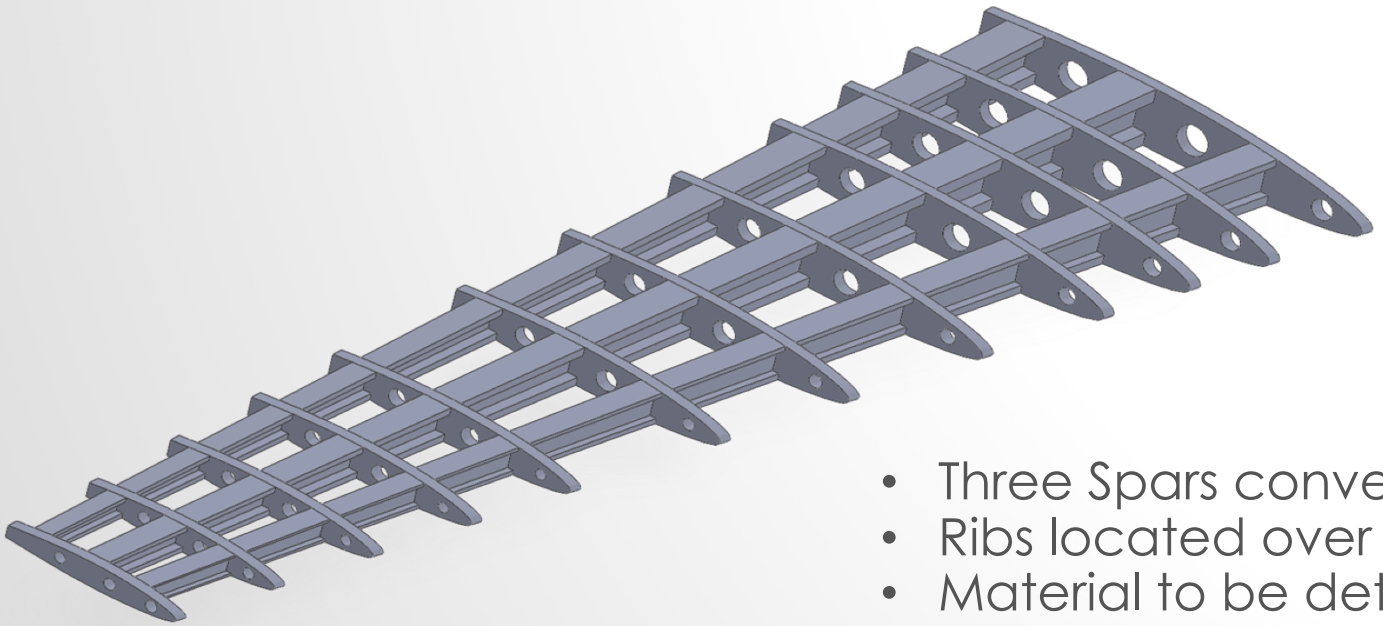
3.4 Inboard Profile - Human Factors

SCALE: 1:7 SHEET 9 OF 9

STRUCTURAL LAYOUT



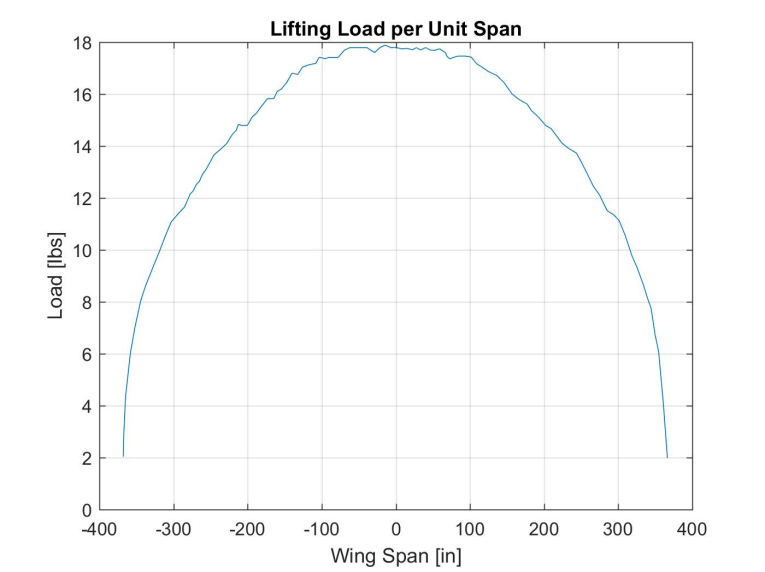
WING STRUCTURE



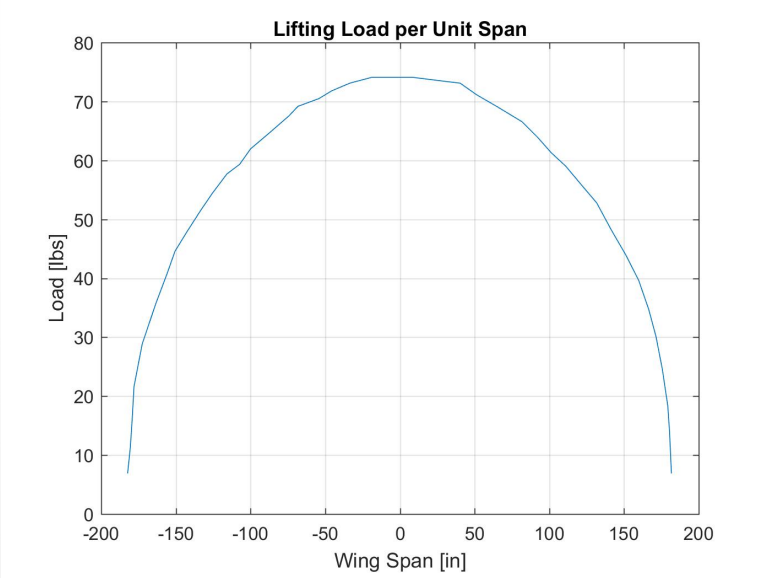
- Three Spars converging to tip.
- Ribs located over stores.
- Material to be determined.

WING LOADING

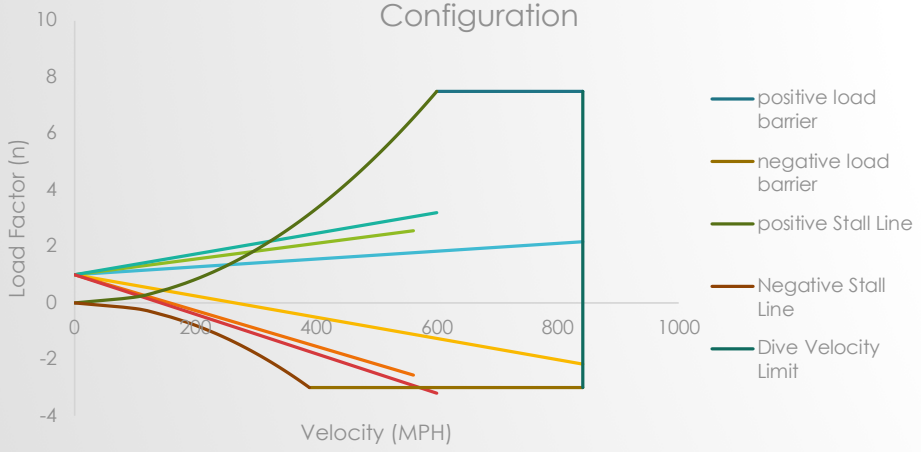
Lifting load at zero degrees AOA 500 MPH		
Average Lift	Average Lift per Wing	Total Lift of Wing



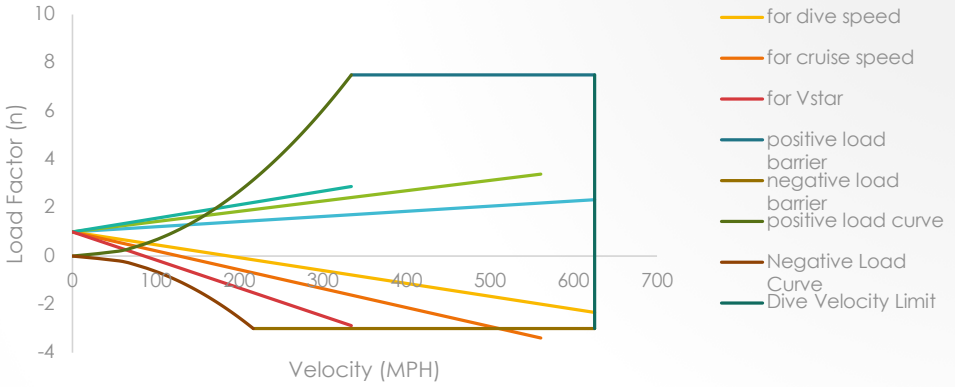
Lifting load at 5 degrees AOA 500 MPH		
Average Lift	Average Lift per Wing	Total Lift of Wing



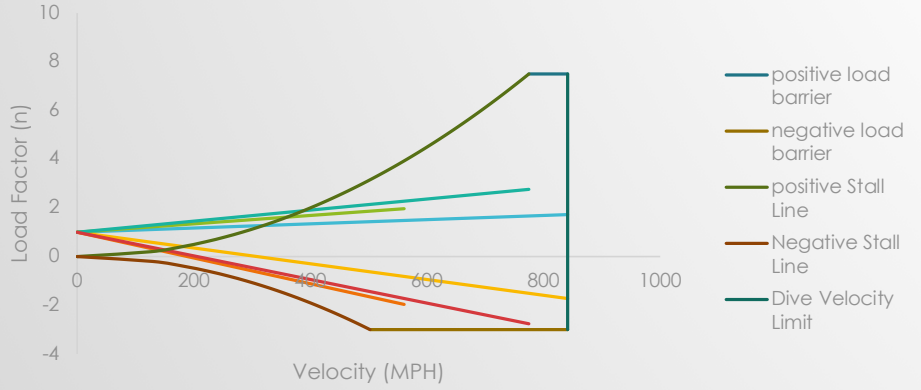
V-N Diagram for 35000 FT Lightest Weight Configuration



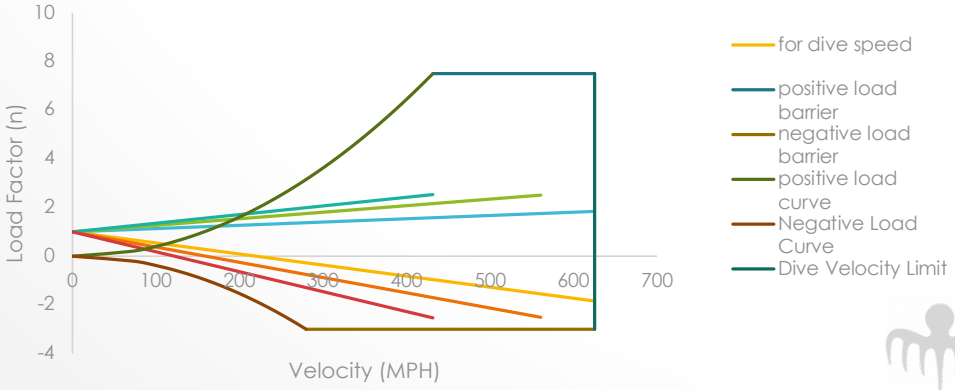
V-N Diagram for Sea Level Lowest Weight Configuration



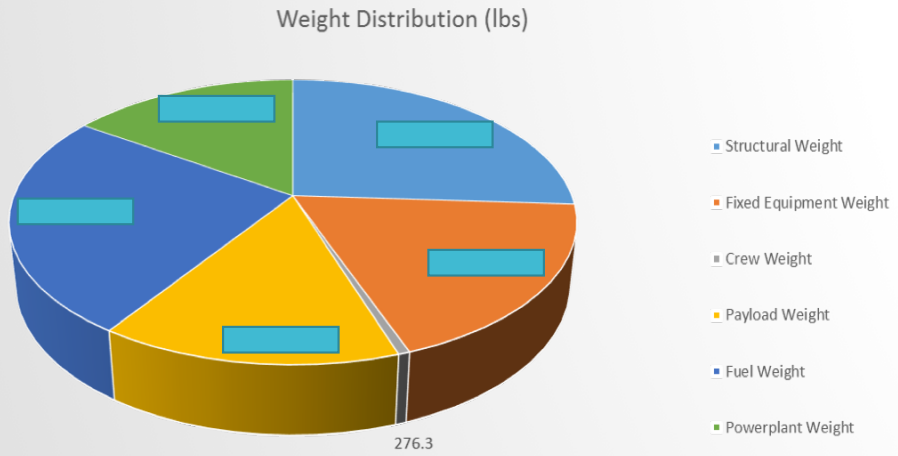
V-N Diagram for 35000 FT Greatest Weight Configuration

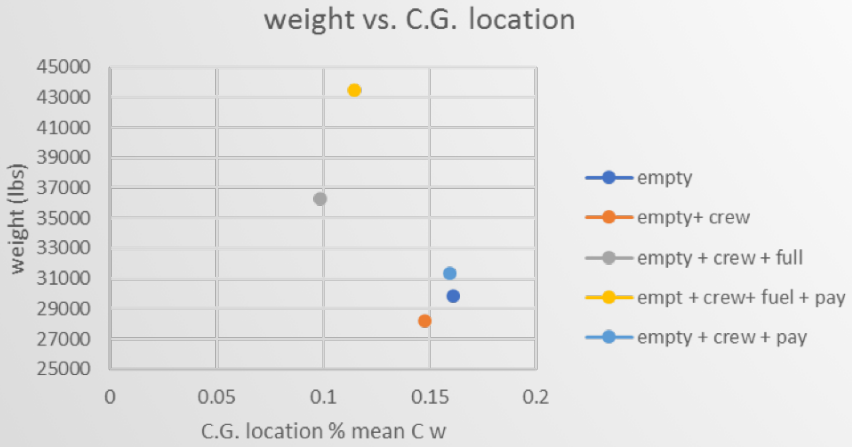


V-N Diagram for Sea Level Greatest Weight Configuration



MASS PROPERTIES



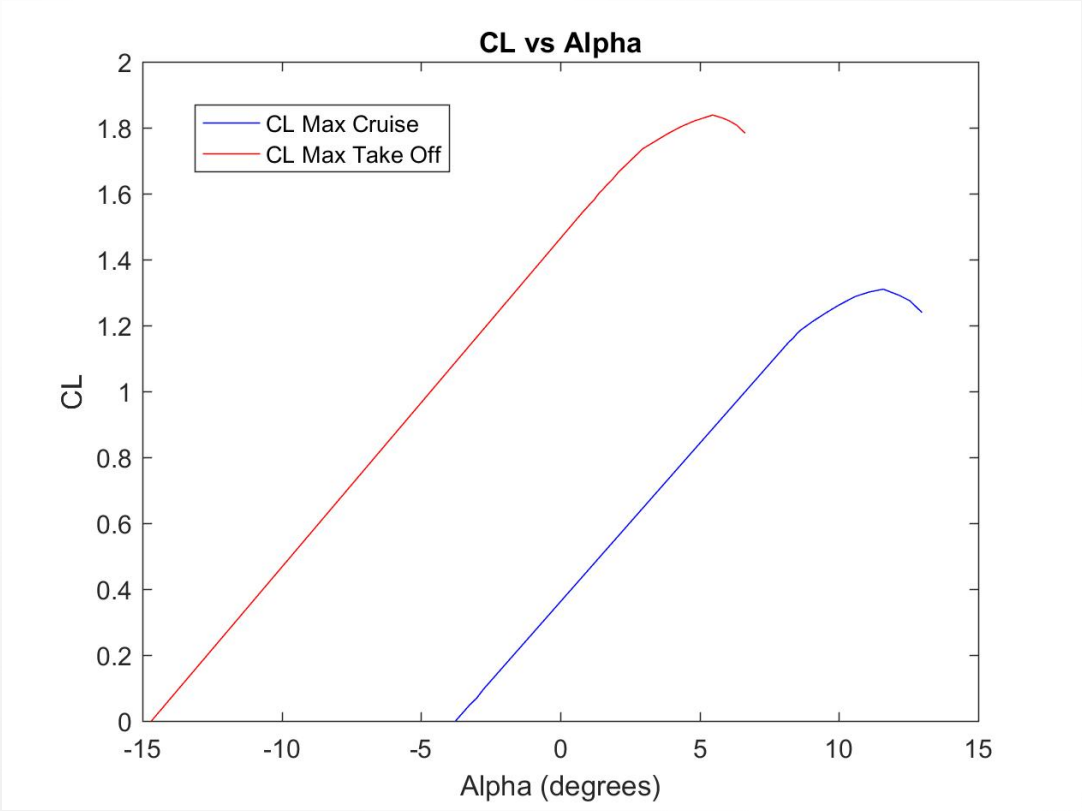


Aircraft C.G.	X (ft)	Y (ft)	Z (ft)	% MAC Chord
Weight Empty	39.9	0.02	6.3	16.1
Weight Empty + crew	39.8	0.02	6.3	14.8
Empty + Crew + Fuel	39.3	0.02	6.1	9.9
Empty + Crew + Fuel + Payload	39.5	0.01	5.7	11.4
Empty + Crew + Payload	39.9	0.02	5.8	15.9
Total Aircraft Weight (lbs)				

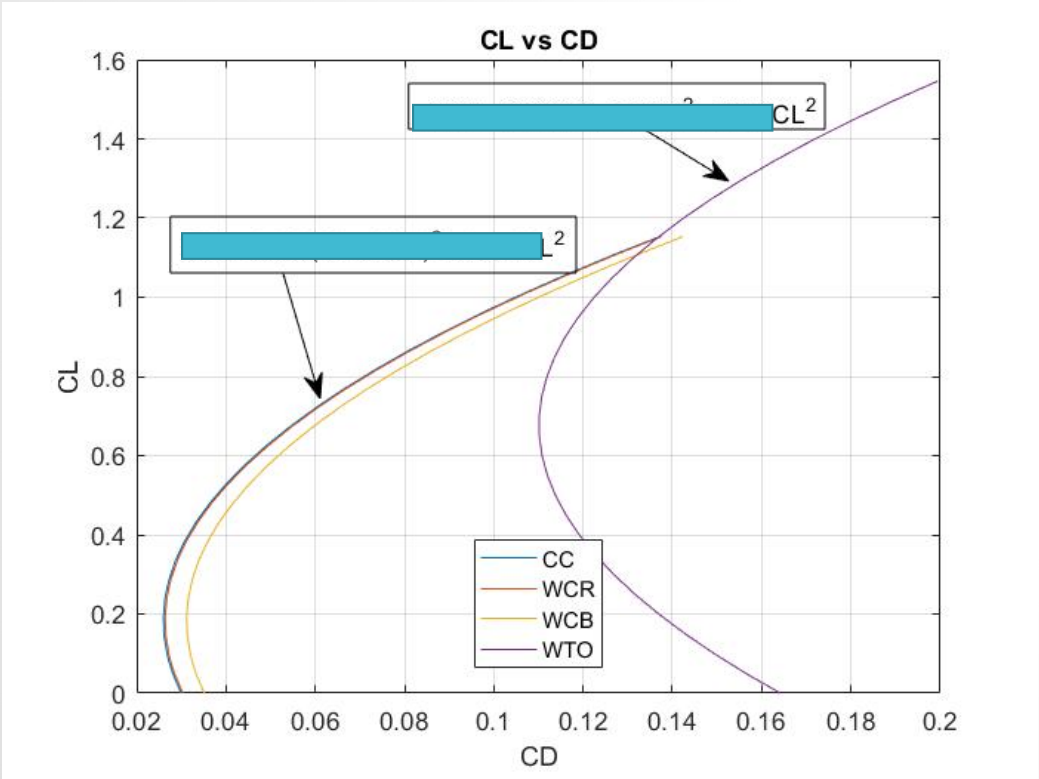
Aircraft Moments of Inertia			
Ixx (slug*ft^2)	Iyy (slug*ft^2)	Izz (slug*ft^2)	Izx (slug*ft^2)

AERODYNAMICS LIFT CURVES

Aerodynamics Data	
Wing Airfoil	
Tail Airfoil	
Flaps	
Taper ratio	
Wing LE Sweep	
C_{Lbreak}	
C_{LMax}	
$C_{Lbreak\ Flaps}$	
$C_{LMax\ Flaps}$	
Flap span	
Flap area	

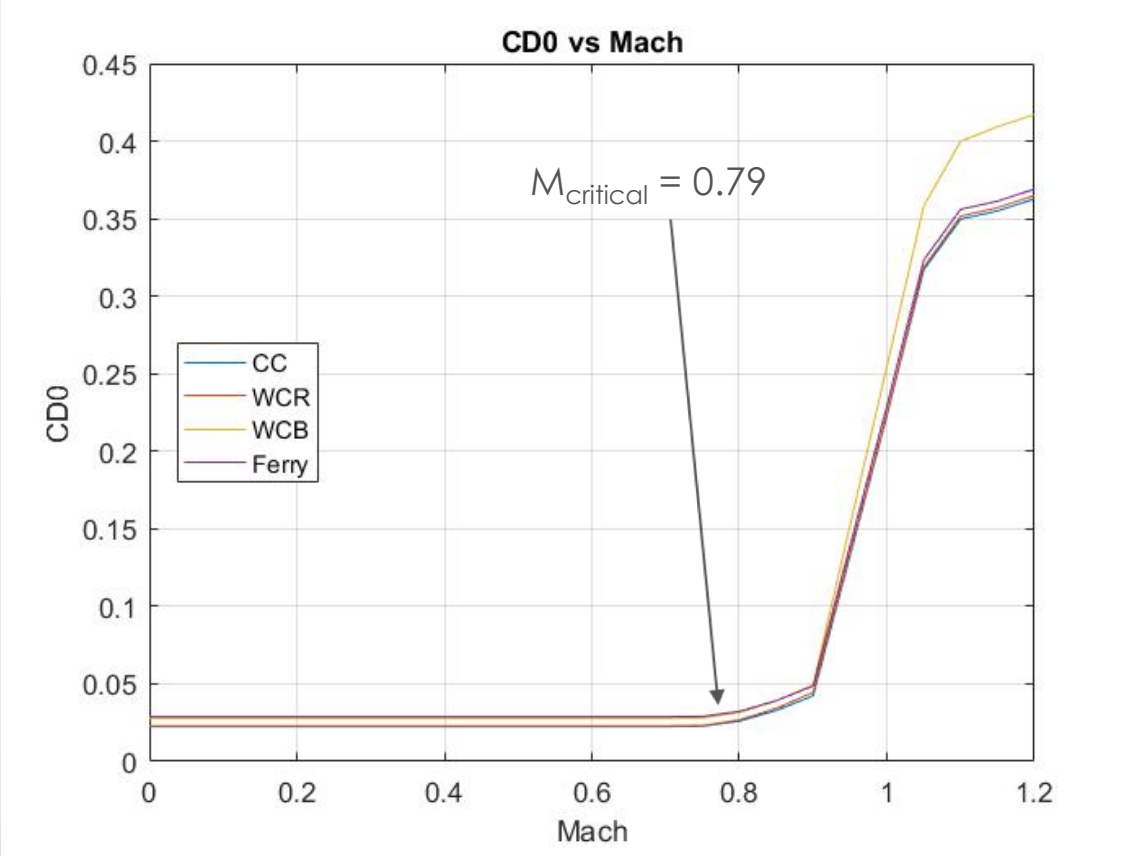


DRAG POLARS

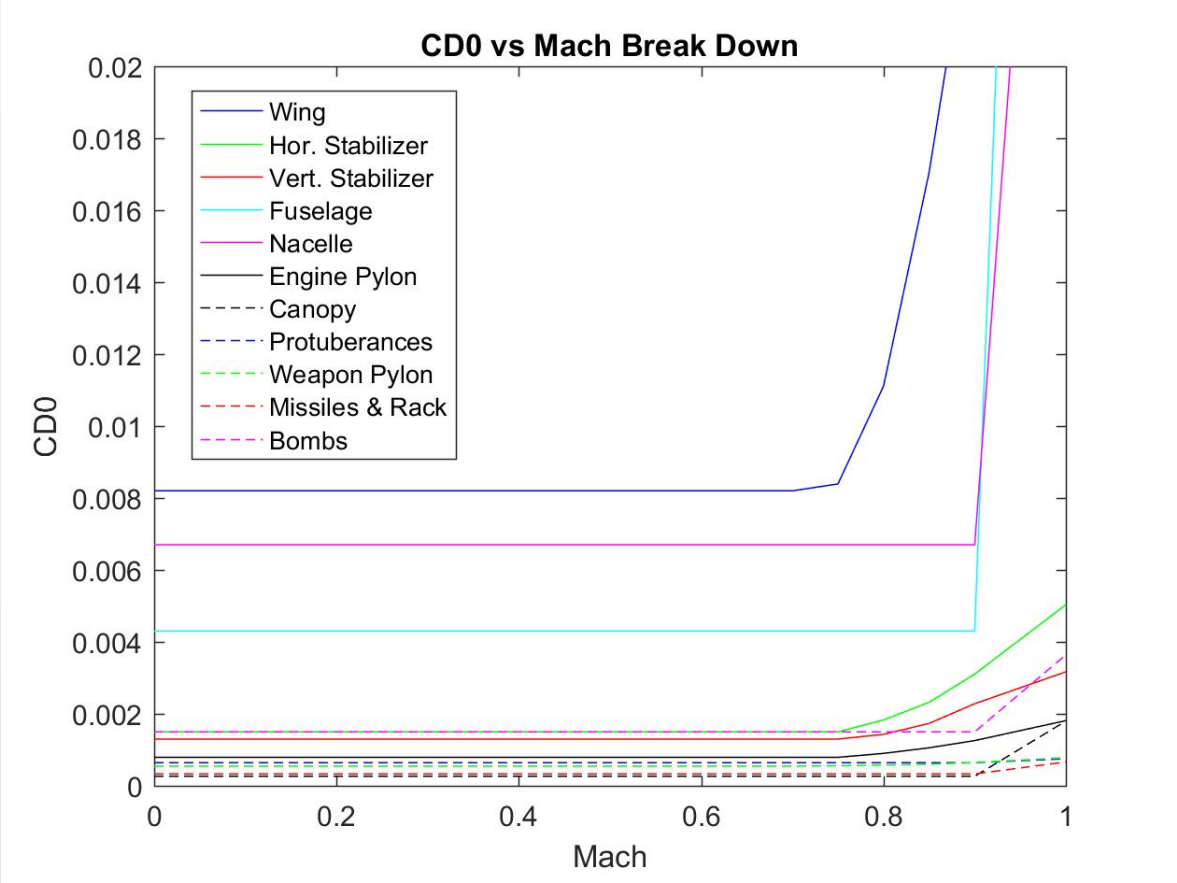


Configuration	C_{D0}
CC	
WCR	
WCB	

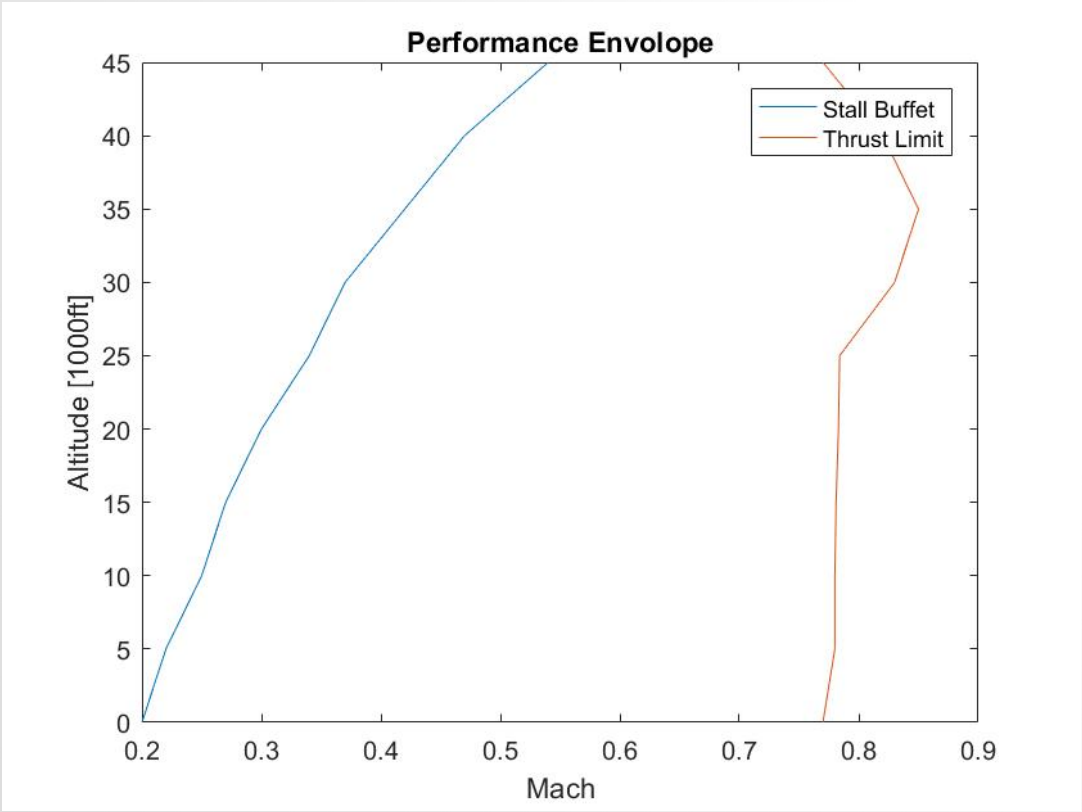
C_{D0} vs MACH

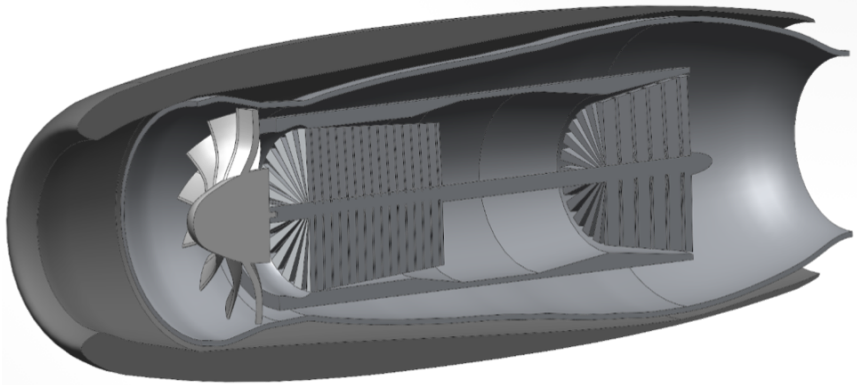

CD0 vs Mach
$M_{critical}$ = 0.79
CC
WCR
WCB
Ferry
CD0
Mach
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
0.2
0.4
0.6
0.8
1
1.2

C_{D0} vs MACH - BREAKDOWN

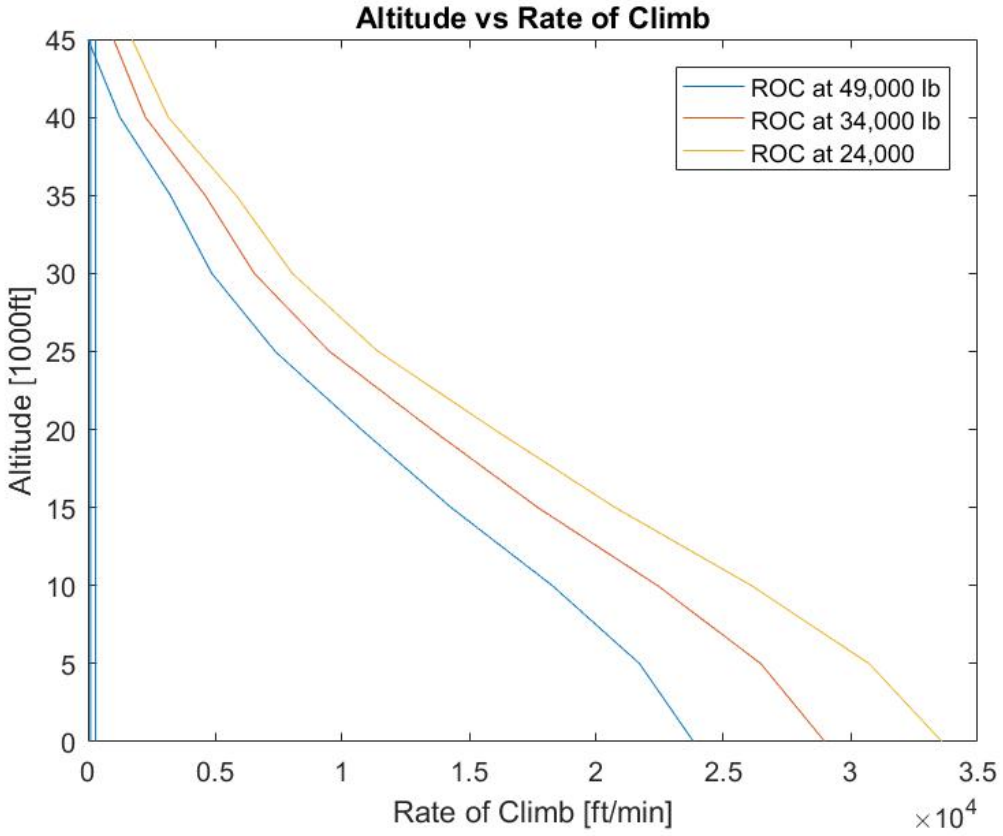


PERFORMANCE SUMMARY





PERFORMANCE SUMMARY

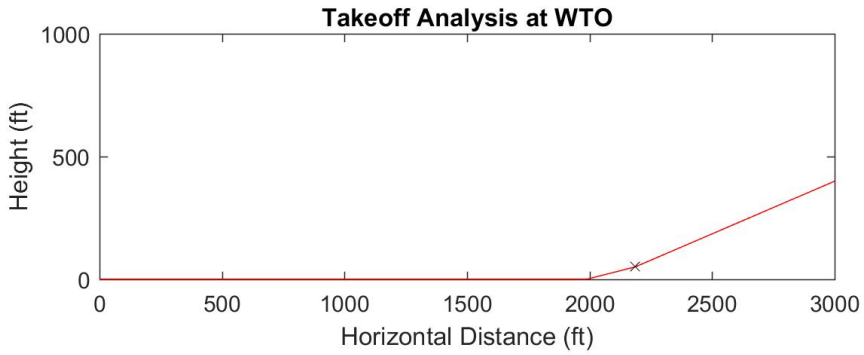


Engine Data	
T/W	
Static Thrust (lbs)	
Length of Engines (ft)	
Inlet Diameter (ft)	
Total Diameter (ft)	

Rate of Climb	300 ft/min	100 ft/min
Operational	45,000	Met
Service	45,000	Met

TAKEOFF AND LANDING ANALYSIS

Takeoff at WTO		
Segments	Required [ft]	Distance [ft]
Ground Run	2500	1537
Rotation	/	453
Transition	/	196
Total	/	2216



Landing Analysis		
Weight [lbs]	Requirement [ft]	Distance [ft]
49,000	2500	2300
34000	2500	2024
24000	2500	1762

DIMENSIONLESS STABILITY DERIVATIVES

Longitudinal Non-dimensional Derivatives

	C_x	C_z (-C_L)	C_m
u^			
α^			
q^			
α_dot^			

Longitudinal Dimensional Derivatives (Etkin 4.4)

	X	Z	M
u			
w			
q			
w_dot^			

A Matrix (Longitudinal)

Lateral Non-dimensional Derivatives

	C_y	C_l	C_n
β			
p^			
r^			
β_dot^			

Lateral Dimensional Derivatives (Etkin 4.5)

	Y	L	N
v			
p			
r			

B Matrix:(Lateral)

STABILITY AND CONTROL RESULTS

Characteristic Eqn Coefficients (Longitudinal Matrix)				
A	B	C	D	E

Characteristic Eqn Coefficients (Lateral Matrix)				
A	B	C	D	E

A Matrix	R	0.003
	E>0?	UNSTABLE
	R>0?	STABLE

B Matrix	**R**	$-1E^{-6}$
	E>0?	STABLE
	R>0?	UNSTABLE

STABILITY AND CONTROL RESULTS

	Real	Imaginary	Stable/Unstable	Undamped Frequency	Damping ratio	Period	Time to double or half	Cycles to double or half	Time Constant
Mode	n	Ω		ω_n	ζ	T(s)	t (s)	N	τR(s)
1 (Phugoid)			STABLE						
2 (Short Period)			STABLE						
1 (Spiral)			STABLE						
2 (Rolling Convergence)			UNSTABLE						
3 (Dutch Roll)			UNSTABLE						

REQUIREMENTS SUMMARY

CAS ID	Requirement	Required	Achieved
1	Max Speed	0.85	0.85
2	Operational Ceiling [ft]	40,000	45000
3	Takeoff Ground Run [ft]	<2500	1537
4	Landing Ground Run [ft]	<2500	2282
5	OEI Total Takeoff Distance [ft]	x	5,336
6	OEI Rudder Deflection [degrees]	≤20	7.80
7	Cnβ	>0	
8	Clβ	<0	
9	Cma	<0	
10	Short Period Damping Ratio	0.35-1.30	
11	Phugoid Damping Ratio	>0.04	
12	Dutch Roll Damping Ratio	>0.02	
13	Dutch Roll Undamped Natural Frequency	>0.40	
14	Roll-mode Time [sec]	<1.00	
15	Spiral Time to Double Amplitude [sec]	>12	
16	Structural Load Factor (+)	7.50g	7.50g
17	Structural Load Factor (-)	(-3g)	(-3g)
18	Max Sustained Normal Load Factor in Level g Turn	5	5
19	Remaining Fuel CAS Mission [gallons]	33.11	68.63
20	Remaining Fuel Ferry Mission [gallons]	14.71	847

LIFE CYCLE COSTS

Category	DT&E Cost	Production Cost
Engines		
Avionics		
Airframe Engineering		
Manufacturing Labor		
Material and Equipment		
Tooling		
Quality Control		
Development Support		
Flight Test & Operations		
Sub Total		
Total		

*Adjusted for USD Jan 2017

	AVG MIL AIRCRAFT	SU-25	A-10	A-X	A-X
Units	N/A	>1000	713	855	200
Unit Cost [USD]					

QUESTIONS?