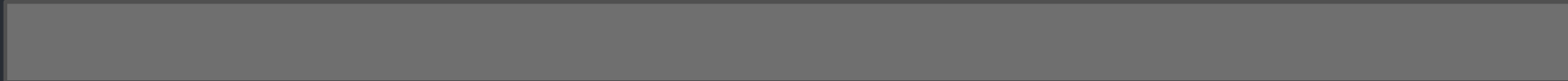
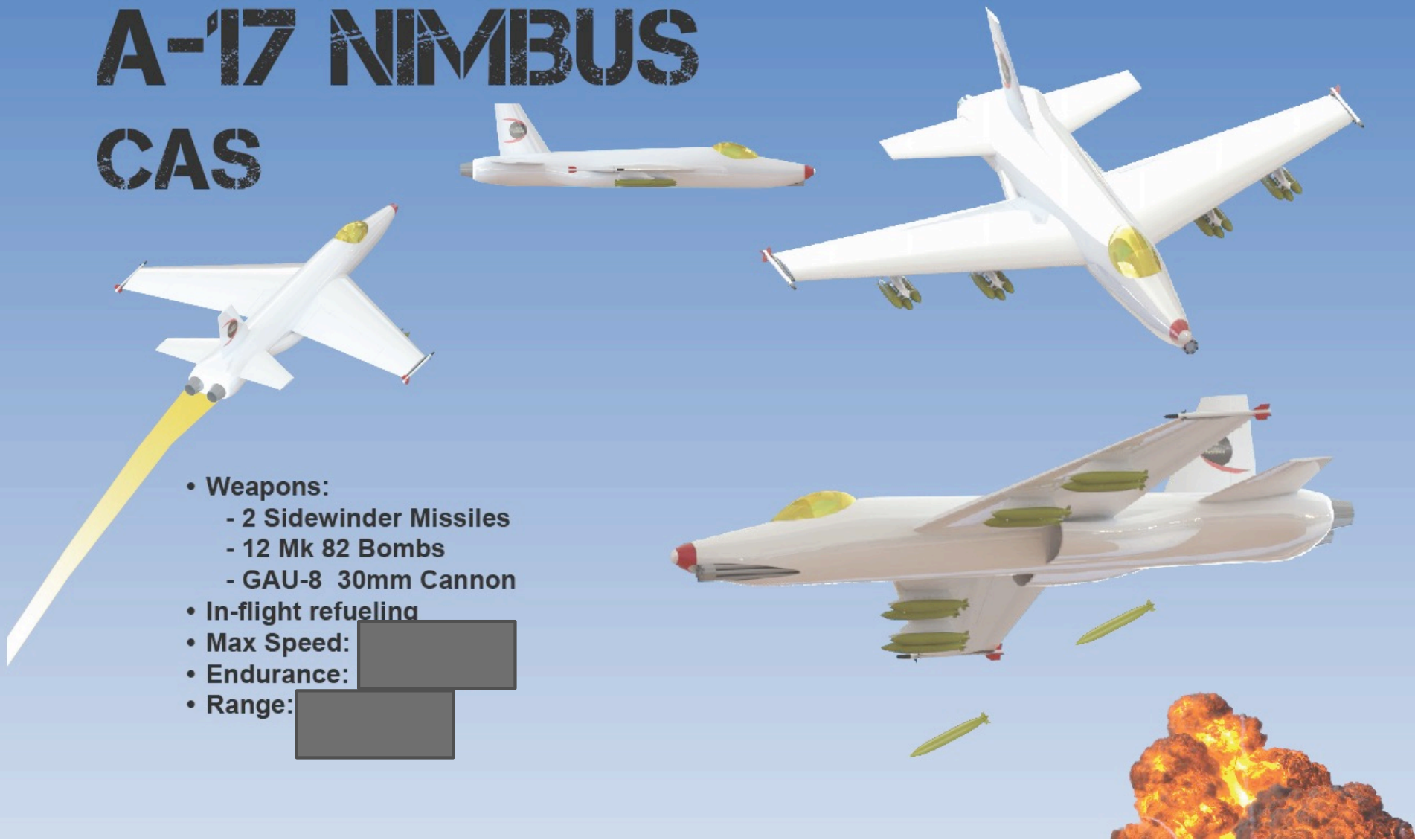


# TEAM 5: TBM AEROSPACE



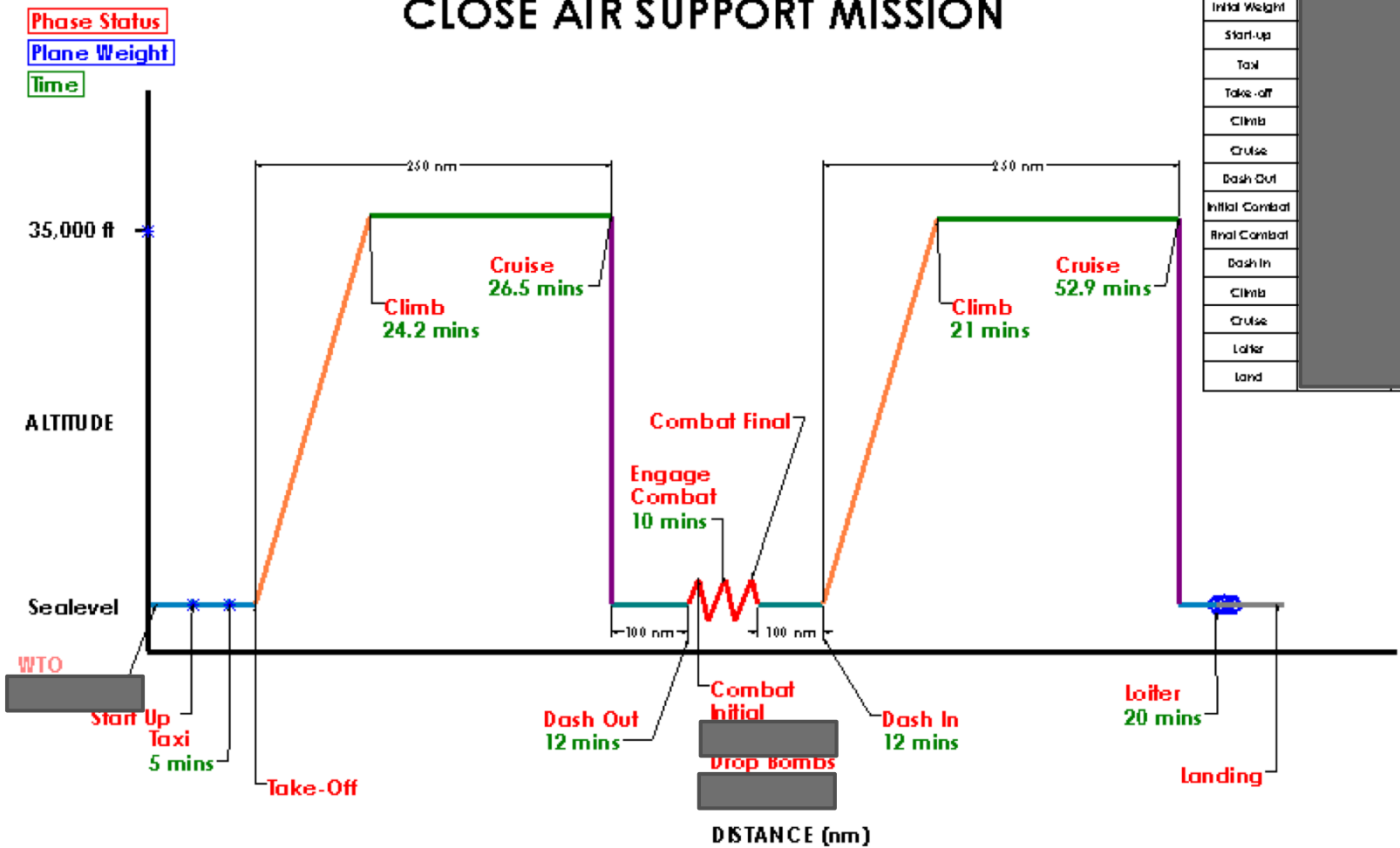
# A-17 NIMBUS

## CAS



- Weapons:
  - 2 Sidewinder Missiles
  - 12 Mk 82 Bombs
  - GAU-8 30mm Cannon
- In-flight refueling
- Max Speed: [REDACTED]
- Endurance: [REDACTED]
- Range: [REDACTED]

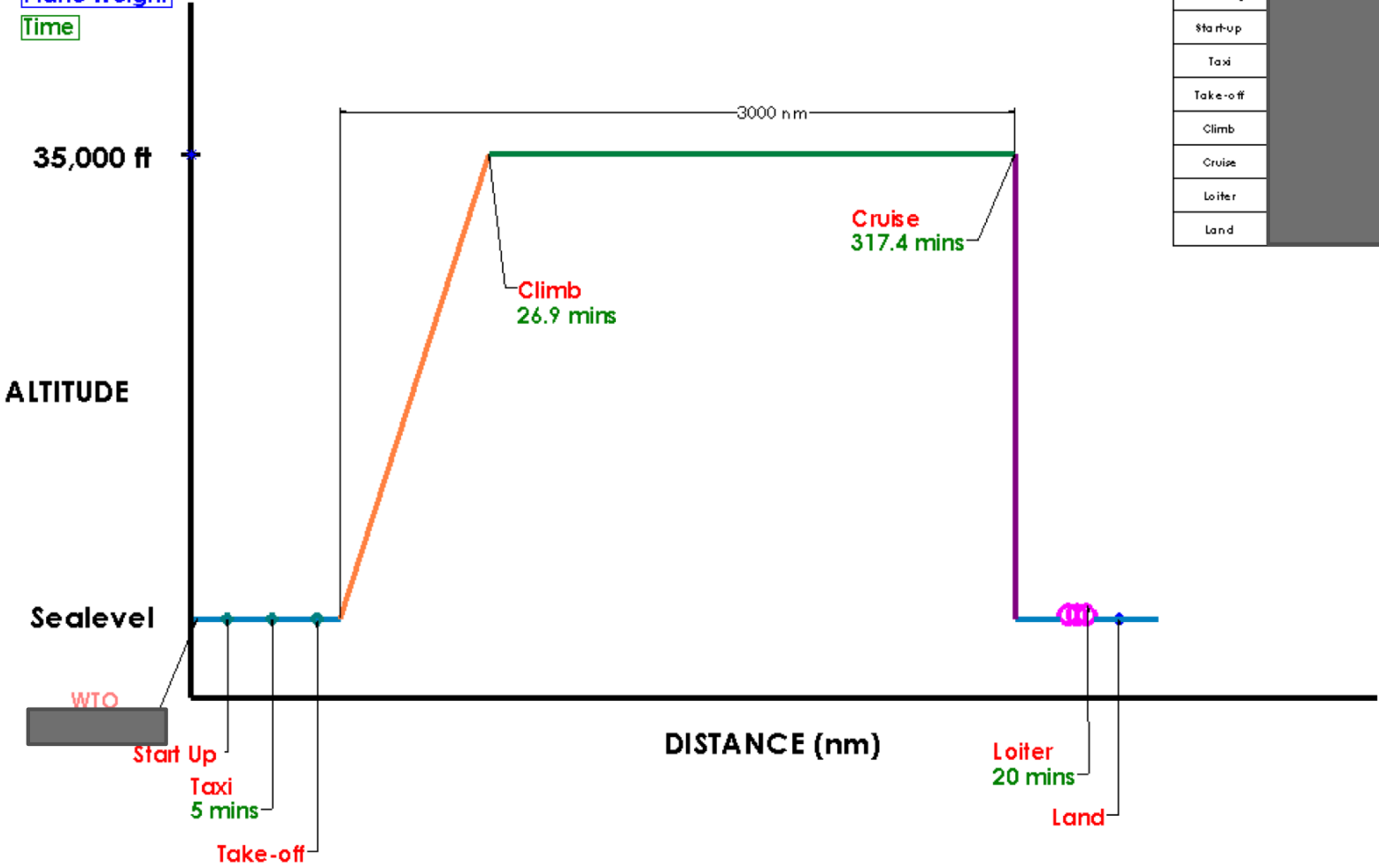
# CLOSE AIR SUPPORT MISSION



	Weight (lbs)	Fuel Burned (lbs)
Initial Weight		
Start-up		
Taxi		
Take-off		
Climb		
Cruise		
Dash Out		
Initial Combat		
Final Combat		
Dash In		
Climb		
Cruise		
Loiter		
Land		

# FERRY MISSION

Phase Status  
Plane Weight  
Time



	Weight (lbs)	Fuel Burned (lbs)
Initial Weight		
Start-up		
Taxi		
Take-off		
Climb		
Cruise		
Loiter		
Land		



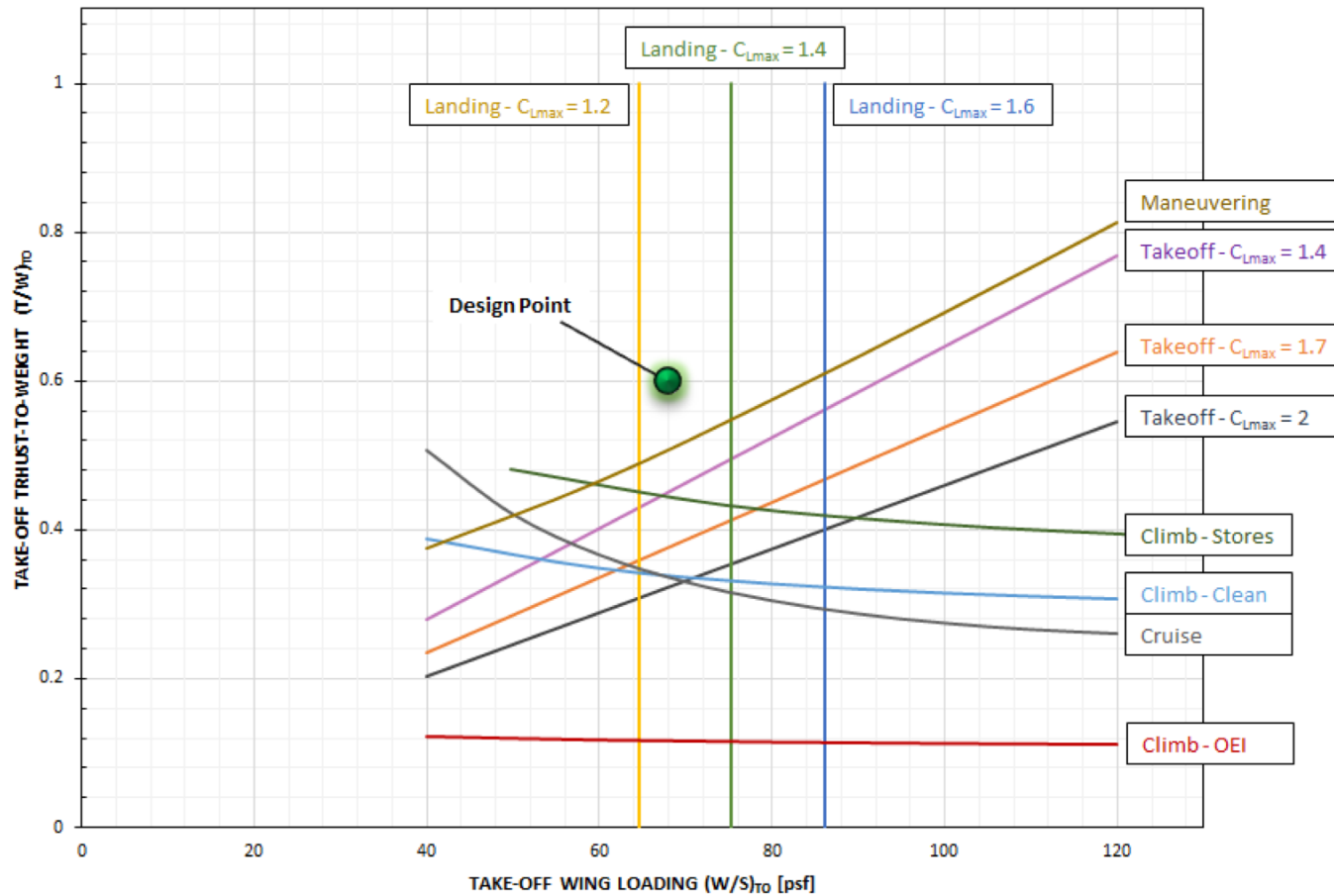
# COMPARATIVE AIRCRAFT



	Sukhoi Su-27	A-10	F/A-18 Hornet	F-15 Eagle	A-17 Nimbus
<b>Wing Area</b>	667 ft <sup>2</sup>	506 ft <sup>2</sup>	400 ft <sup>2</sup>	608 ft <sup>2</sup>	
<b>Wing Loading</b>	77.3 lb/ft <sup>2</sup>	99 lb/ft <sup>2</sup>	93 lb/ft <sup>2</sup>	73.1 lb/ft <sup>2</sup>	
<b>Thrust/Weight</b>	1.07	0.36	0.96	1.07	
<b>W<sub>TO</sub></b>	67,100 lb	50,000 lb	51,900 lb	68,000 lb	
<b>Engine(s)</b>	(2) Saturn/Lyulka AL-31F turbofans	(2) General Electric TF34-GE-100A turbofans	(1) M61A1 Vulcan cannon	(2) Pratt & Whitney F100-PW-100 or -220 afterburning turbofans	(2) F91 turbofans
<b>Weapons</b>	(1) GSh-30-1 cannon (6) Medium-range AA missiles R-27 (2) Short-range heat-seeking AA missiles R-73	(1) GAU-8/A Avenger cannon (2) AIM-9 Sidewinder missiles (6) AGM-65 Maverick missiles	(4) AIM-9 Sidewinder (2) AIM-7 Sparrow	(1) M61A1 Vulcan 6-barrel cannon (4) AIM-7 Sparrow (4) AIM-9 Sidewinder (8) AIM-120 AMRAAM	(1) GAU-8 cannon (2) AIM-9L Sidewinder missiles (12) Mk 82 GP bombs

# WING SIZING

Matching Results for Sizing of CAS



## Design Point

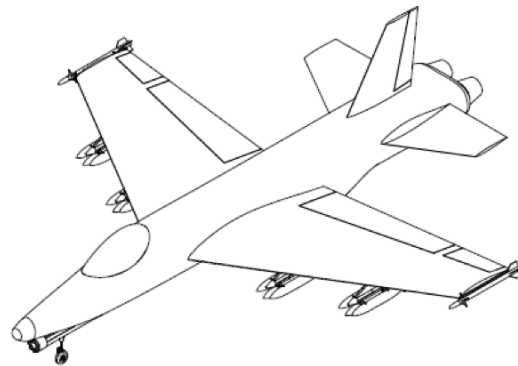
$(W/S)_{TO}$	68
$(T/W)_{TO}$	0.6

## Wing Size

AR  
S  
b



# 3 - VIEW



## MTOW

•  LBS

## TAKEOFF WING LOADING

•  LB/FT<sup>2</sup>

## TAKEOFF T/W

•

## WING AREA

•

## WING SPAN

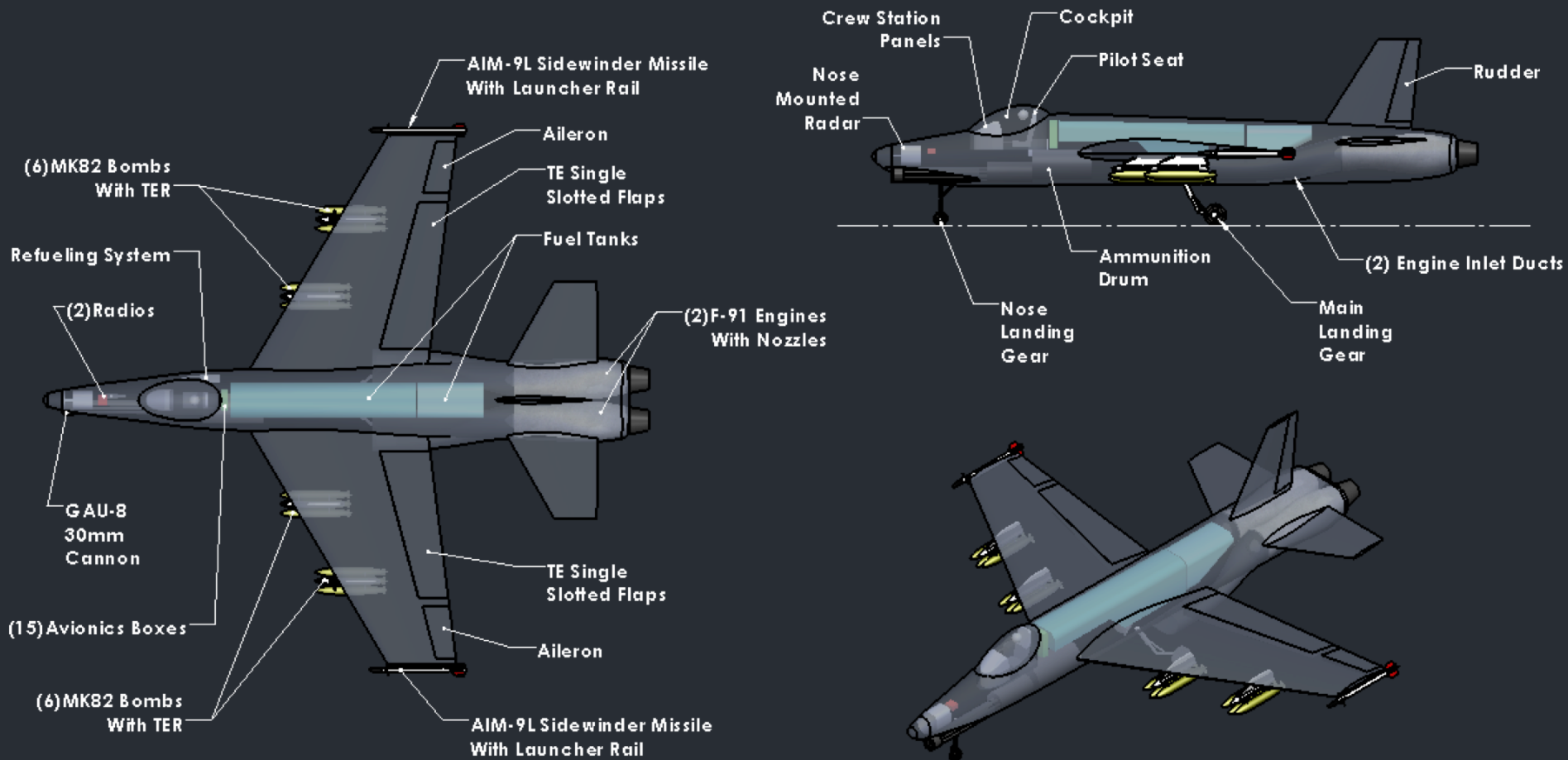
•

## OVERALL LENGTH

•

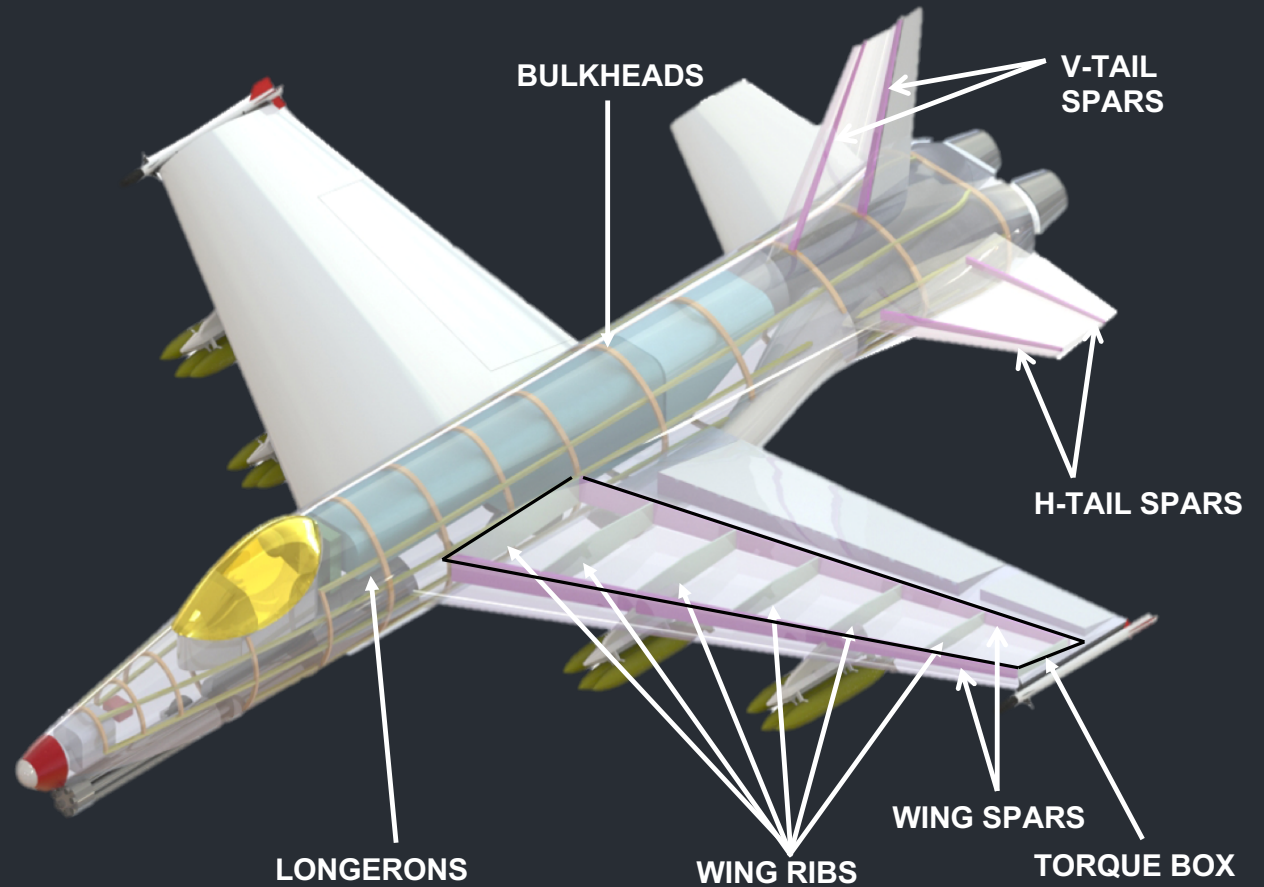
All measurements in feet

# INBOARD PROFILE



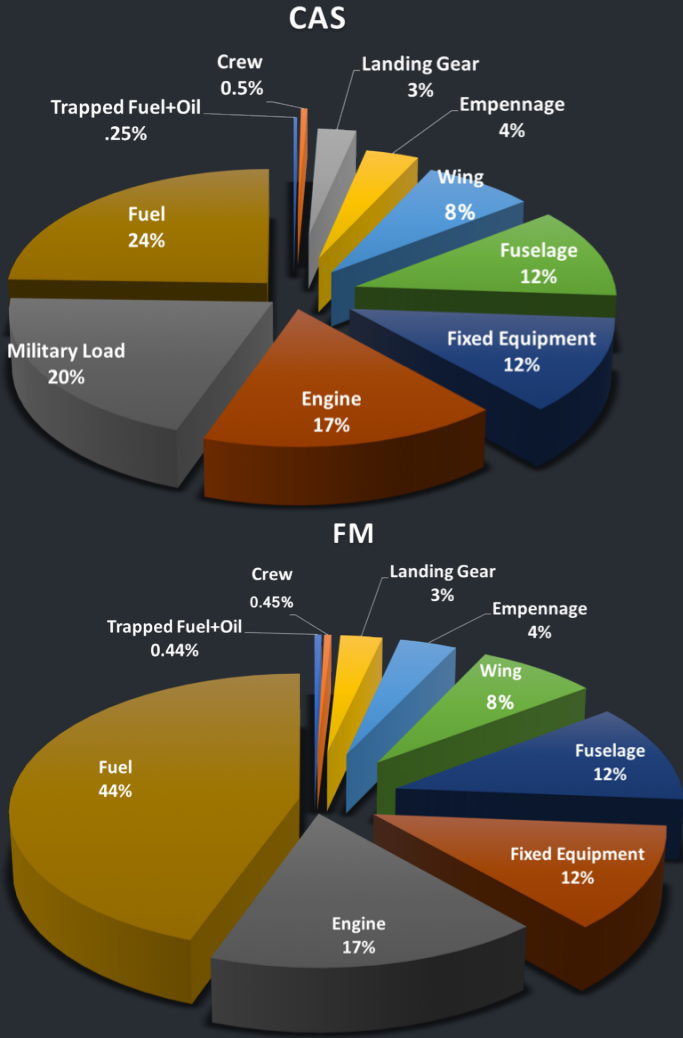
# STRUCTURAL LAYOUT

No.	Part	Material	Location
6	Ribs	Aluminum Alloy T861	35"
2	Spars	Aluminum Alloy T861	.2MAC - .7MAC
	Spar Caps	Aluminum Alloy 6061-T6	
	Skins	Aluminum Alloy 2024-T3	



# WEIGHT & BALANCE

Weight Summary	Weight (lb)	
	CAS	FM
Operating Empty Weight ( $W_{OE}$ )		
Empty Weight ( $W_E$ )		
Trapped Fuel and Oil ( $W_{TFO}$ )		
Crew Weight ( $W_{CREW}$ )		
Fuel ( $W_F$ )		
$W_{OE} + 60\% \text{ fuel}$		
$W_{OE} + W_F$		
Payload Weight ( $W_{PL}$ )		
$W_{OE} + W_F + W_{PL}$		



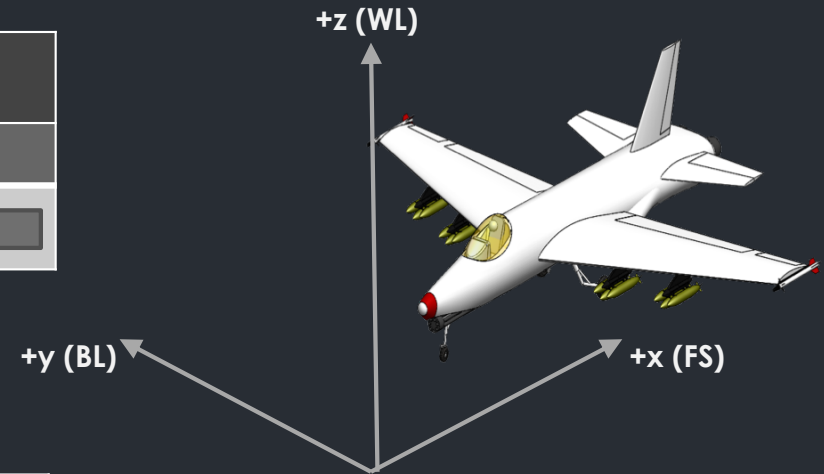
# MOMENTS OF INERTIA

Reference ACS (0, 0, 0)

$\Sigma I_{XX}$	$\Sigma I_{YY}$	$\Sigma I_{ZZ}$	$\Sigma I_{XZ}$
lb ft <sup>2</sup>	lb ft <sup>2</sup>	lb ft <sup>2</sup>	lb ft <sup>2</sup>

Transformed from ACS to CG

$\Sigma I_{XXB}$	$\Sigma I_{YYB}$	$\Sigma I_{ZZB}$	$\Sigma I_{XZB}$
lb ft <sup>2</sup>	lb ft <sup>2</sup>	lb ft <sup>2</sup>	lb ft <sup>2</sup>



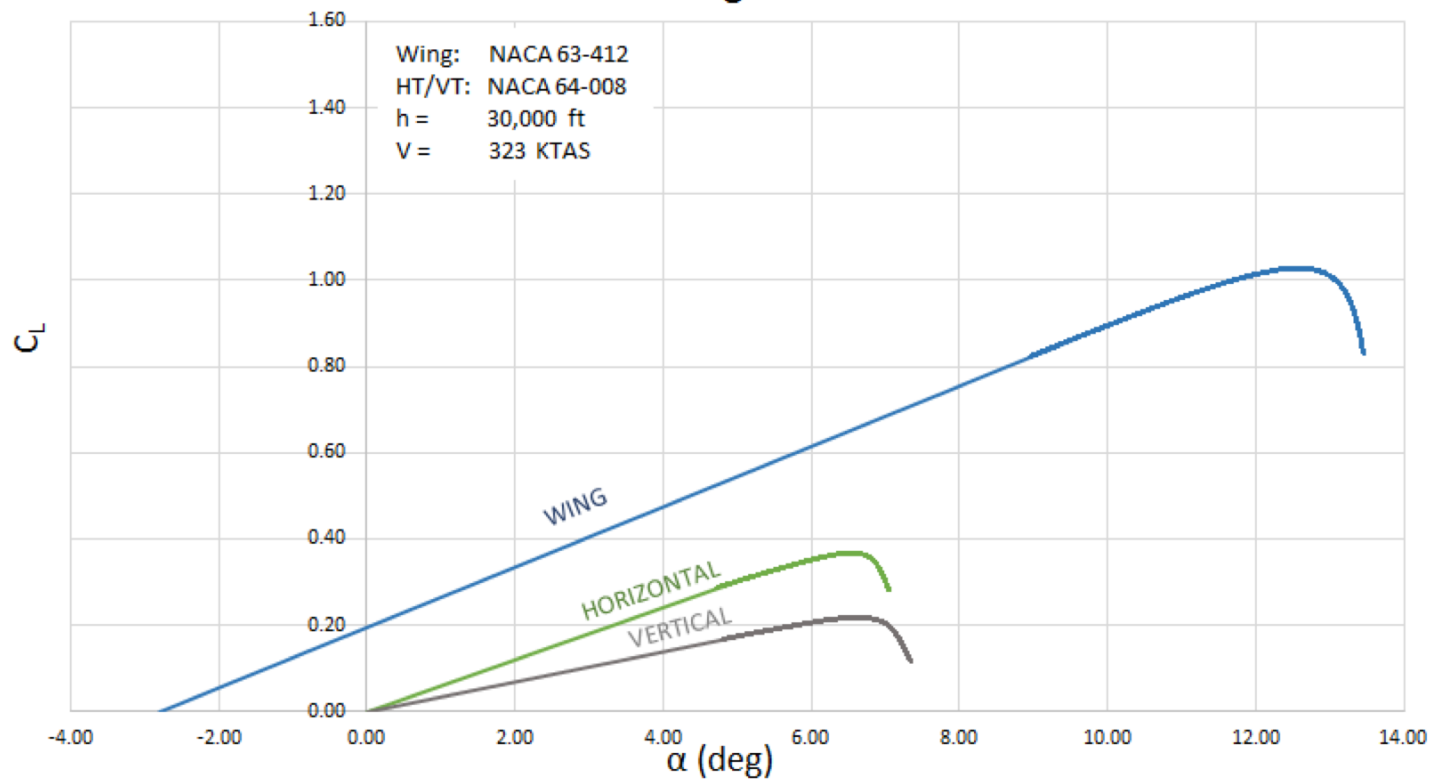
C.G. Range %MAC	
Most FWD	Most AFT
<b>13%</b>	<b>23%</b>



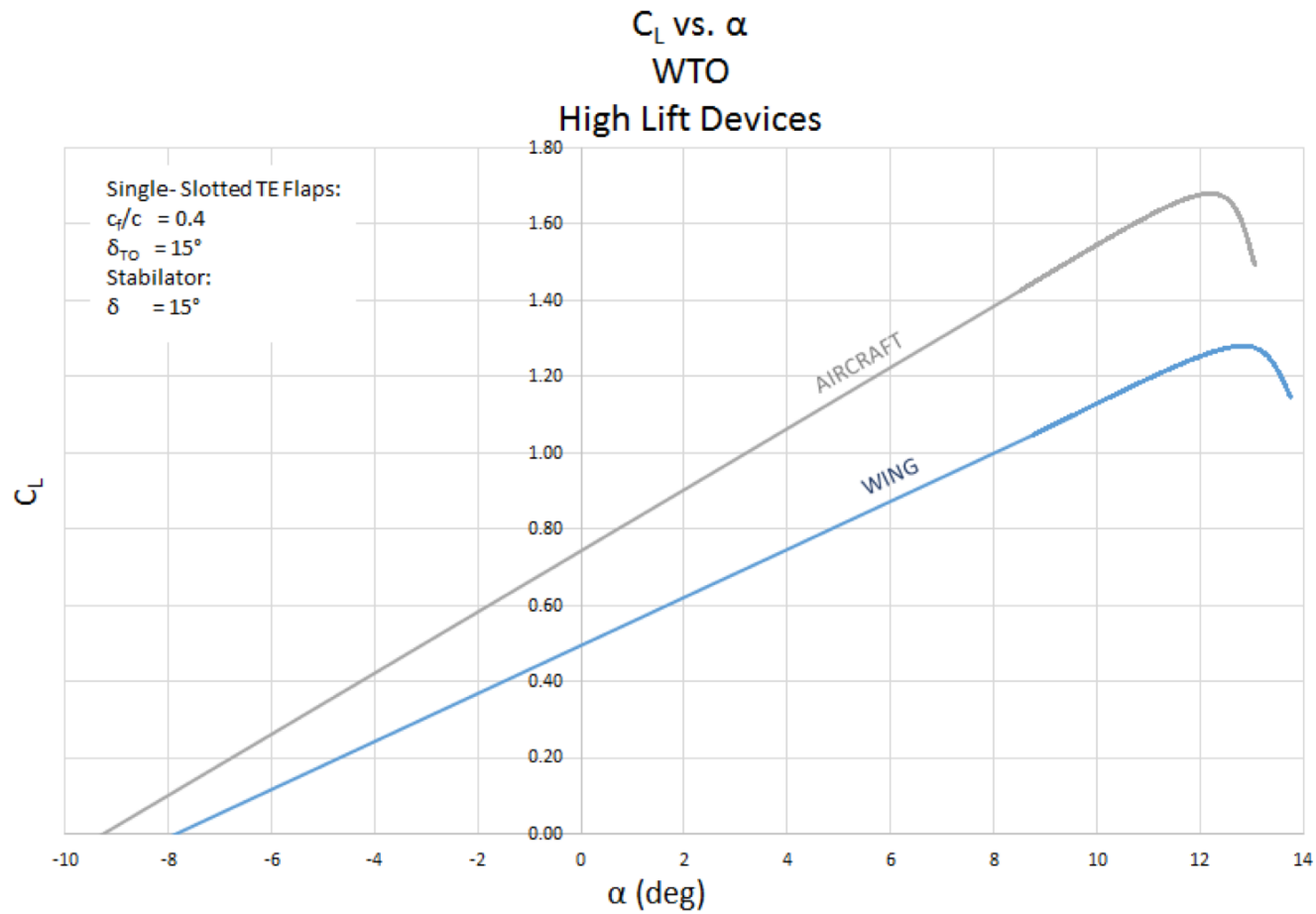
# LIFT CURVES

$C_L$  vs.  $\alpha$   
WC

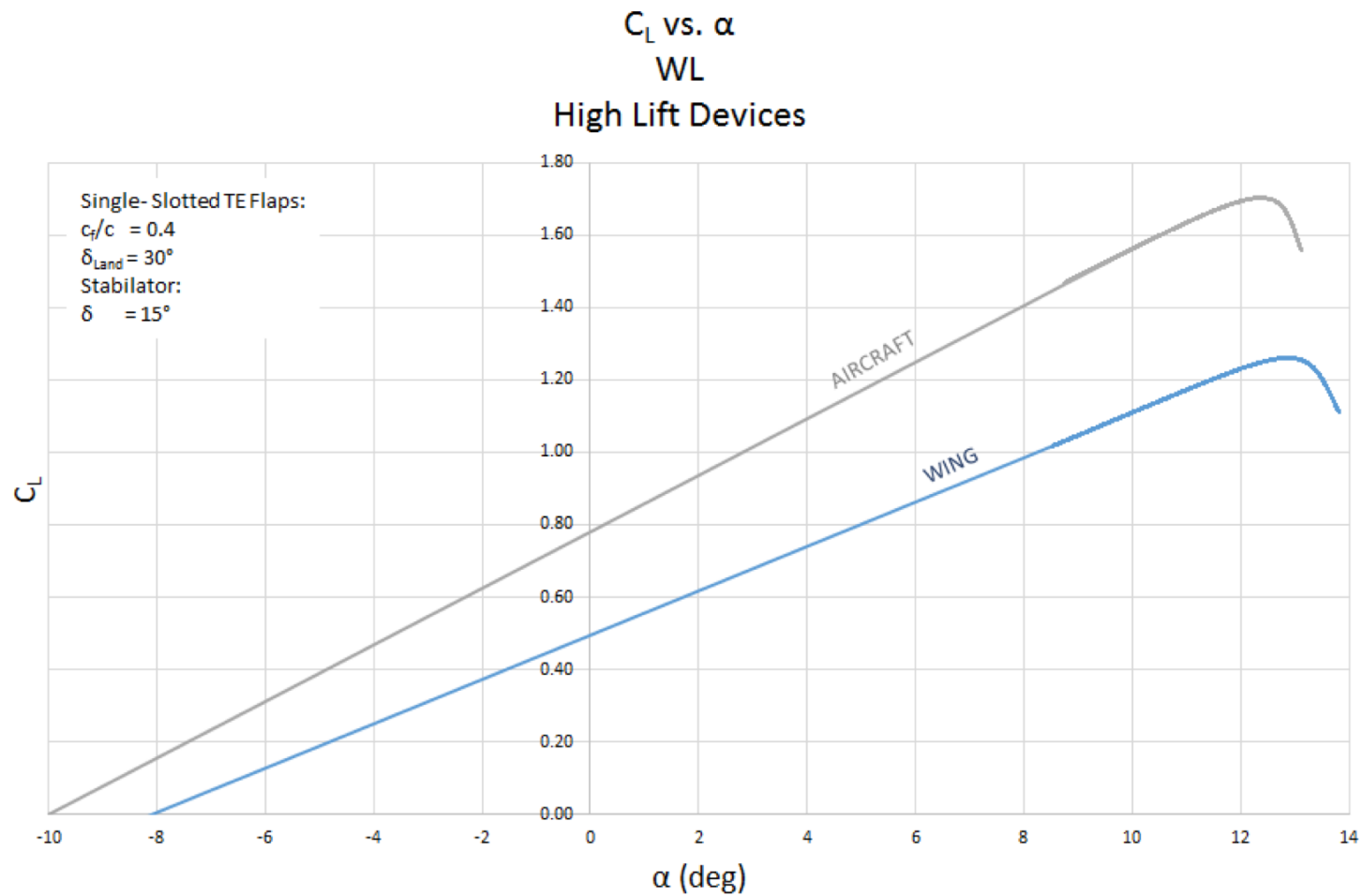
All Lifting Surfaces



# HIGH LIFT DEVICES - TAKEOFF



# HIGH LIFT DEVICES - LANDING

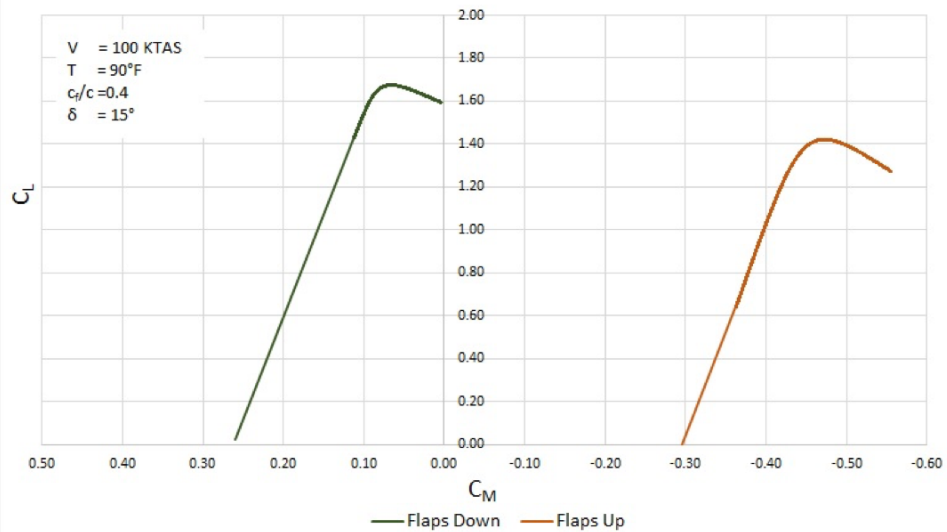


# MOMENTS

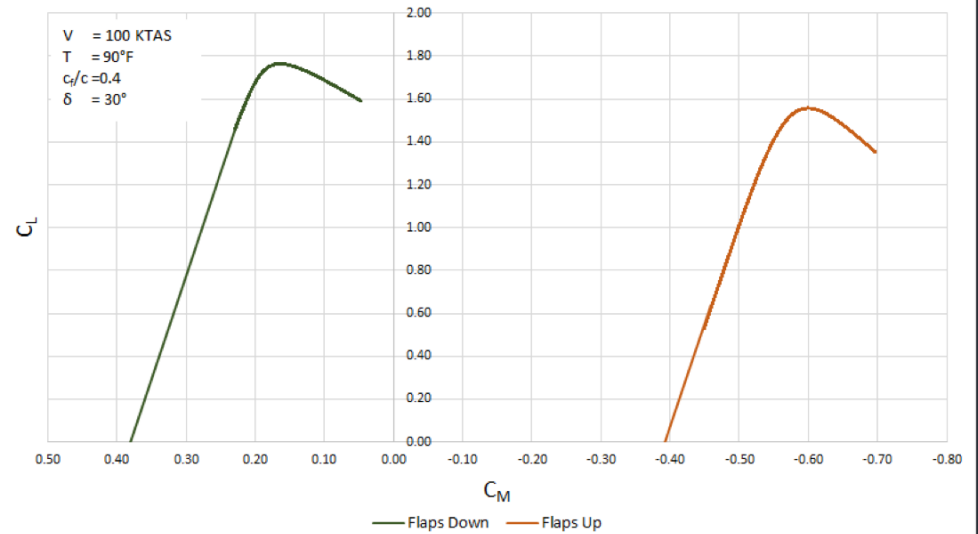
$X_{REF} = 16.67\% \text{ MAC}$

- Chosen halfway between most forward and most aft CG location along MAC

$C_L$  vs.  $C_M$  Aircraft  
WTO

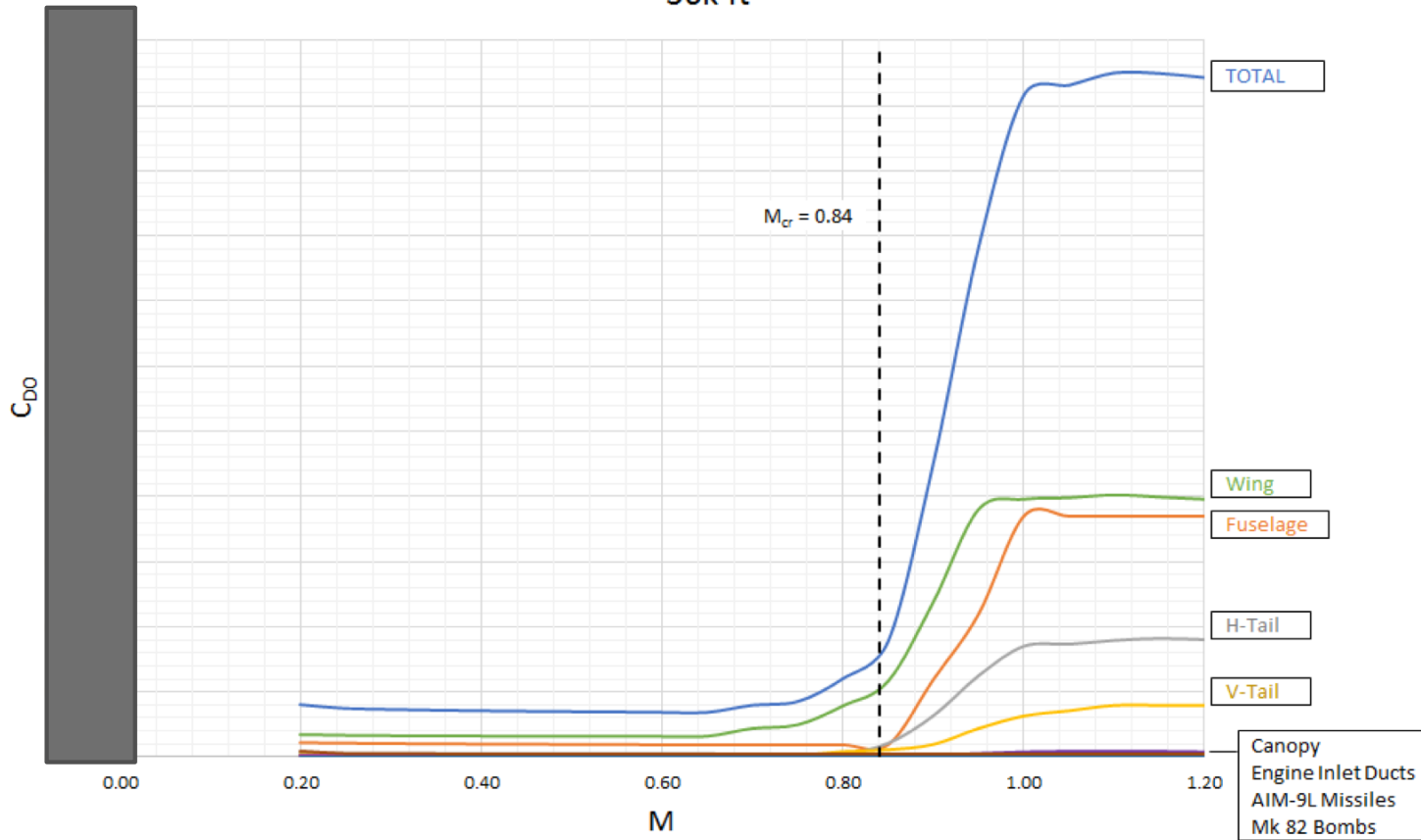


$C_M$  vs.  $C_L$  Aircraft  
WL



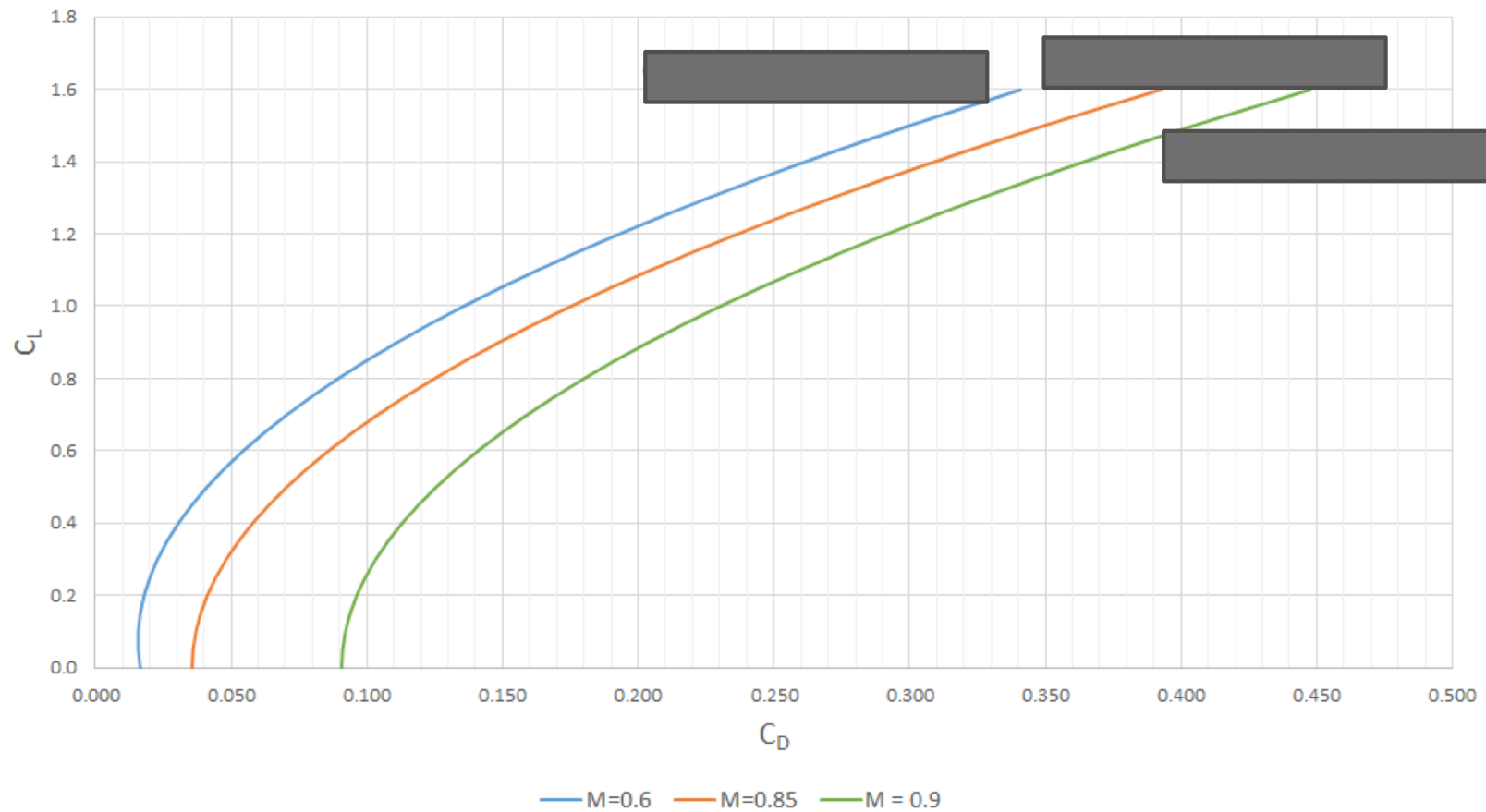
# $C_{D0}$ VS M

$C_{D0}$  vs. Mach  
36k ft



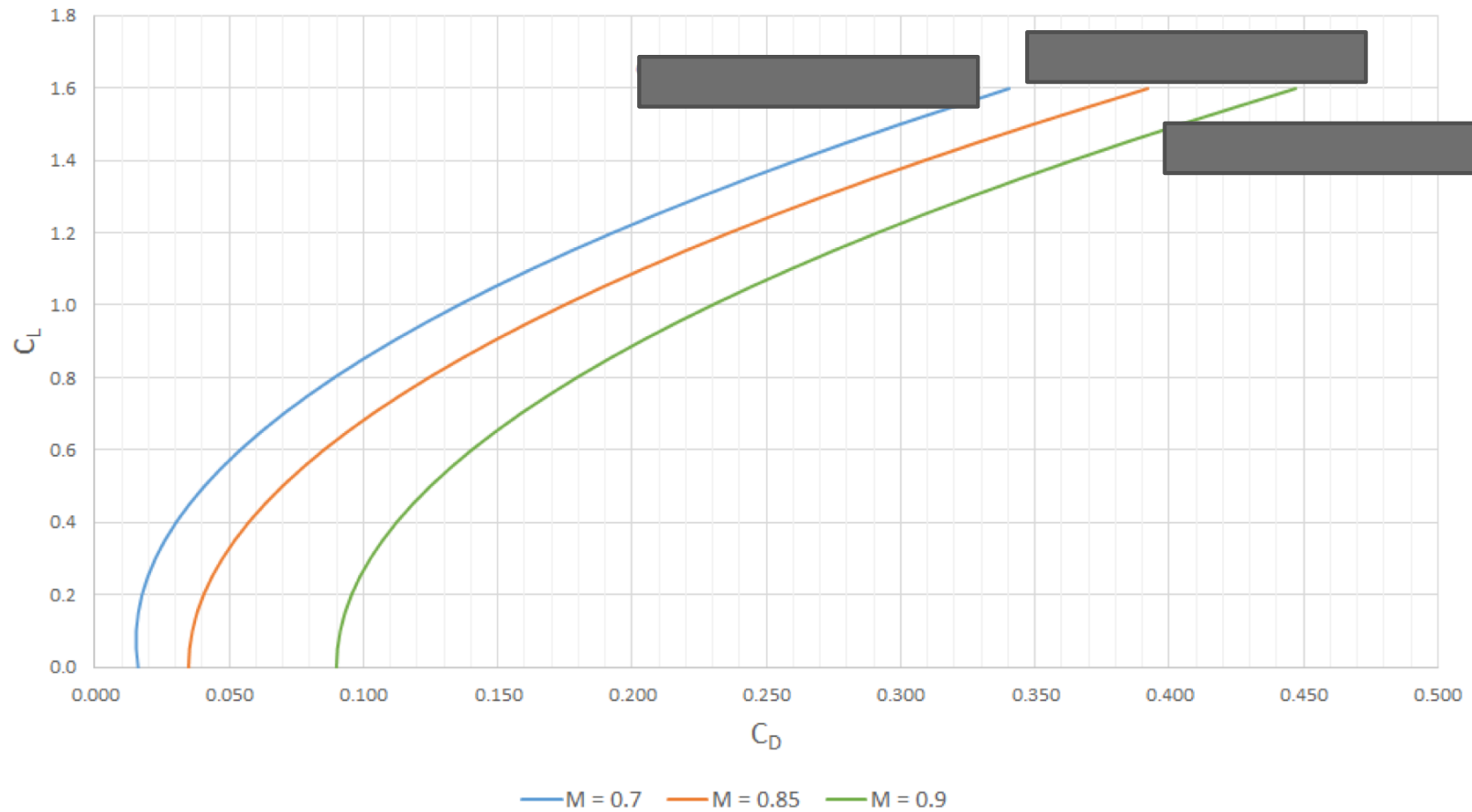
# DRAG POLARS

Drag Polar - WC - 30k ft



# DRAG POLARS

Drag Polar - CC - 40k ft

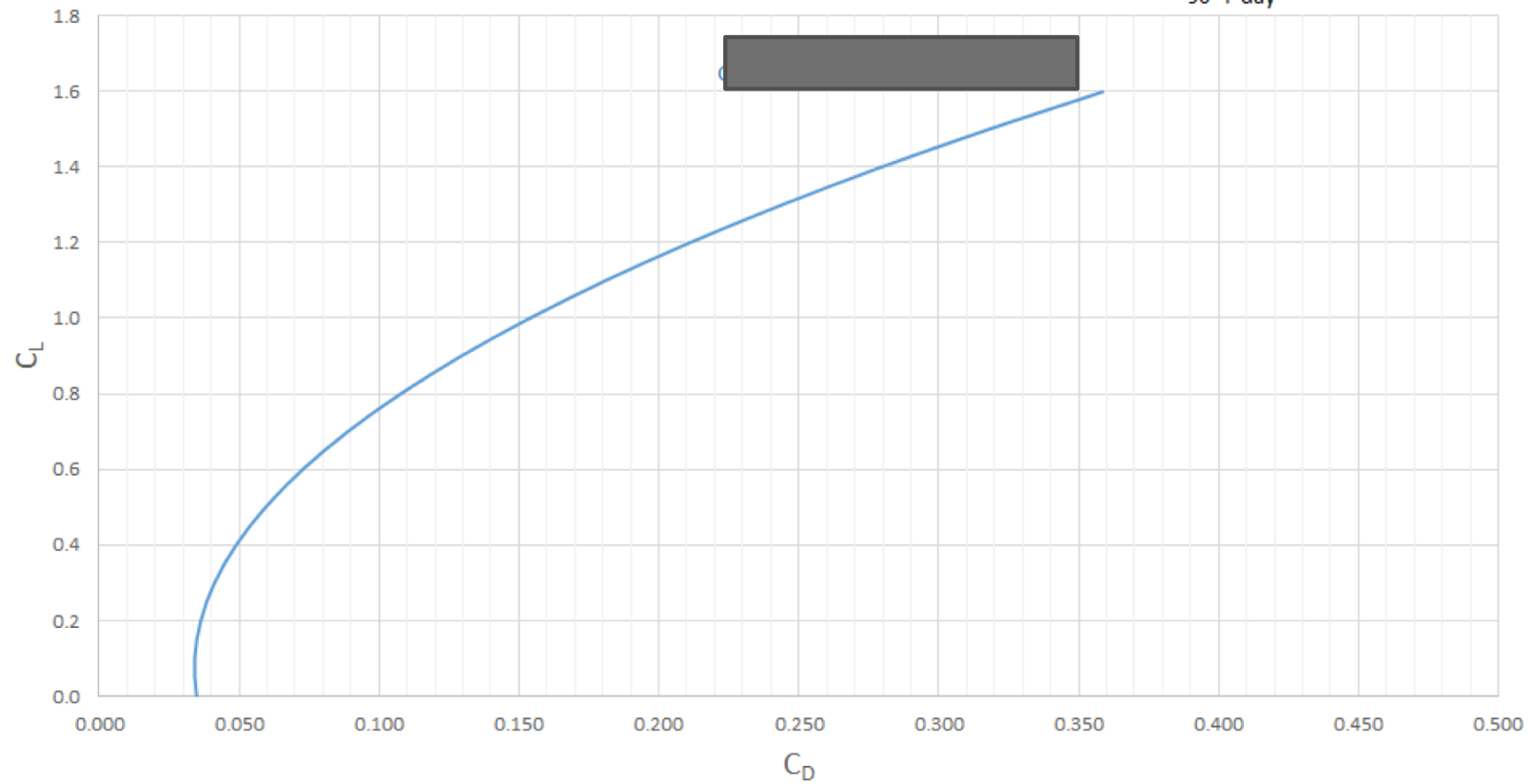




# DRAG POLARS

Drag Polar - WTO - Sea Level  
V = 100 KTAS

- Gear Down
- Single-Slotted TE Flaps, 15°
- 90° F day

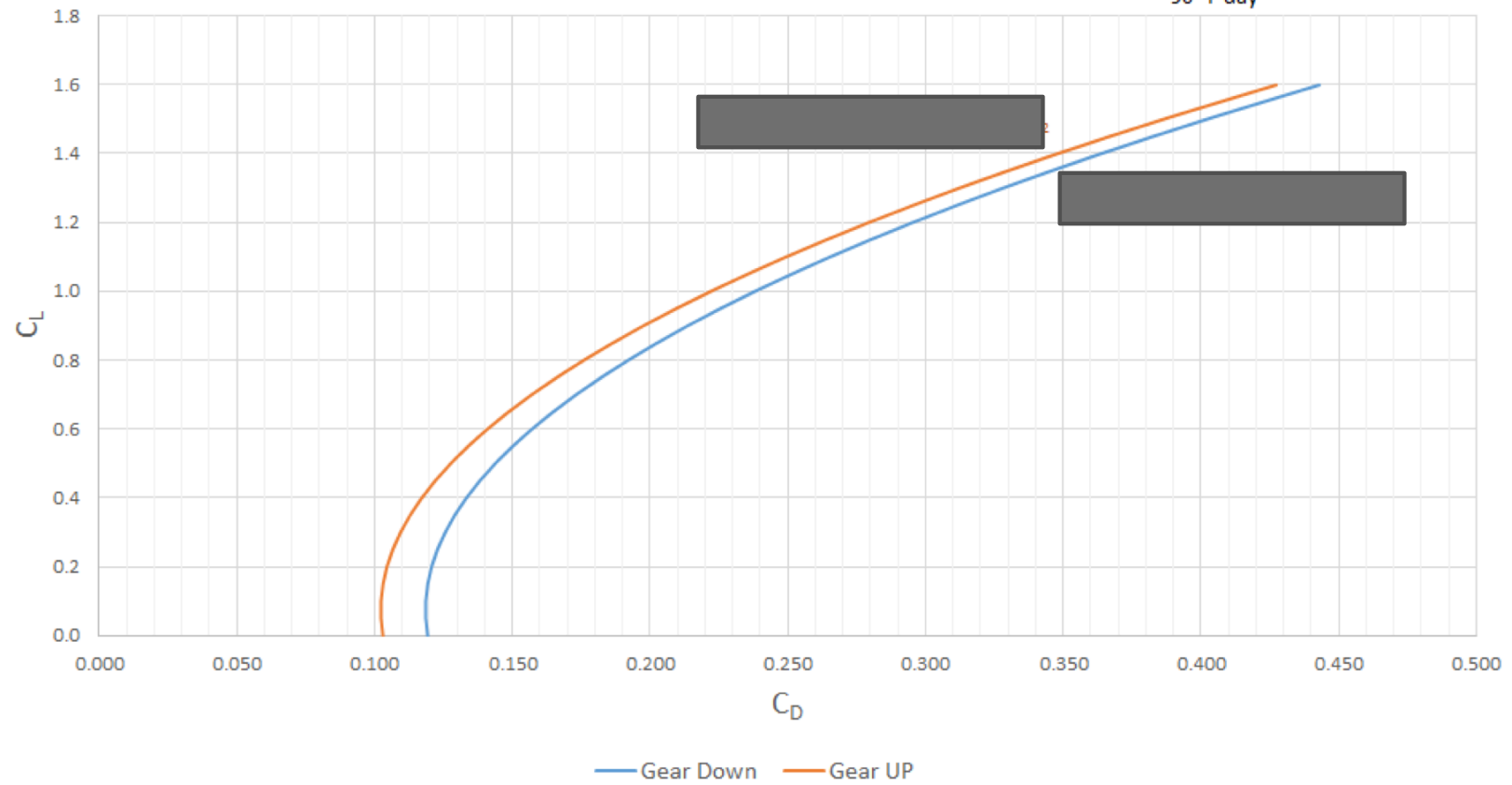


# DRAG POLARS

Drag Polar - WL - Sea Level

V = 100 KTAS

- Single-Slotted TE Flaps, 30°  
- 90° F day



# PROPULSION

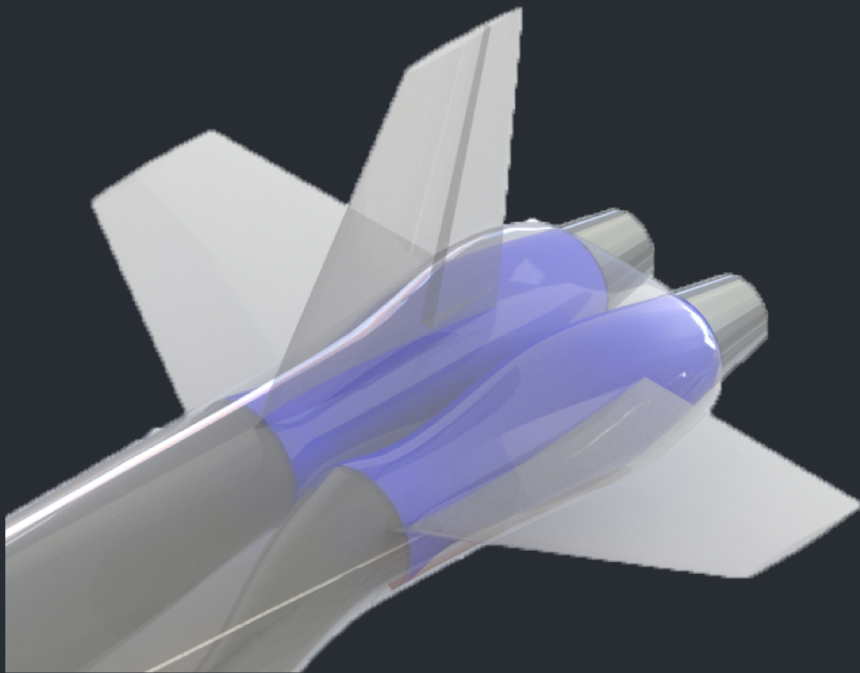
## ENGINE DATA

**TYPE :** (2) F91 CONCEPTUAL TURBOFAN ENGINES

**RUBBERIZATION FACTOR :**

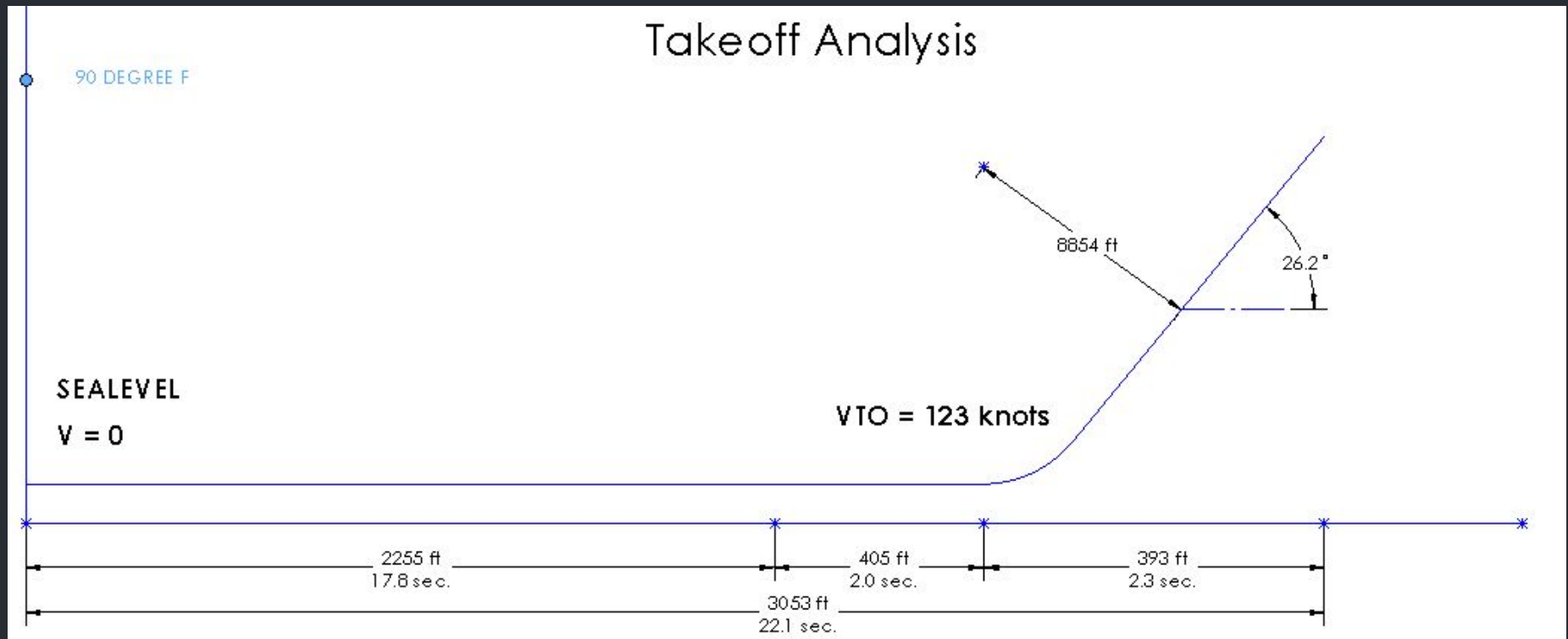
**INLET AREA :**

**THRUST REQUIRED PER ENGINE :**



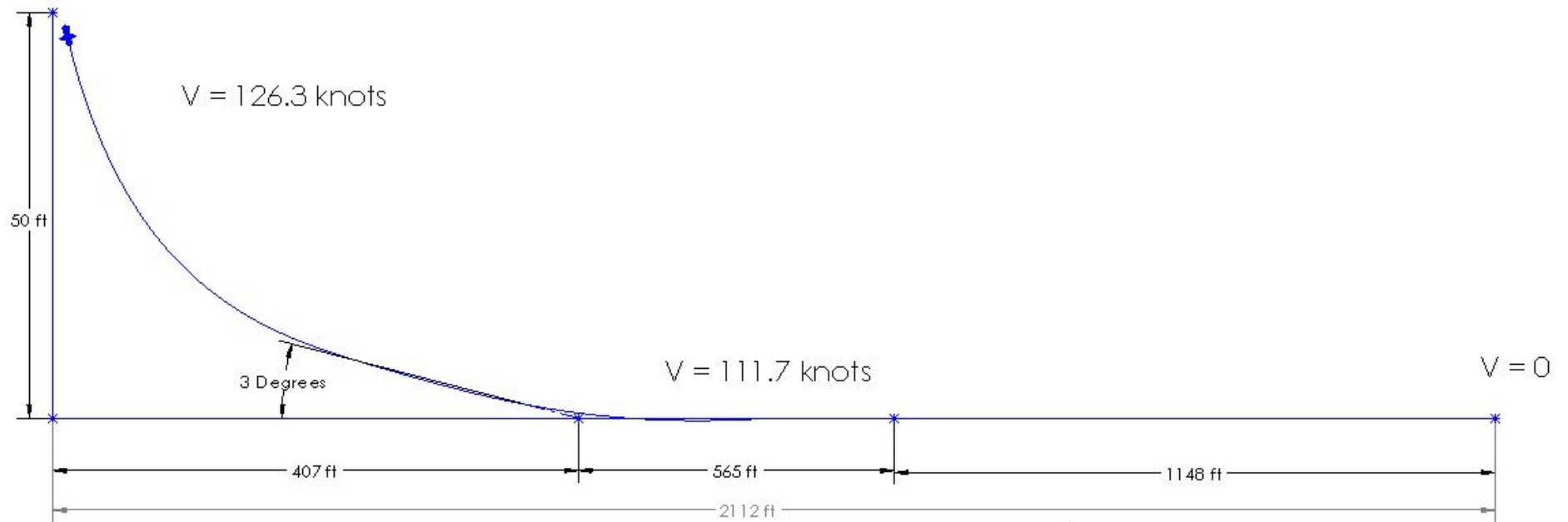
Air Flow	<input type="text"/>	lbs/s
Weight	<input type="text"/>	4 lbs
Length	<input type="text"/>	ft
CG location from nose	<input type="text"/>	ft
Fan Radius	<input type="text"/>	ft
Fan Hub Radius	<input type="text"/>	ft
Nozzle Radius	<input type="text"/>	ft
Max Engine Radius	<input type="text"/>	ft

# PERFORMANCE – TAKEOFF ANALYSIS



# PERFORMANCE – LANDING ANALYSIS

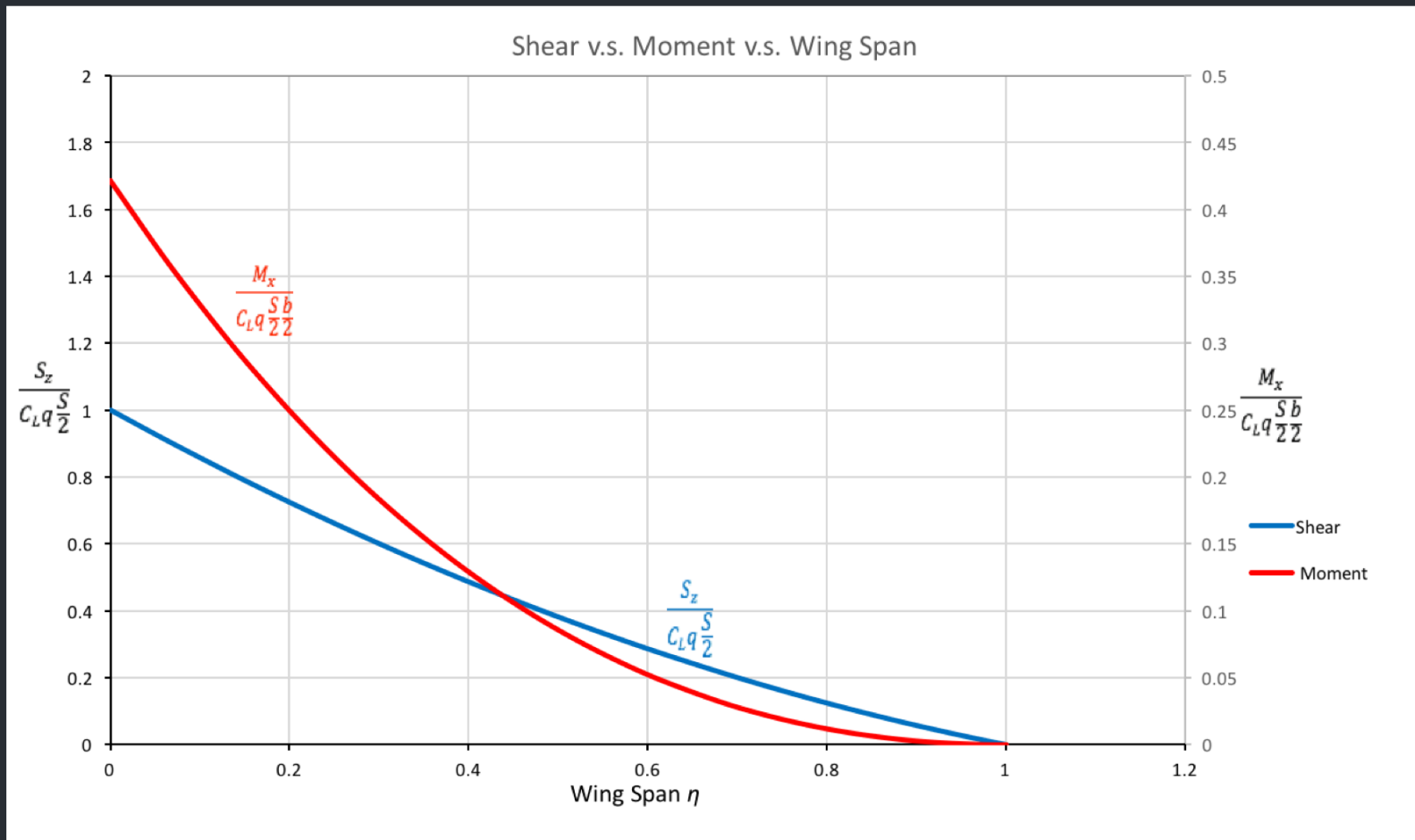
## Landing Analysis



# PERFORMANCE SUMMARY

ID	Requirement	Design	Structures	Mass Properties	Aerodynamics	Performance	Propulsion	Stability and Control	Required	Achieved
CAS-4.2.1	Engine Type						X		2 Turbofans or 2 Turbojets	
CAS- 4.10.1	Operational Ceiling					X	X		40,000 ft	
CAS- 4.10.4	Maximum speed (Configuration WCR, 60% fuel, 35,000ft)					X	X		0.85 Mach	
CAS- 4.10.5	Maximum take-off ground run (Configuration WTO)					X	X		< 2500 ft	
CAS- 4.10.6	Maximum landing ground run					X	X		< 2500 ft	
CAS- 4.10.3	Minimum rate of climb, 40,000 ft, WCB					X	X		300 fpm	

# LOADS/WING STRUCTURAL SIZING





# DIMENSIONLESS STABILITY DERIVATIVES

## CONDITIONS:

- WCR
- 60% Fuel
- █████ LBS
- 35,000 FT
- M 0.547

Longitudinal Nondimensional Derivatives			
	Cx	Cz	Cm
a			
u			
q			
a_dot			

Lateral Nondimensional Derivatives			
	Cy	Cl	Cn
B			
p			
r			
B_dot			

# STABILITY AND CONTROL RESULTS

Description	Requirement	Obtained	
<b>Longitudinal Stability</b>			
Phugoid Damping Ratio	$> 0.04$		
Short Period Damping Ratio	0.35-1.3		
Routh's Criteria	$A, B, D, E > 0$		
	$R > 0$		
<b>Longitudinal Characteristic Equation</b>			
<div style="background-color: #808080; width: 100%; height: 20px;"></div>			

# STABILITY AND CONTROL RESULTS

Description	Requirement	Obtained	
<b>Lateral Directional Stability</b>			
Dutch Roll Damping Ratio	$> 0.02$		
Dutch Roll Undamped Natural Frequency	$> 0.4$		
Roll-mode Time Constant	$< 1.0 \text{ s}$		
Spiral Time to Double Amplitude	$> 12 \text{ s}$		
Routh's Criteria	$A, B, D, E > 0$		
	$R > 0$		
<b>Longitudinal Characteristic Equation</b>			
<div style="background-color: #808080; width: 100%; height: 20px;"></div>			

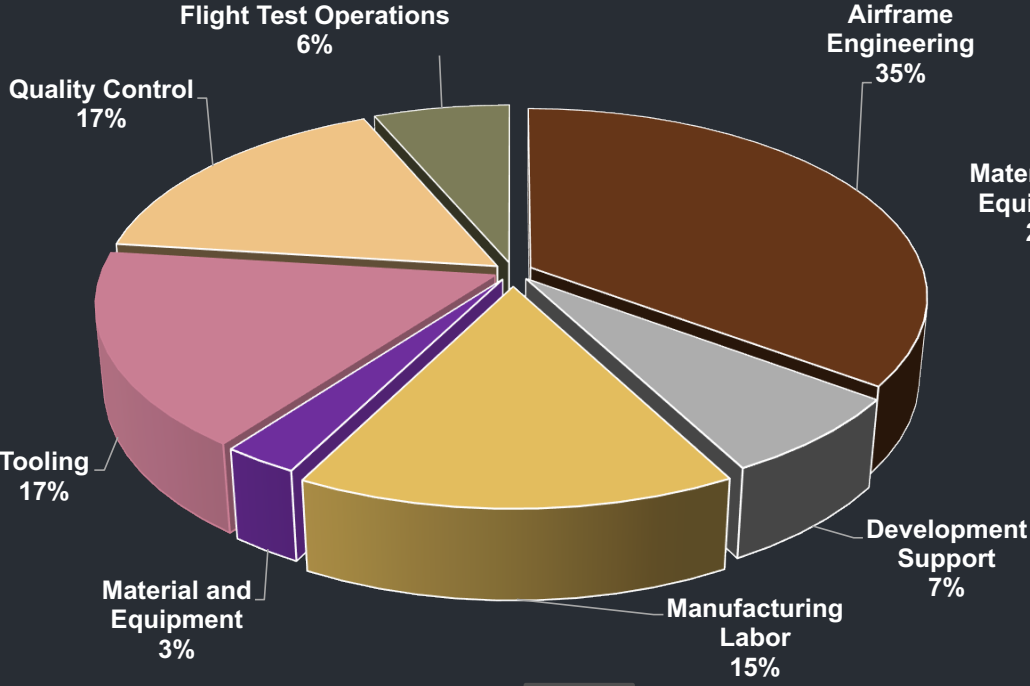
# Future Lateral Stability Analysis

A - 17 Vertical Tail Configuration	Grumman A-6	Nicolai Recommendation
Span <input type="text"/>	Vertical Tail Ratio 0.069	Jet fighters at any speeds. Vertical Ratio 0.076
Area <input type="text"/>		
Vertical Tail Ratio <input type="text"/>		

## FUTURE DESIGN CHANGES

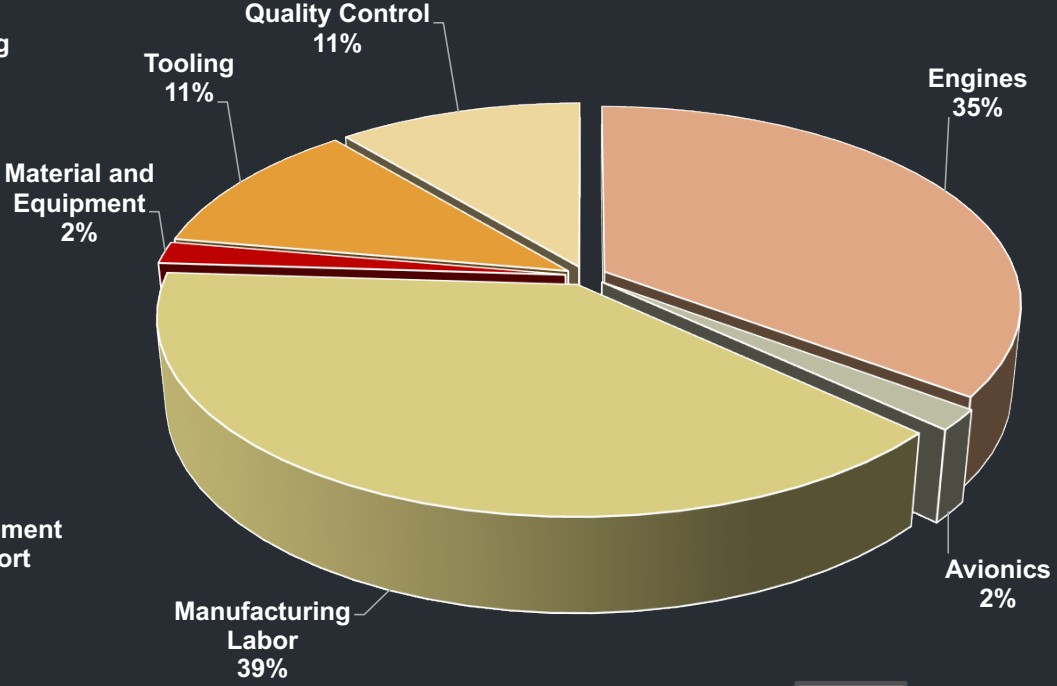
- INCREASE VERTICAL TAIL AREA & RATIO
- CHANGES CONFIGURATION TO V - TWIN OR H - TWIN TAIL CONFIGURATION
- INCREASE  $C_{LB}$  TO 0.4
- INCREASE  $C_{NR}$  TO -0.36

# DT&E COSTS



Total DT&E: [ ] B

# PRODUCTION COSTS



Total Production: [ ] B

COST PER AIRCRAFT: \$ [ ] M

SUBTOTAL FOR 209 AIRCRAFT: \$ [ ] B

# REQUIREMENTS SUMMARY

ID	Requirement	Design	Structures	Mass Properties	Aerodynamics	Performance	Propulsion	Stability and Control	Required	Achieved
CAS-4.1.1	Pilot Allowance and Personal Equipment Allowance	X							Pilot - 200 lb Personal Equip - 26.3 lbs	Pilot - 200 lb Personal Equip - 26.3 lbs
CAS-4.1.2	Cockpit Pressurization	X							8000ft cabin alt at 40,000ft	8000ft cabin alt at 40,000ft
CAS- 4.1.3	Emergency Oxygen	X							Operate at 30,000ft for 1 hr	Operate at 30,000ft for 1 hr
CAS-4.1.4	Baggage Provisions	X							50 lbs	50 lbs
CAS-4.2.1	Engine Type						X		2 turbofans	2 turbofans
CAS-4.3.1-3	Armament Provisions	X							1 cannon, 2 missiles, 12 bombs	1 cannon, 2 missiles, 12 bombs
CAS-4.4.1-2	Avionics suite provisions	X							Radar, radios, avionics boxes	Radar, radios, avionics boxes
CAS-4.5.1	Structural Load Factor	X	X	X	X	X	X	X	+7.5g to -3.0g	+7.5g to -3.0g
CAS-4.5.3	Maximum Dynamic Pressure	X	X						1000 lb/ft <sup>2</sup>	1000 lb/ft <sup>2</sup>

# REQUIREMENTS SUMMARY

ID	Requirement	Design	Structures	Mass Properties	Aerodynamics	Performance	Propulsion	Stability and Control	Required	Achieved
CAS-4.10.1	Maximum sustained load factor	X							5.0g	5.0g
CAS-4.10.3	Operational Ceiling (Configuration WCB)					X	X		40,000 ft	45,000 ft
CAS-4.10.4	Maximum Speed (Configuration WCR, 60% fuel, 35,000 ft)					X	X		0.85 Mach	0.85 Mach
CAS-4.10.5	Maximum take-off ground run					X	X		< 2500 ft	2255 ft
CAS-4.10.6	Maximum landing ground run					X	X		< 2500 ft	1149 ft
CAS-5.1.1	Short period damping ratio							X	0.35-1.30	
CAS-5.1.1	Phugoid damping ratio							X	> 0.04	4
CAS-5.1.2	Dutch roll damping ratio							X	> 0.02	
CAS-5.1.2	Dutch roll undamped natural frequency							X	> 0.4	
CAS-5.1.2	Roll-mode time constant							X	< 1.0 sec	sec
CAS-5.1.2	Spiral time to double amplitude							X	> 12 sec	sec



**QUESTIONS?**