



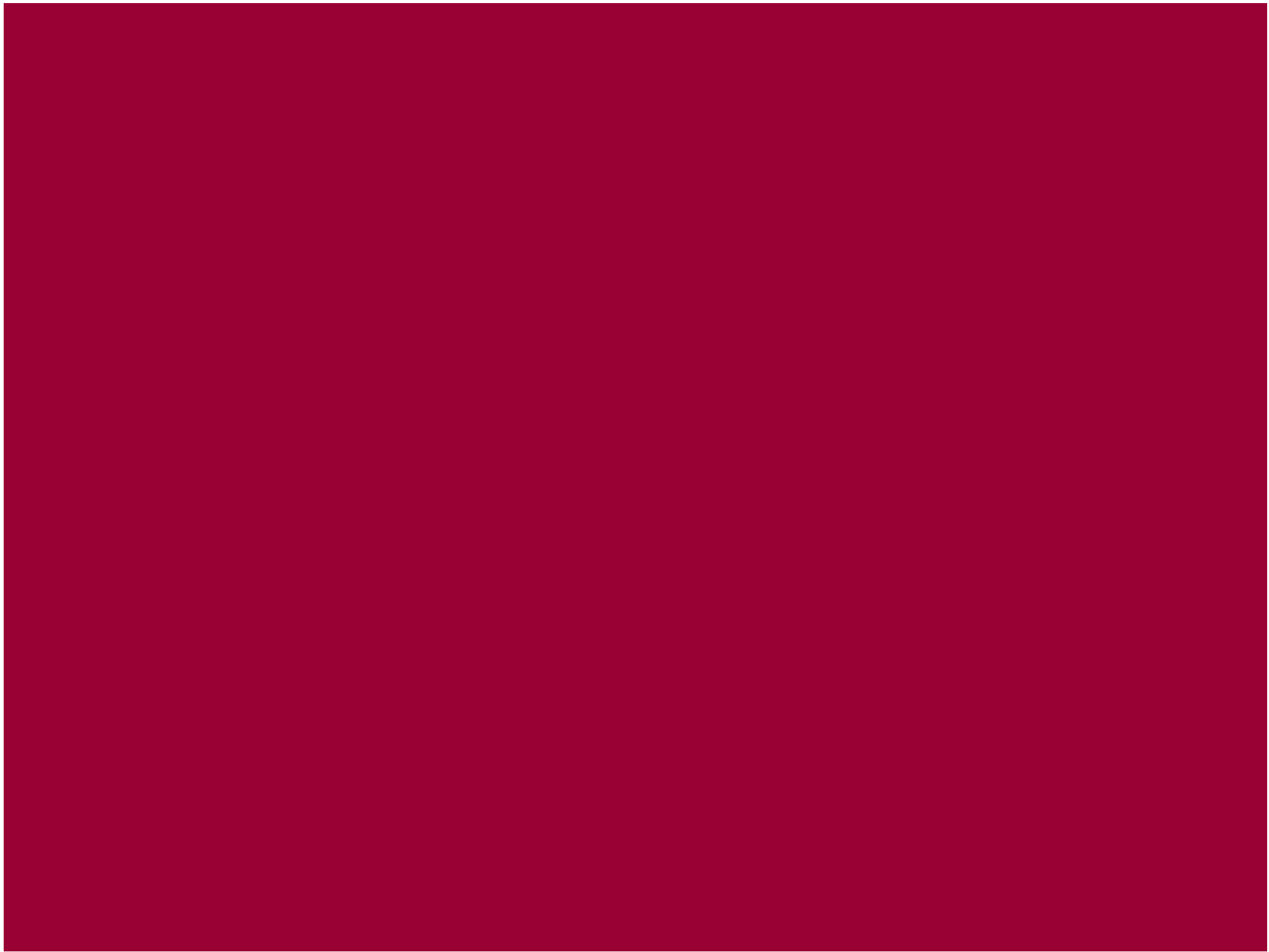
Team 8

Supersonic Business Jet

Design Review



Department of Aerospace Engineering
San Diego State University



Gotta go fast!

Sanik





Supersonic Business Jet
Sanik Mk. 1, Military Variant
OV-1



Design Mission



Specifications



Action Data



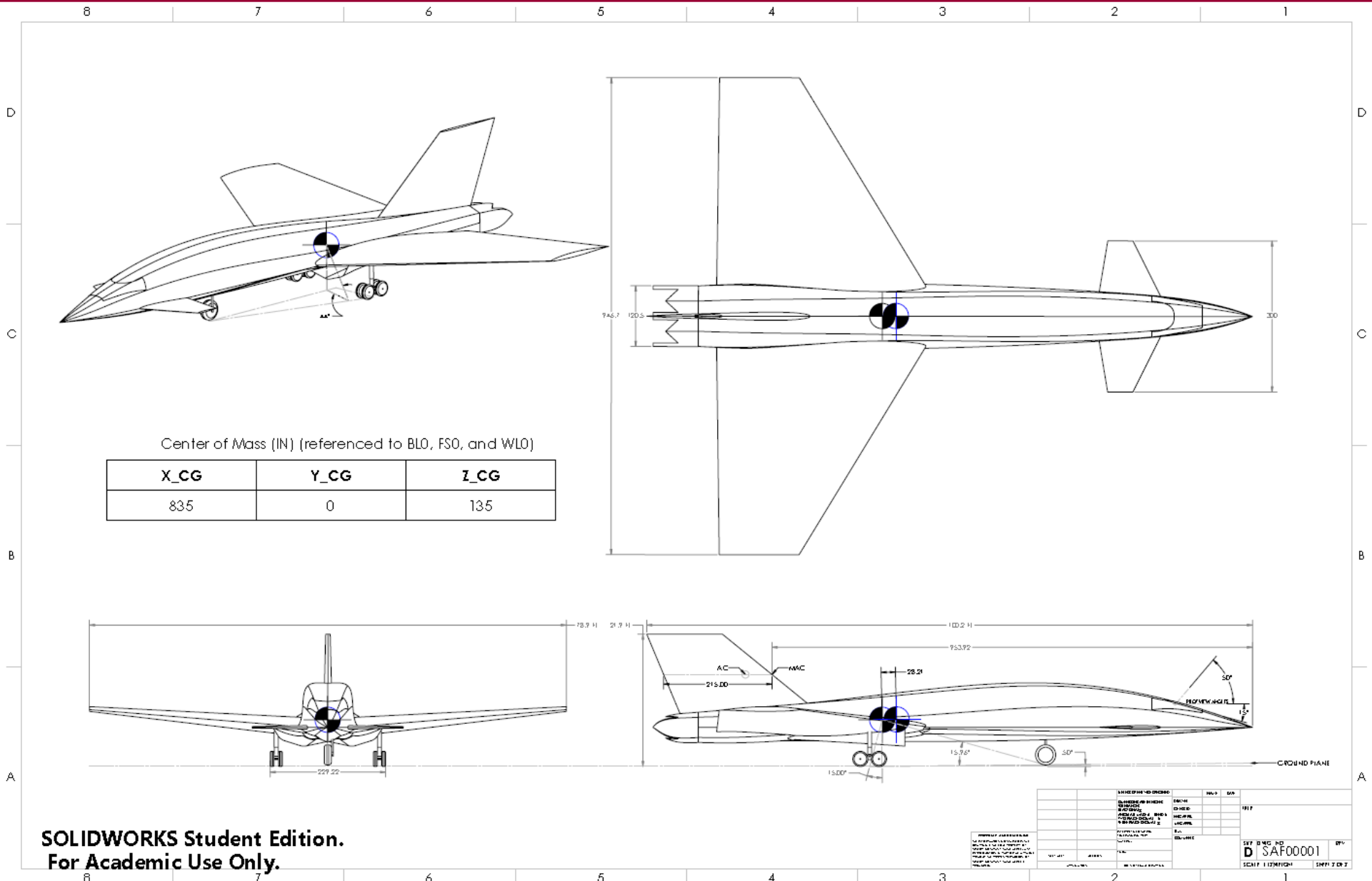
Speed



Range

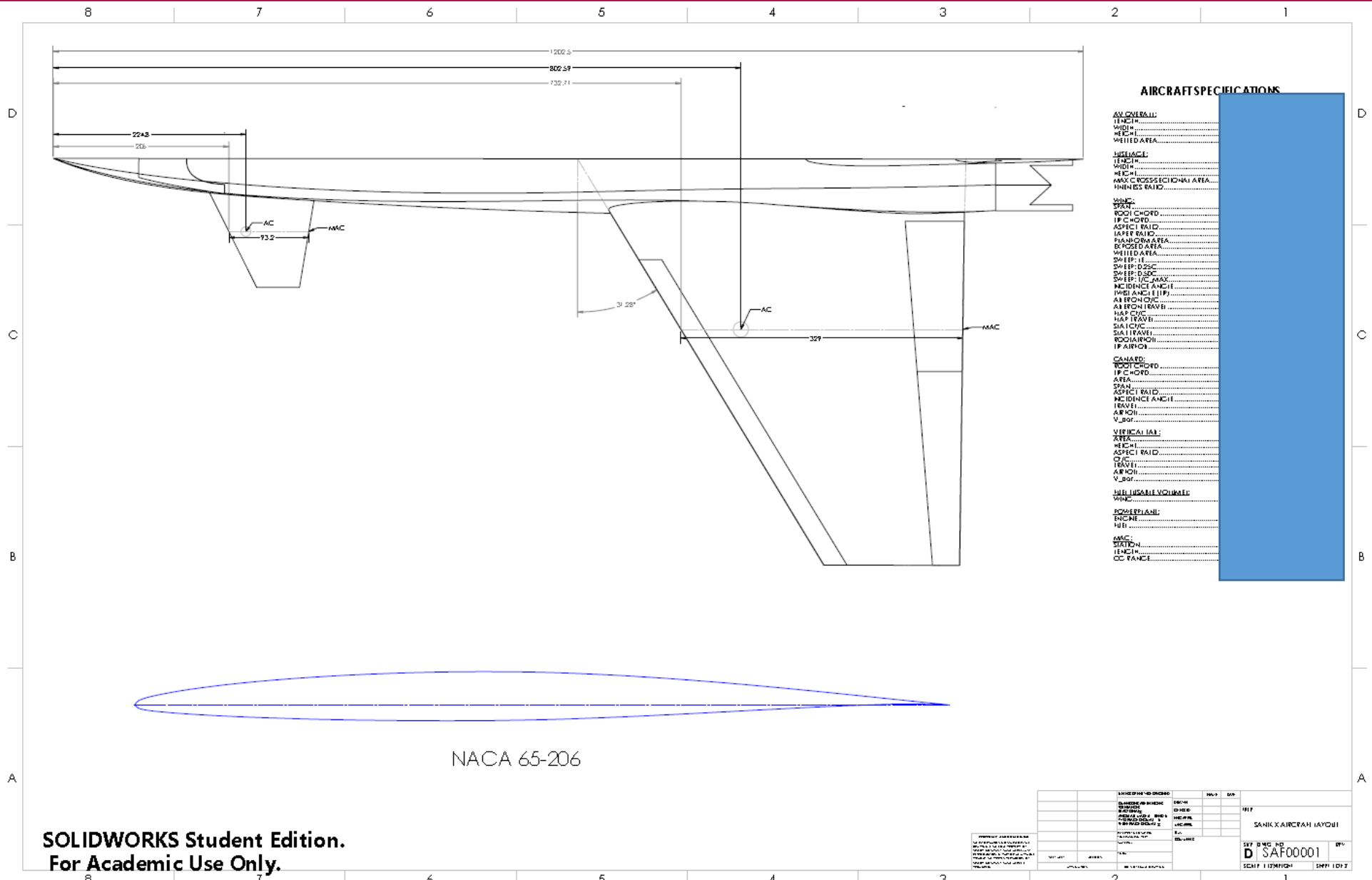


3-View

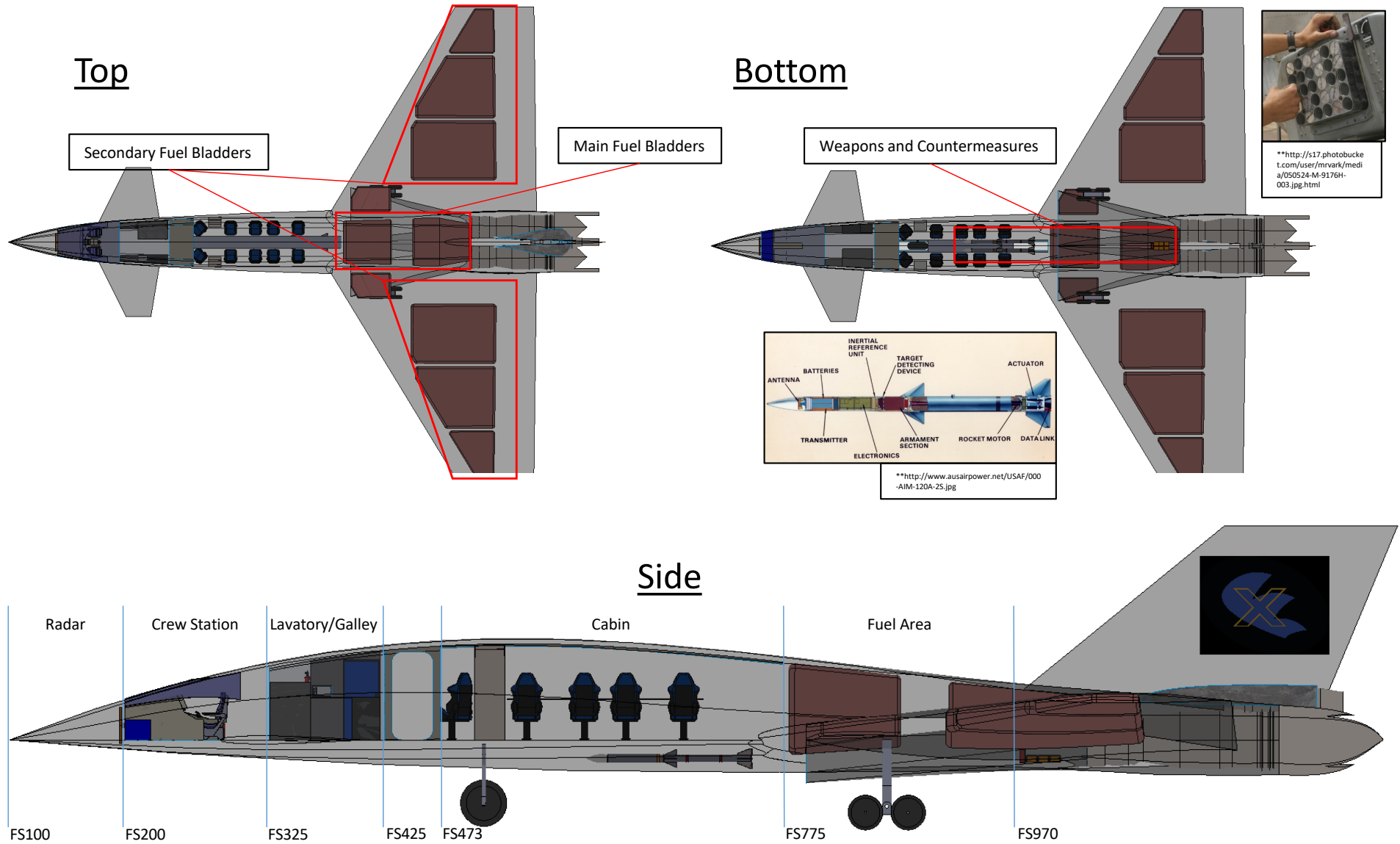


SOLIDWORKS Student Edition.
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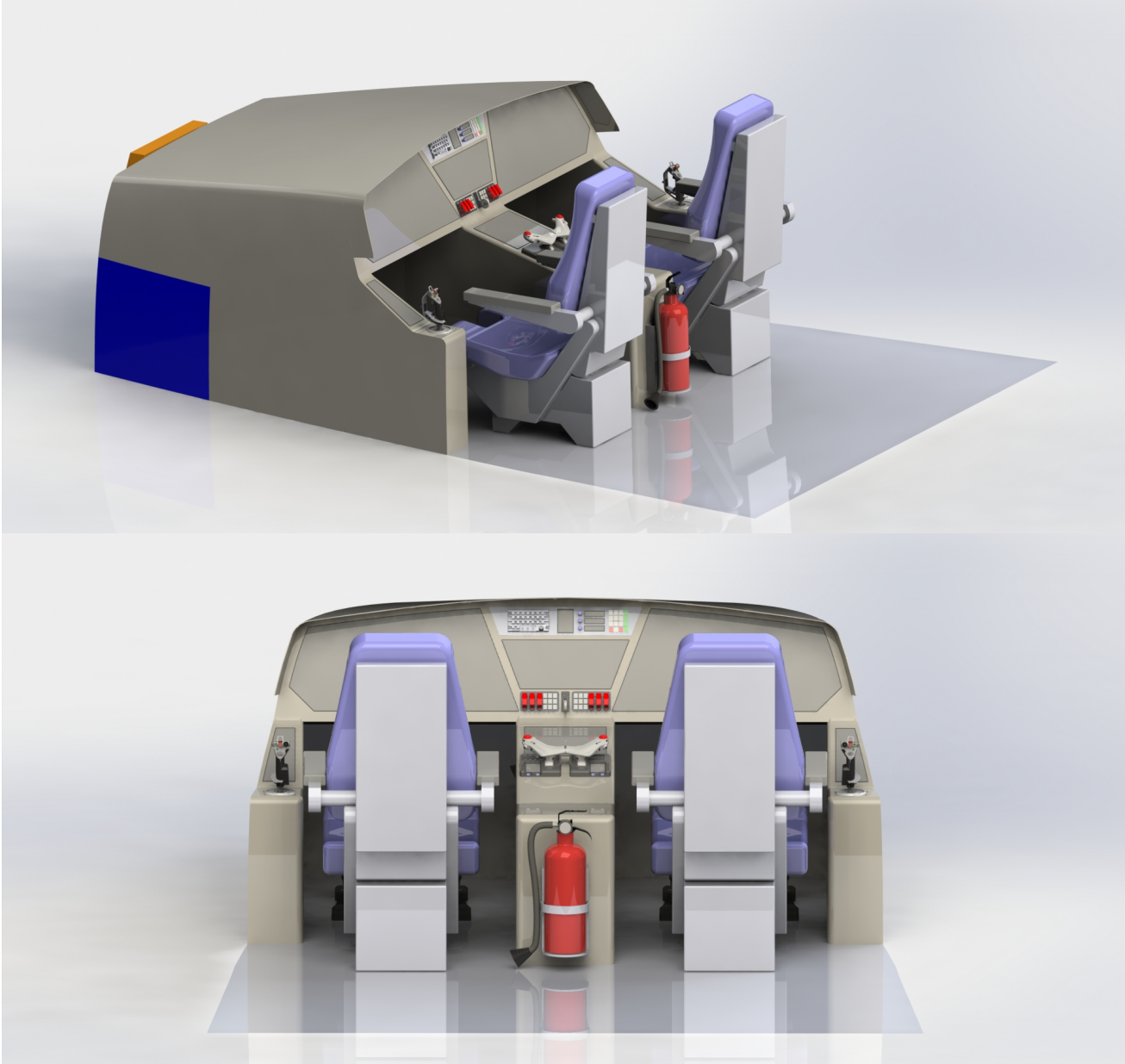
Planform



Inboard Profile



Inboard Profile – Crew Station



Inboard Profile – Cabin (Transport Mode)



Inboard Profile – Cabin (Transport Mode)



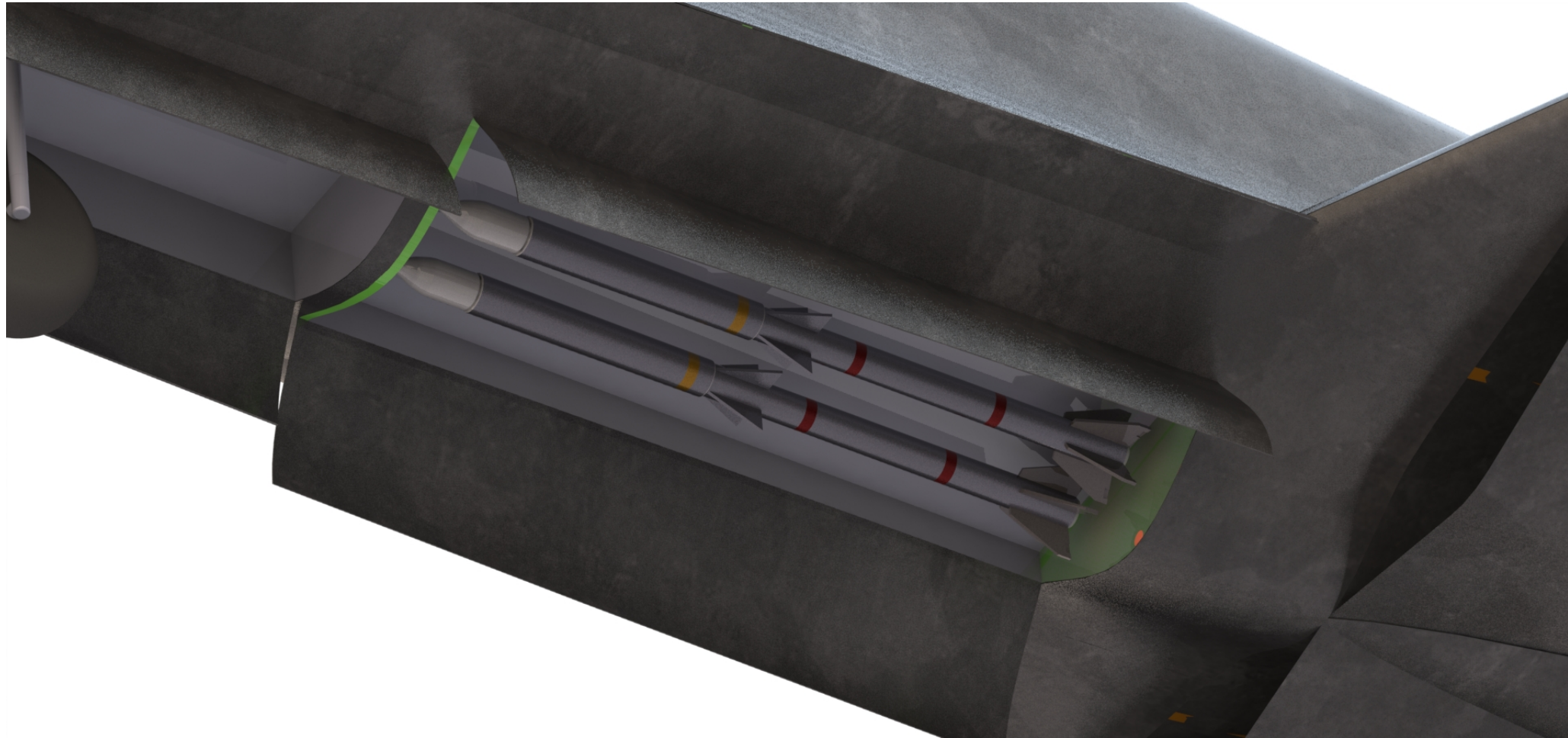
Inboard Profile – Cabin (Conference Mode)



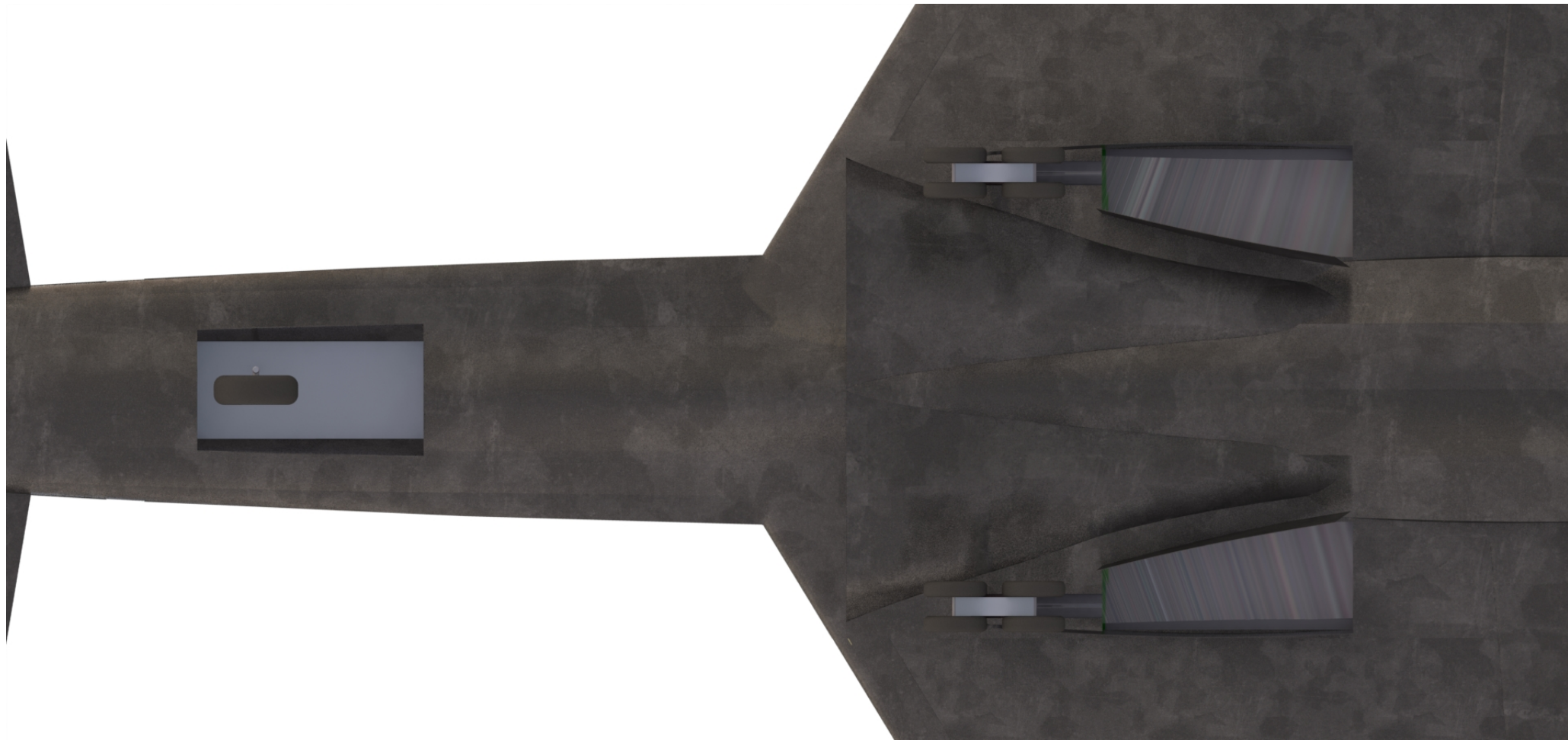
Inboard Profile – Cabin (Conference Mode)



Inboard Profile – Internal AIM-120D



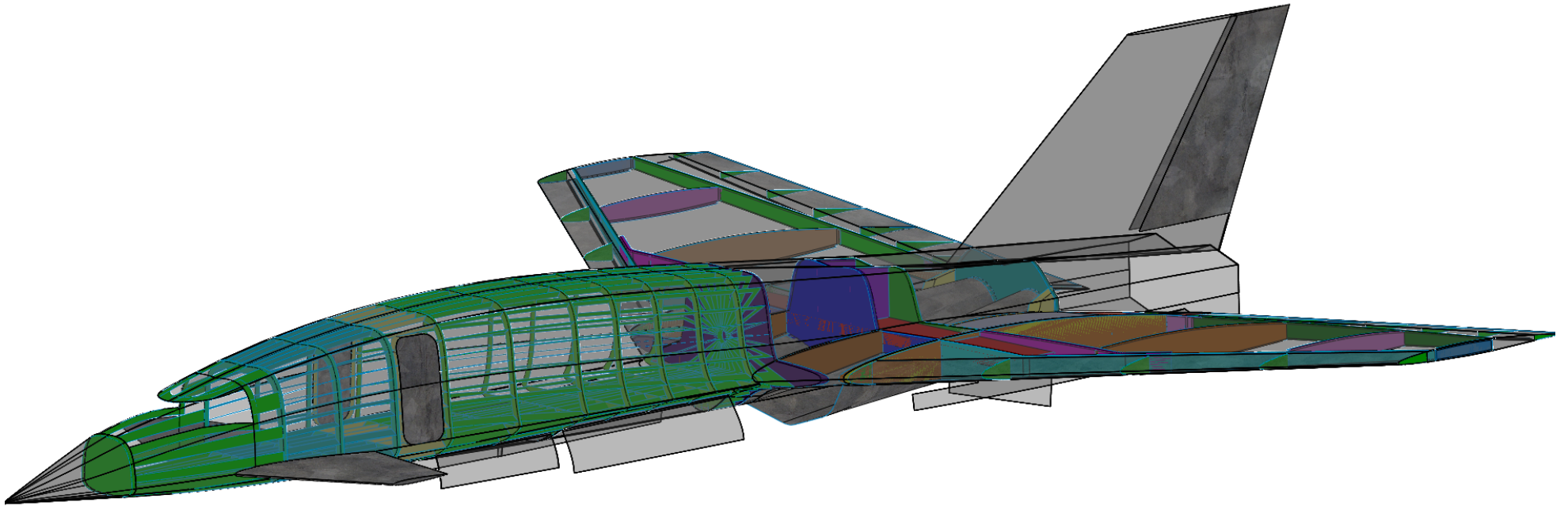
Inboard Profile – Landing Gear (Down)



Inboard Profile – Landing Gear (Up)

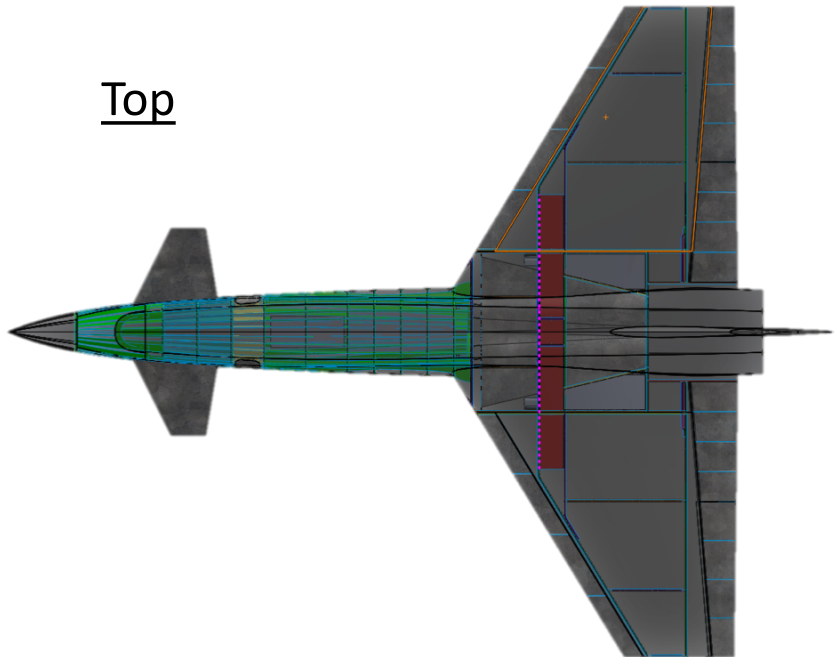


Structural Layout

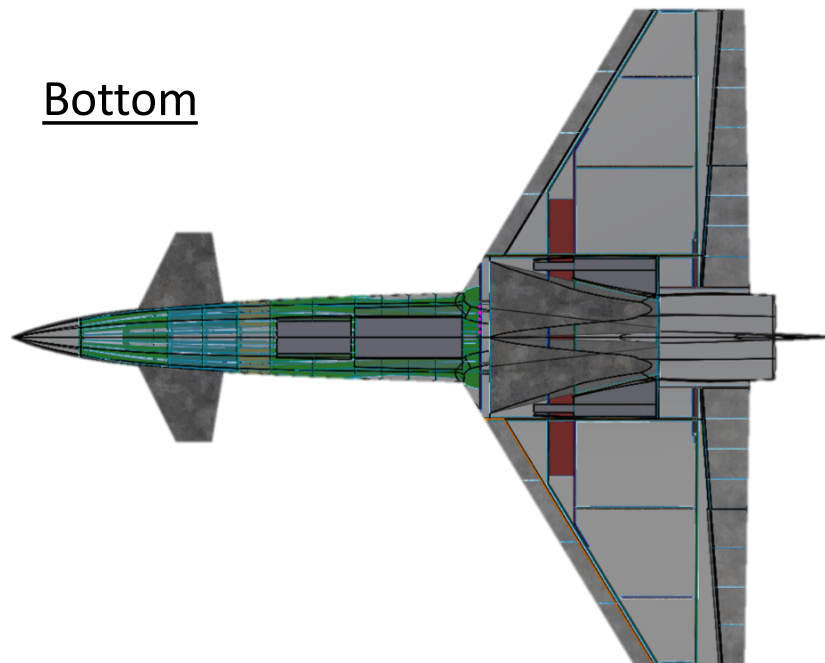


Structural Layout

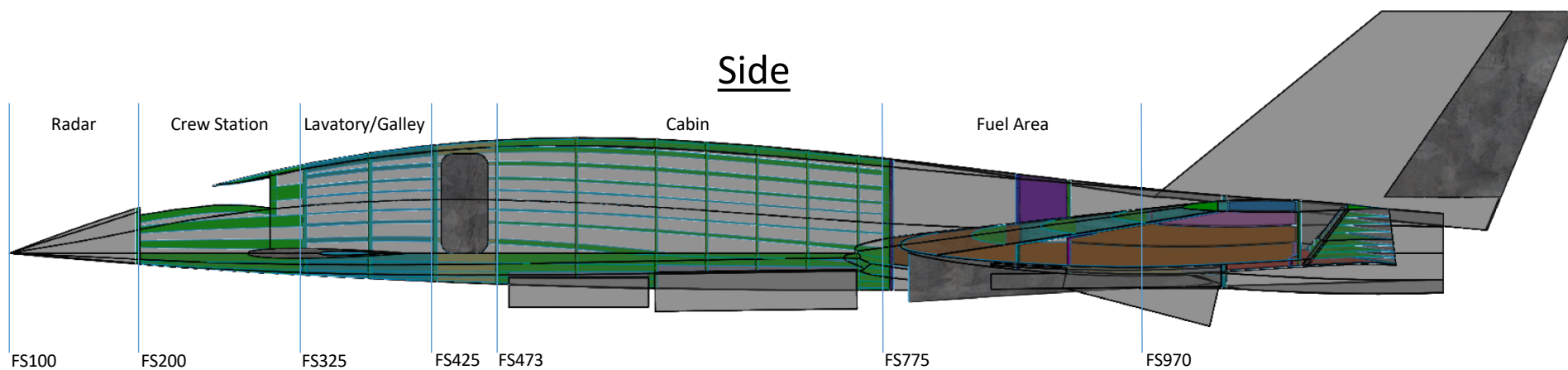
Top



Bottom



Side



Mass Properties

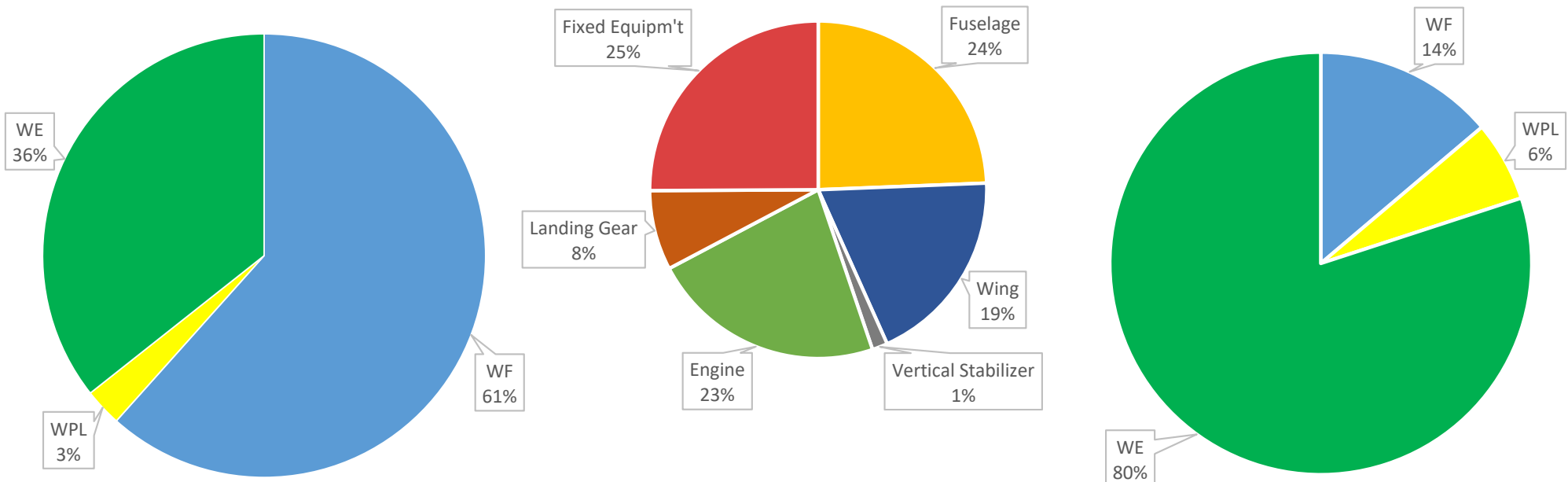
Aircraft Weight (Full Fuel)		Weight (lb)
Operating Empty Weight (WOE)		[Blue Bar]
Empty Weight (WE)		
Trapped Fuel and Oil (Wtfo)		
Crew Weight (WCREW)		
Fuel (WF)		[Blue Bar]
WOE + 60% fuel		
WOE + WF		
Payload Weight (WPL)		
WOE + WF + WPL		

Aircraft Weight (10% Fuel)		Weight (lb)
Operating Empty Weight (WOE)		[Blue Bar]
Empty Weight (WE)		
Trapped Fuel and Oil (Wtfo)		
Crew Weight (WCREW)		
Fuel (WF)		[Blue Bar]
WOE + 60% fuel		
WOE + WF		
Payload Weight (WPL)		
WOE + WF + WPL		

Aircraft Weight w/ Full Fuel Breakdown

Empty Weight Breakdown

Aircraft Weight w/ 10% Fuel Breakdown



Mass Properties & Moments of Inertia

Target C.G.		
XCG	YCG	ZCG
in	in	in
835	0	135

Current CG		
XCG	YCG	ZCG
in	in	in
839.64	0	140.78

CG at 10% Fuel		
XCG	YCG	ZCG
in	in	in
805.28	0	129.91

CG at % MAC w/ Full Fuel
2.11%

CG at % MAC w/ 10% Fuel
-8%

Ref CS	ΣI_{xx}	ΣI_{yy}	ΣI_{zz}	ΣI_{xz}
	lb-in ²	lb-in ²	lb-in ²	lb-in ²

Body CS at CG	ΣI_{xxB}	ΣI_{yyB}	ΣI_{zzB}	ΣI_{xzB}
	lb-in ²	lb-in ²	lb-in ²	lb-in ²

Aerodynamics

NACA 65206

Re: 20

S_{REF} :

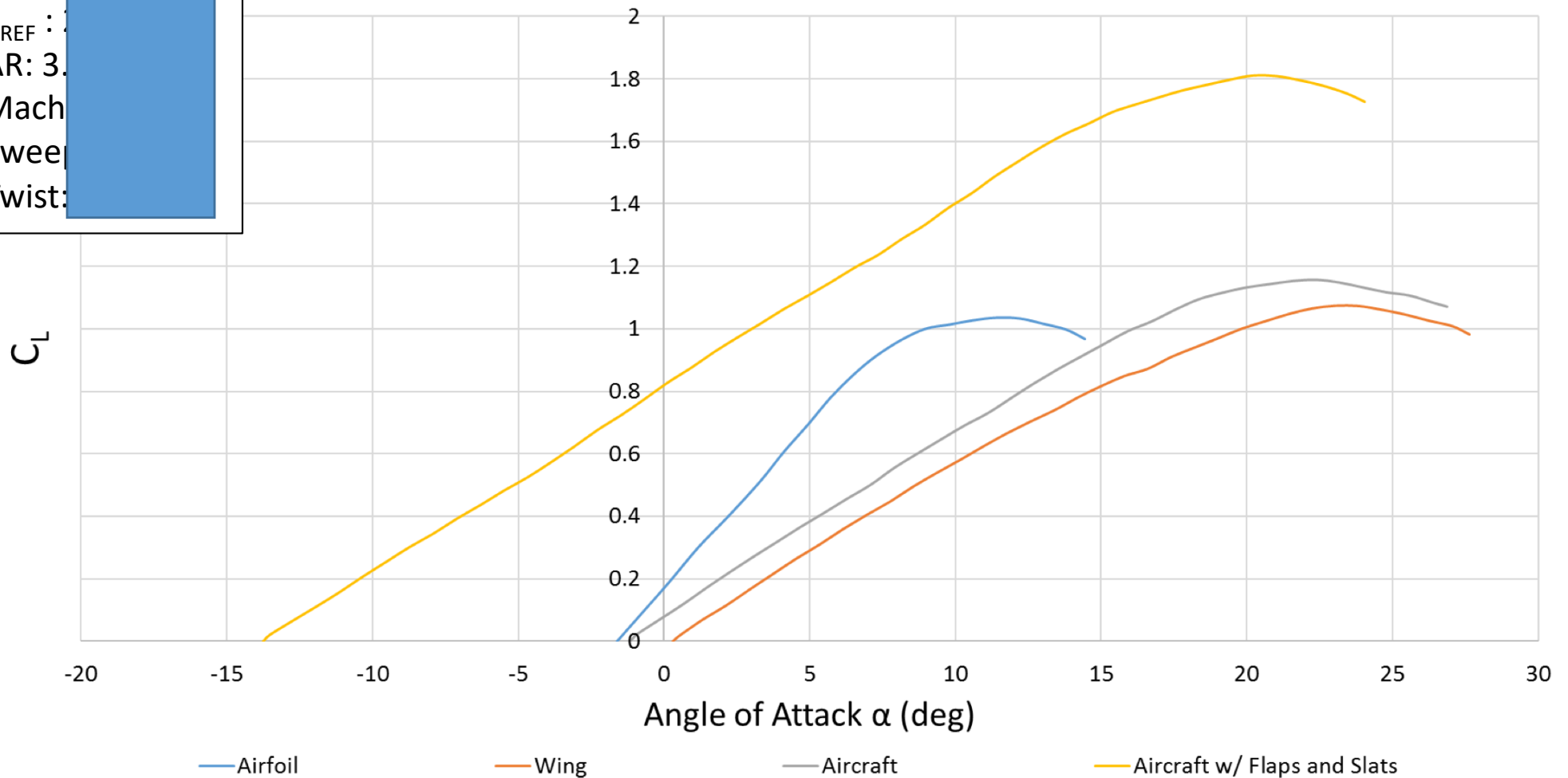
AR: 3

Mach

Sweep

Twist:

TO Lift Curves



Aerodynamics

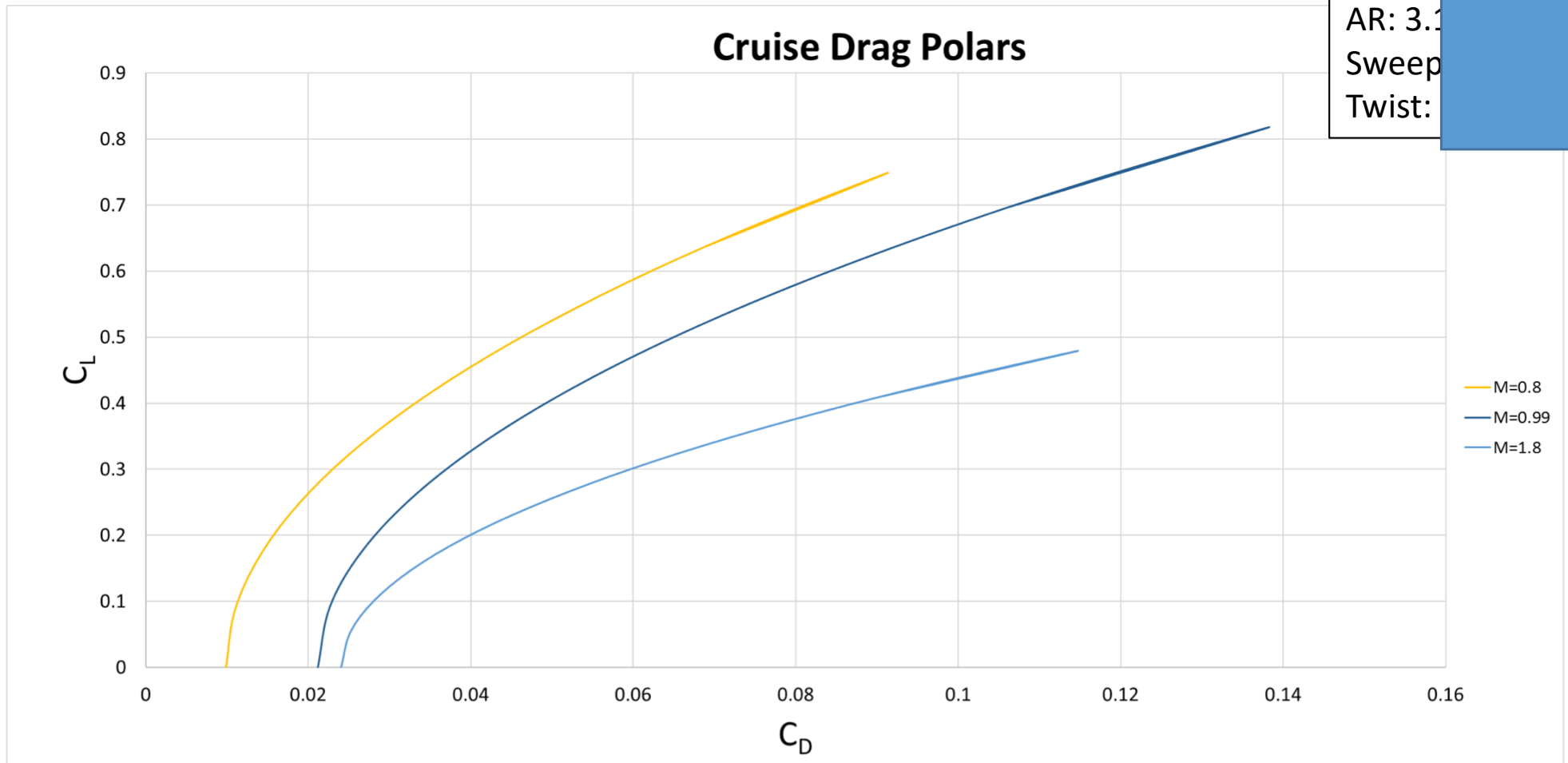
NACA

$S_{REF} : 2$

AR: 3.1

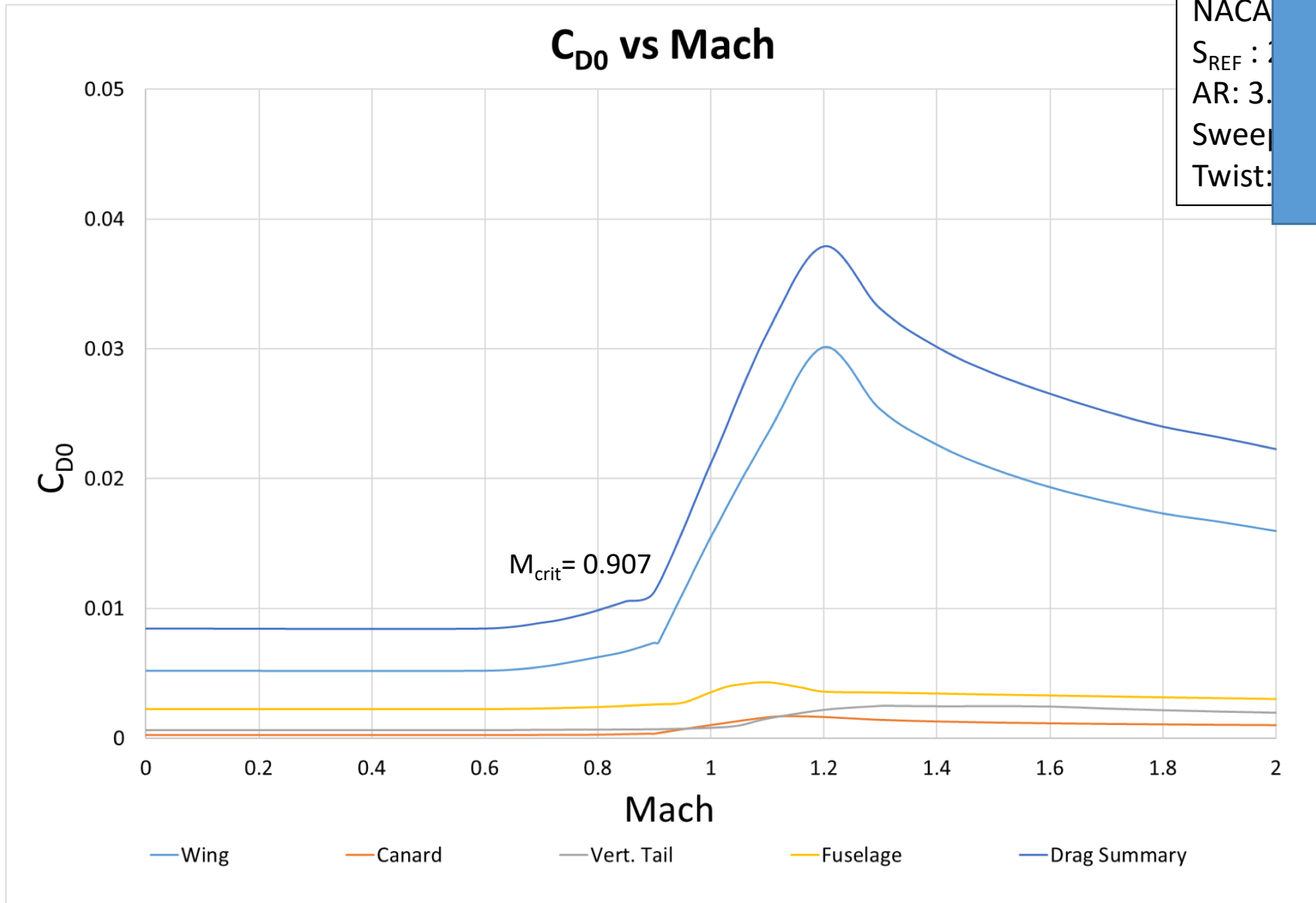
Sweep

Twist:



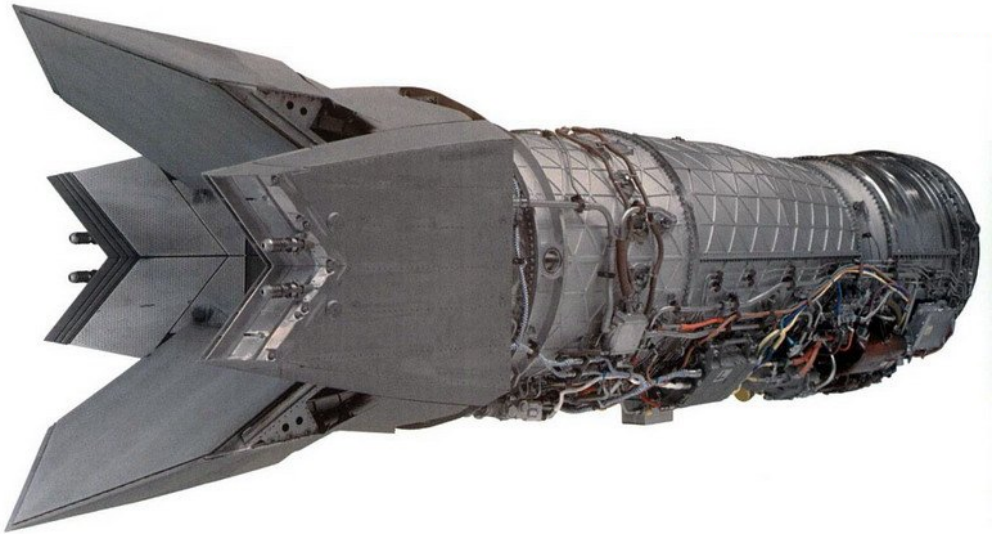
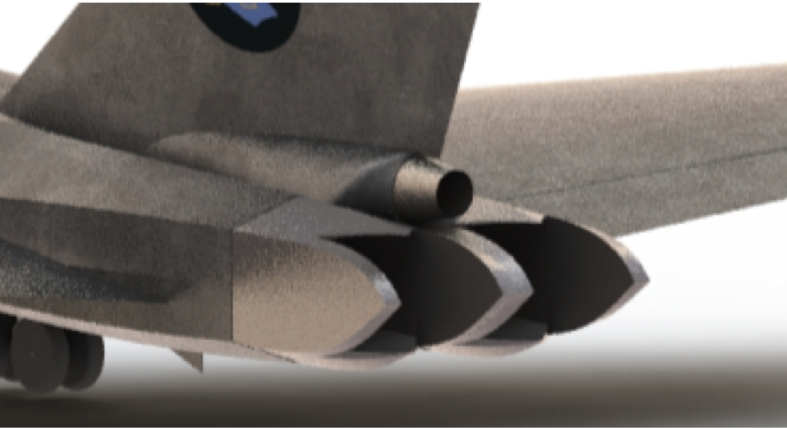
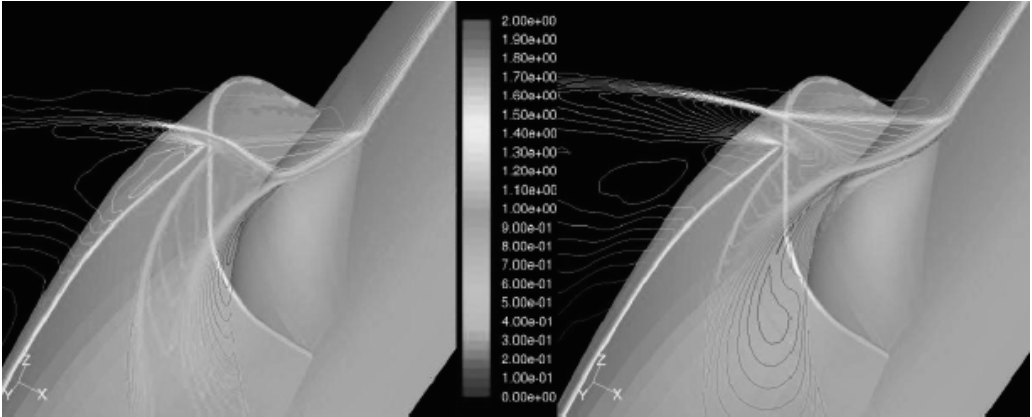
Aerodynamics

NACA
 $S_{REF} : 2$
AR: 3.0
Sweep
Twist:



Engines

F 119-PW-100	
Rubberization	
Weight	
Length	
Diameter	
Capture Areas	
	Max
	Min
Inlet type used	Diverterless Supersonic Inlet
Nozzle type used	Mk I: Variable Ejectors

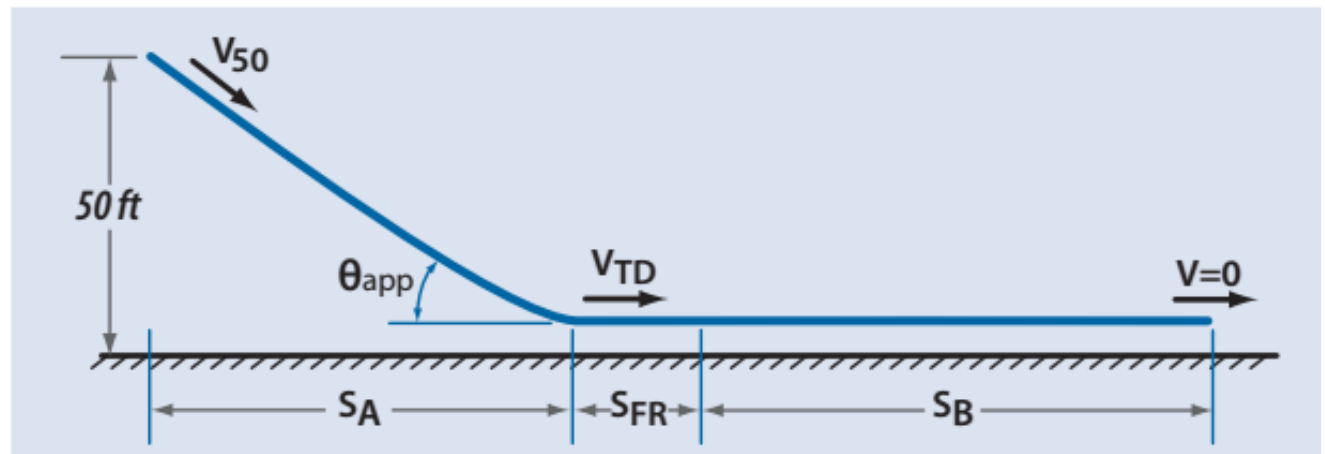
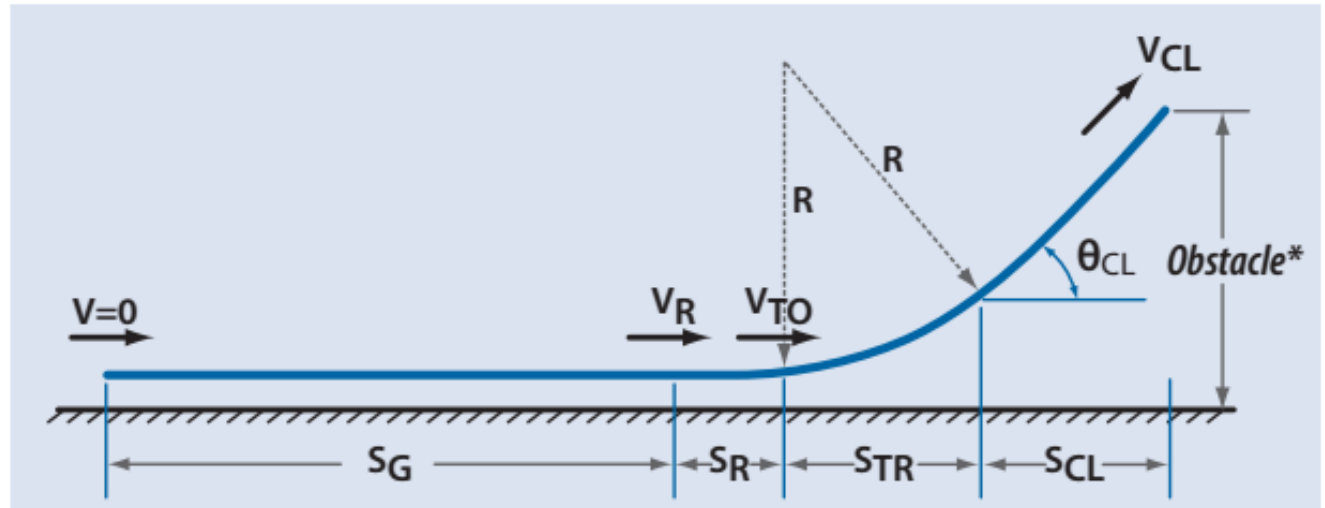


Performance

Summary of Take Off Analysis at Sea Level			
S_G (ft)	1656	θ_{CL} (deg)	25
S_R (ft)	408	V_{TO} (kts)	121
S_{TR} (ft)	3596	t_G (s)	16
S_{Cl} (ft)	33	t_{TR} (s)	18
S_{TO} (ft)	5693	t_{TO} (s)	34

Summary of Take Off Analysis at 5k			
S_G (ft)	2151	θ_{CL} (deg)	25
S_R (ft)	465	V_{TO} (kts)	138
S_{TR} (ft)	4670	t_G (s)	19
S_{Cl} (ft)	33	t_{TR} (s)	20
S_{TO} (ft)	7318	t_{TO} (s)	39

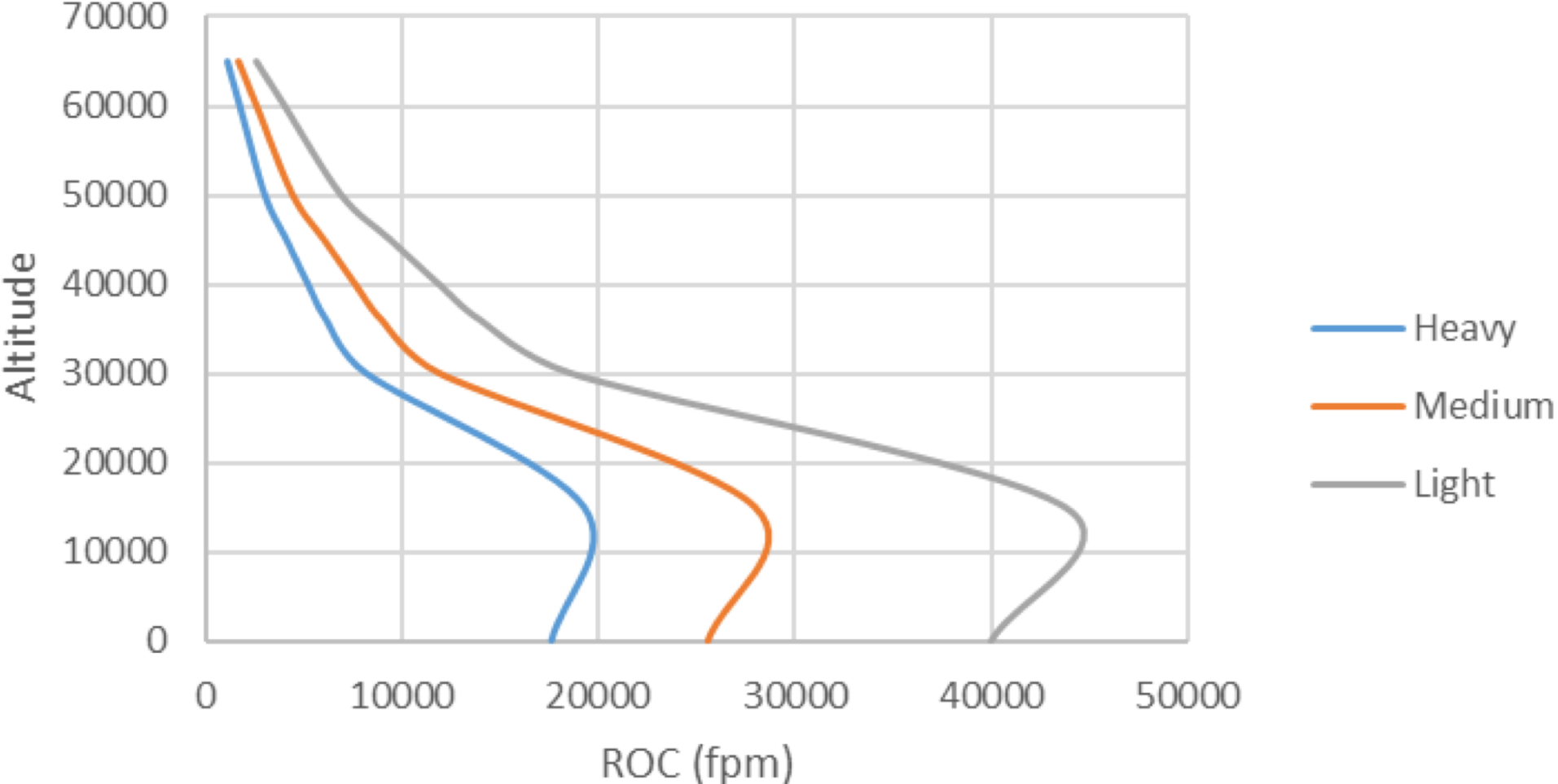
Landing Analysis Summary Sea Level			
S_A	166 ft		
S_{FR}	525 ft		
S_B	3808 ft		
V_{50} (ft/s)	185	V_{50} (kts)	110
V_{TD} (ft/s)	175	V_{TD} (kts)	104



Performance

Altitude vs Rate of Climb

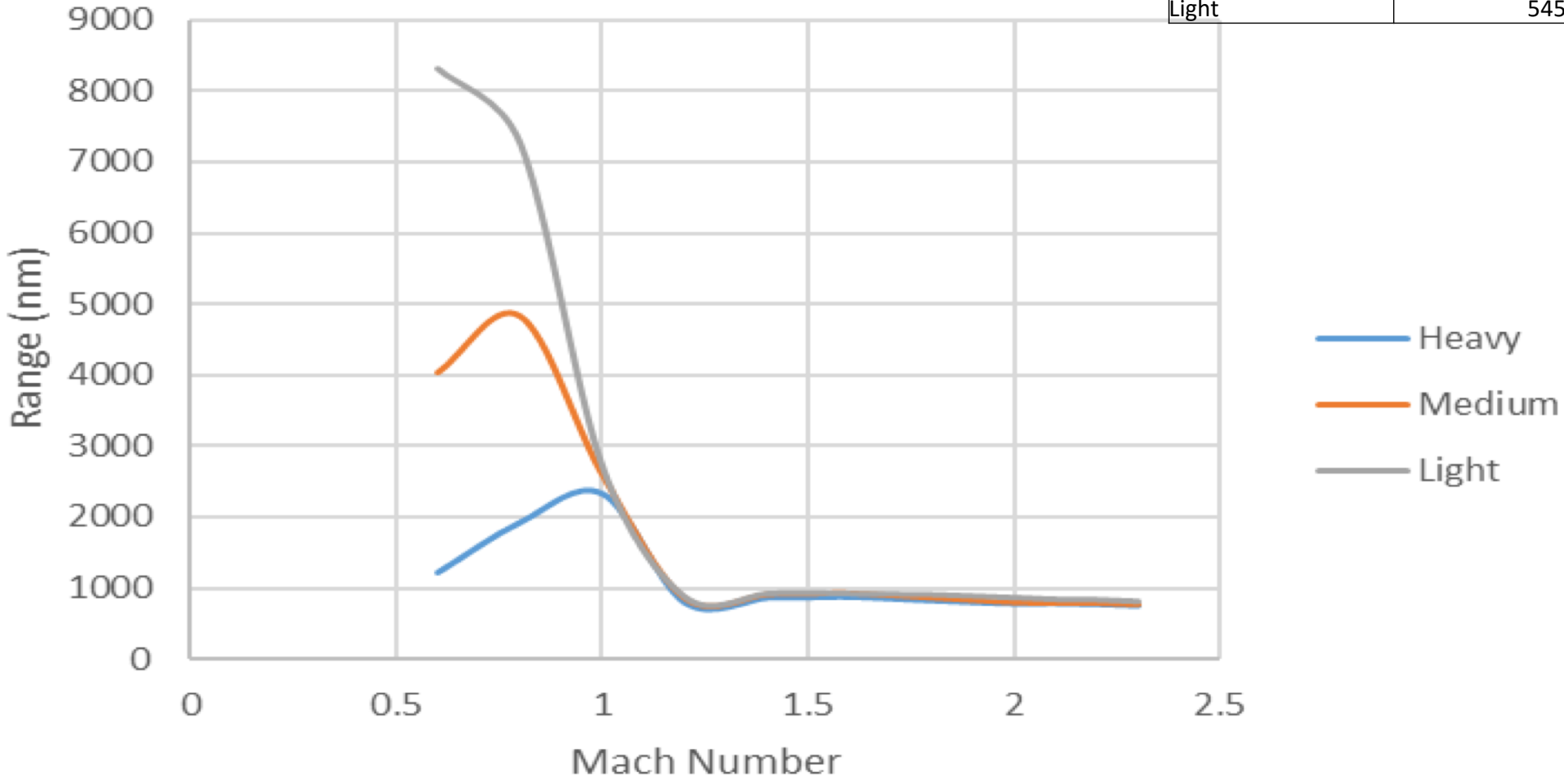
Cruise Weights (lbs)	
Heavy	124130
Medium	85480
Light	54560



Performance

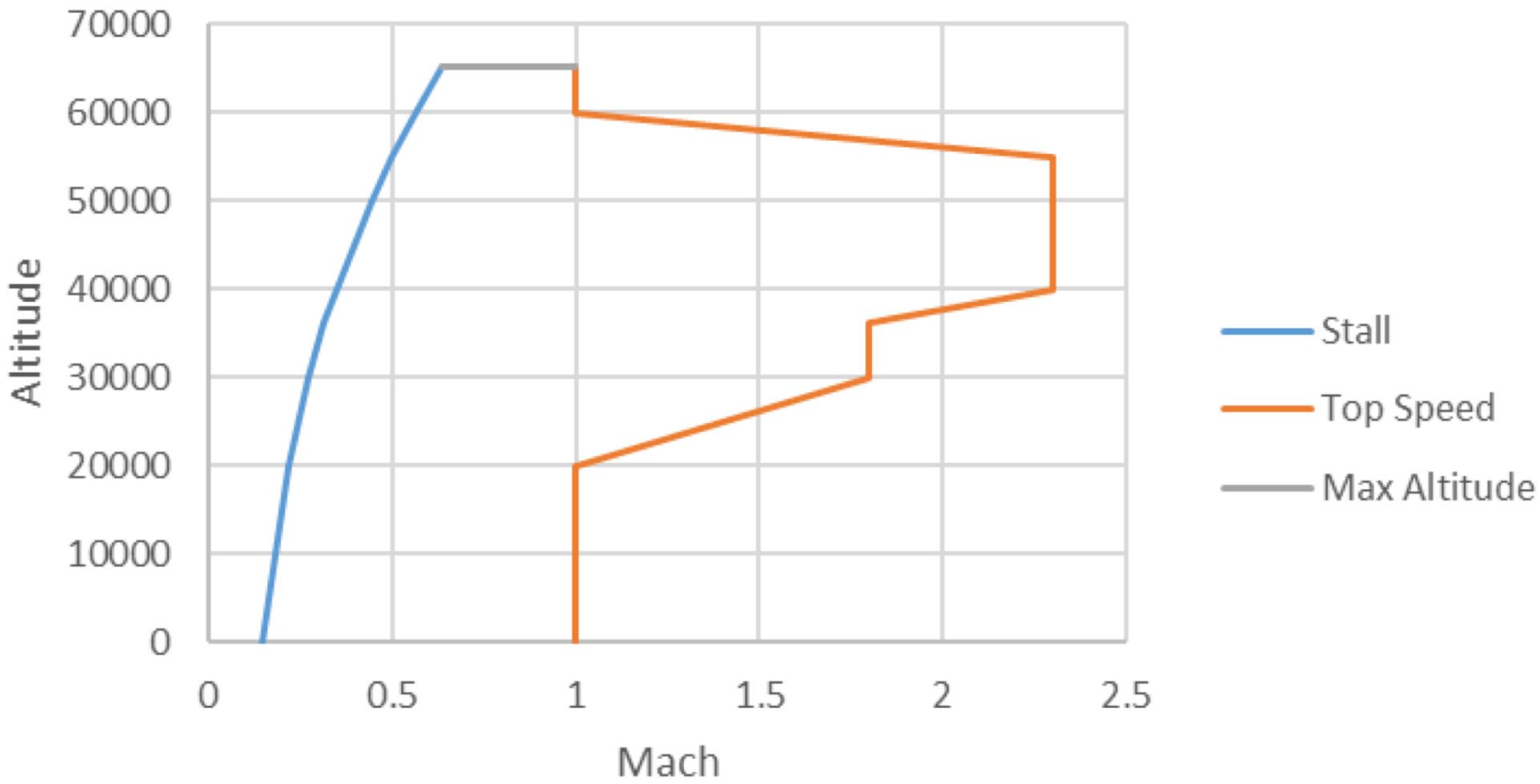
Range vs Mach Number at 40000 Feet Configuration: Clean

Cruise Weights (lbs)	
Heavy	124130
Medium	85480
Light	54560



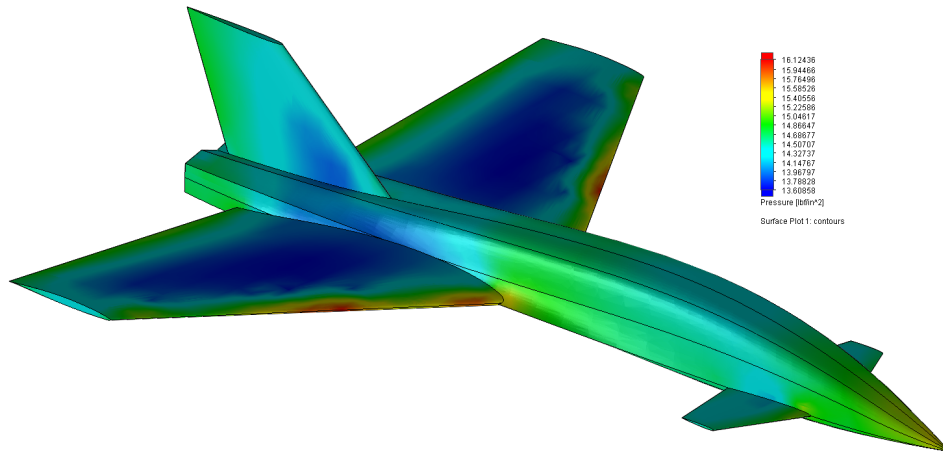
Performance

Flight Envelope

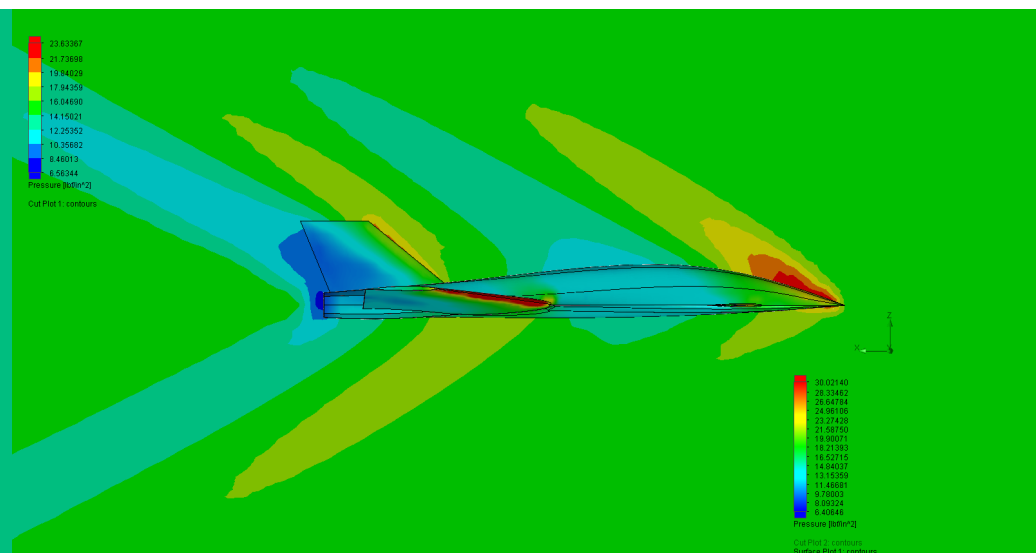
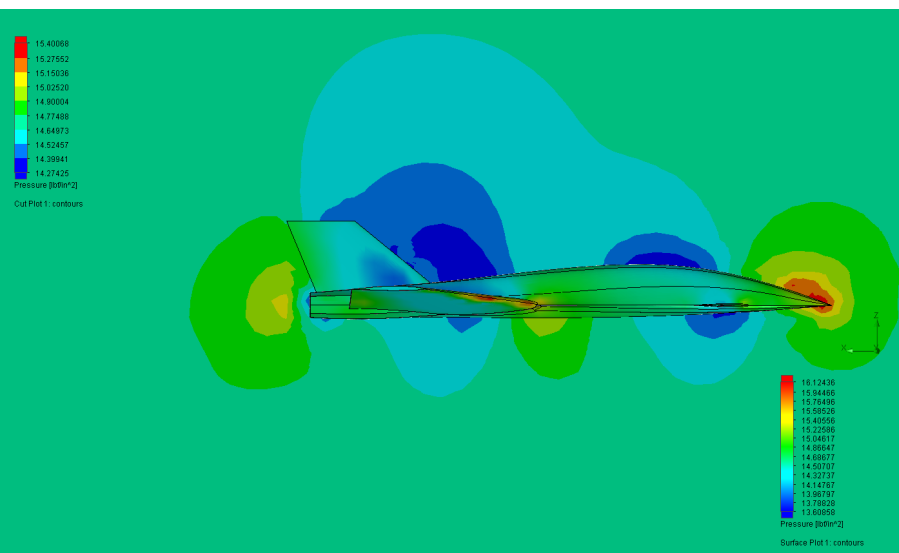
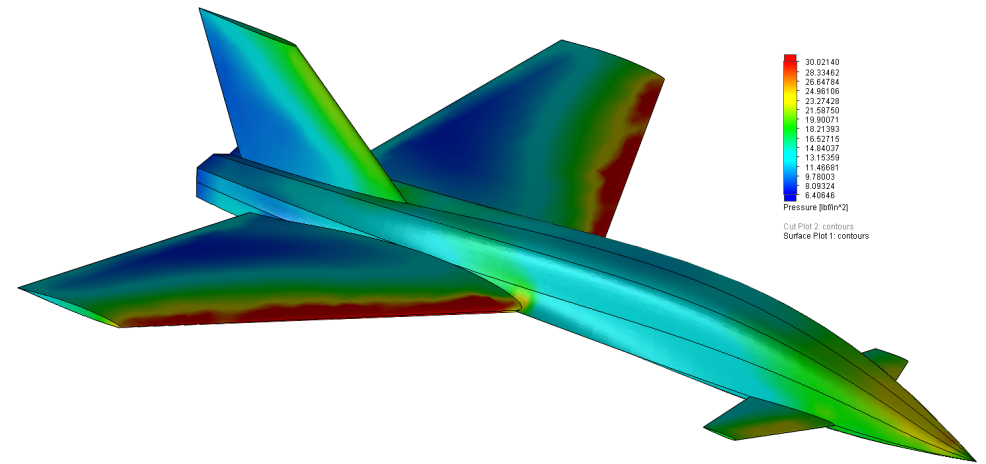


Loads/CFD

Mach 0.8



Mach 1.92



Stability and Control

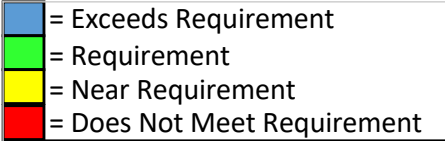
Stability Derivatives @ Long Range Cruise M=0.8
Alt=40,000ft

	C_D	C_L	C_m	C_y	C_l	C_n		C_{T_x}
α								
$\dot{\alpha}$								
u								
q								
r								
p								
β								

Stability and Control

Stability Results @ Long Range Cruise

M=0.8 Alt=40000ft

 = Exceeds Requirement = Requirement = Near Requirement = Does Not Meet Requirement	Damping Ratio	Natural Frequency	Time
Phugoid	[Blue shaded area indicating 'Exceeds Requirement']		
Short Period			
Dutch Roll			
Roll Mode			
Spiral to 2*A			

Life Cycle Costs

Total DT&E cost [\$(2017)]	
Airframe Engineering	[Redacted]
Development Support	
Engines	
Avionics	
Manufacturing Labor	
Material and Equipment	
Tooling	
Quality Control	
Flight Test Operations	
Test Facilities	
Subtotal	

Total Production and Unit Cost [\$(2017)]	
Engines	[Redacted]
Avionics	
Manufacturing Labor	
Material and Equipment	
Sustaining Engineering	
Tooling	
Quality Control	
Manufacturing Facilities	
Subtotal for 200 Aircraft	

Requirements Summary

SRD	ID	Requirement	Allocation						Required	Desired	Achieved
			Proj Man	Aero	Performance	StabCon	Structures	Subsystems			
3.1.1	SBJ-1	Crew Members	X					X	3	N/A	Y
3.1.2	SBJ-2	Pressurized Cabin (7500 ft @ 60000 ft)	X					X	Y	N/A	Y
3.1.3	SBJ-3	Passengers	X					X	10-19	N/A	10
3.1.4	SBJ-4	Galley	X					X	1	N/A	Y
3.1.5	SBJ-5	Lavatory	X					X	1	N/A	Y
3.2.1	SBJ-6	Engines	X	X				X	>=2 turbojet	N/A	2 + 1 optional
3.2.2	SBJ-7	Self-contained Onboard Start	X					X	Y	N/A	Y
3.2.3	SBJ-8	Fuel Dump	X					X	Y	N/A	Y
3.4.1	SBJ-9	Structural Load Factor (14CFR25.321)					X	X	2.5	N/A	2.5
3.8.1	SBJ-10	Completes Design Mission (See Figure 1-*)	X	X	X				Y	N/A	Y
3.8.2	SBJ-11	Maximum Airspeed (M) (55000 ft)		X	X				2.0	2.2	2.3
3.8.3	SBJ-12	Service Ceiling		X	X				65000 ft	N/A	67700 ft
3.8.4	SBJ-13	Range		X	X				4000 NM	4600 NM	4800 NM
3.8.5	SBJ-14	Endurance		X	X				None Specified	N/A	10 hr 45 min
3.8.6	SBJ-15	Sustained Maneuver Load Factor (14CFR25.337)		X			X		2.5	N/A	2.5
3.8.7	SBJ-16	Approach Speed (14CFR25.125)		X	X				>1.23V_SR0	N/A	110 kt
3.8.8	SBJ-17	Maximum Landing Distance (14CFR25.125)			X				Set	N/A	4499 ft
3.8.9	SBJ-18	Maximum Takeoff Run Critical Field Length (14CFR25.113)		X	X	X			Set	N/A	3879 ft
3.8.10	SBJ-19	Rate of Climb, One Engine Inoperative (14CFR25.121)		X	X				>2.4% gradient	N/A	3.98% gradient
4.1.1	SBJ-20	C_mCG α				X			<0	N/A	
4.1.1	SBJ-21	Short Period Damping Ratio				X			0.25-2.0	0.35-1.3	
4.1.1	SBJ-22	Phugoid Damping Ratio				X			>0	>0.04	
4.1.2	SBJ-23	Dutch Roll Damping Ratio				X			>0.02	>0.4	
4.1.2	SBJ-24	Dutch Roll Undamped Natural Frequency				X			>0.4	>1.0	
4.1.2	SBJ-25	Roll-mode Time Constant				X			<1.4 sec	<1.0 sec	
4.1.2	SBJ-26	Spiral Time to Double Amplitude				X			>8 sec	>12 sec	