Short Range High Capacity(SRHC)-530G Transport Aircraft

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Design Proposal

Per the 2019 RFP of AIAA Student Design Competition, the proposed aircraft SRHC - 530G has a travel range of 3500 NMI with an additional 200 NMI loiter contingency. It can carry up to 400 passengers with a crew count of 10 and has a take off and landing distance that is less than or equal to 9000 ft. The SRHC - 530G employs 2 GE 9x engines to power the aircraft. Furthermore, hydrogen propulsion technology is explored to provide fuel and cost efficient options.

Key Design Parameters

The production aircraft will have two variants for airlines to pick from. The main difference between the variants is the fuel used: Kerosene and Hydrogen Fuel Cell. The parameters below are specifically for the kerosene variant, and the hydrogen variant is designed with a minimal change approach, so the numbers below will be slightly changed.

Aerodynamic Parameters	
S_{wing}	4717 ft^2
AR	11.5
MAC	20.23ft
Taper Ratio	0.176
$C_{Lcruise}$	0.51
$C_{LMax,TO}$	2.14
$C_{LMax,L}$	2.69
$C_{D0,cruise}$	0.0131
Flat Plate Area	67.98 ft^2
Airfoil	Beoing Airfoil J

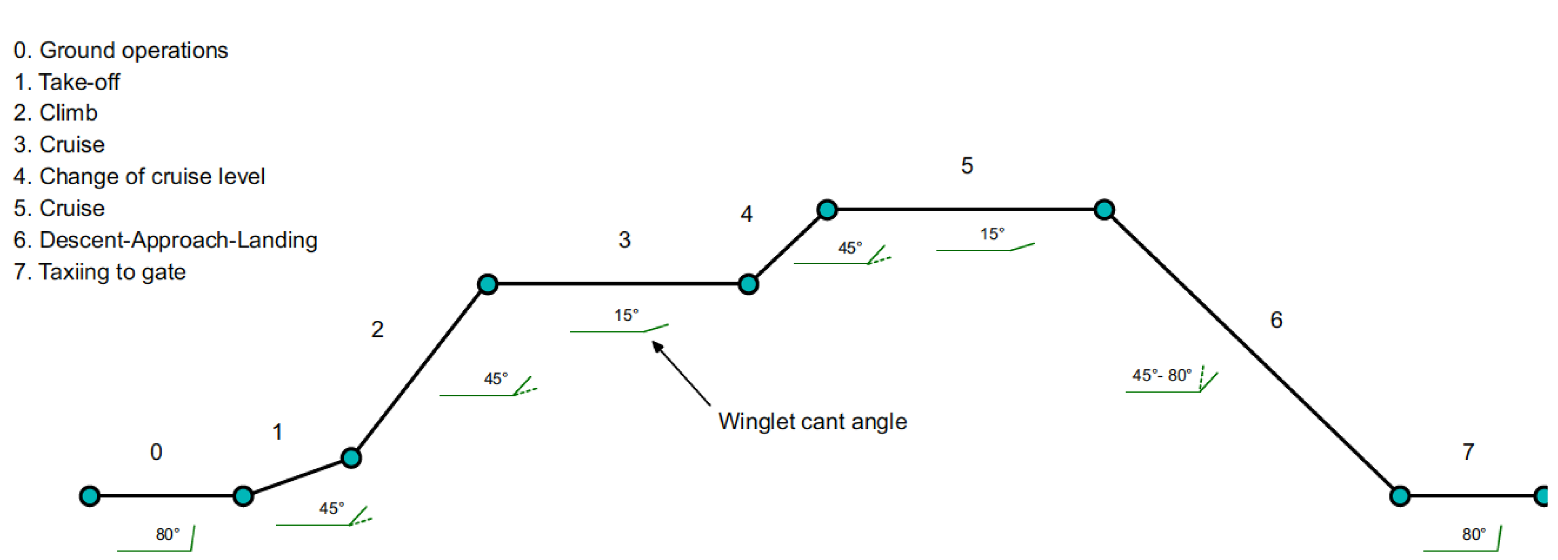
Engine Specifications	
GE9x	
Max Thrust [lbf]	100-105,000
Weight [lbf]	40,000
Length [in]	290
Diameter [in]	134
Pressure Ratio	60:1
Bypass Ratio	10:1

Fuselage and Weight Parameters	
Capacity	414 (2-class)
Length	239.8 ft
Cabin Width	18.2 ft
Fuselage Width	19.3 ft
Empty Operating Weight	296,000 lbs
Maximum Take-off Weight	566,000 lbs
Maximum Payload Weight	92,000 lbs

Velocities	
V_{cruise}	Mach 0.8
V_{TO}	202.2 ft/s
V_{LD}	211.4 ft/s

Advanced Technologies

The airplane will utilize variable cant wingtip angle technology to decrease drag between take-off and cruise conditions. The airplane will have its wingtips at 45deg during take-off which effectively reduces induced-drag, and then change to 15deg angle during cruise where profile drag is minimized for an overall drag-optimized performance. A tentative tip angle flight plan is as follows (3):



The Design

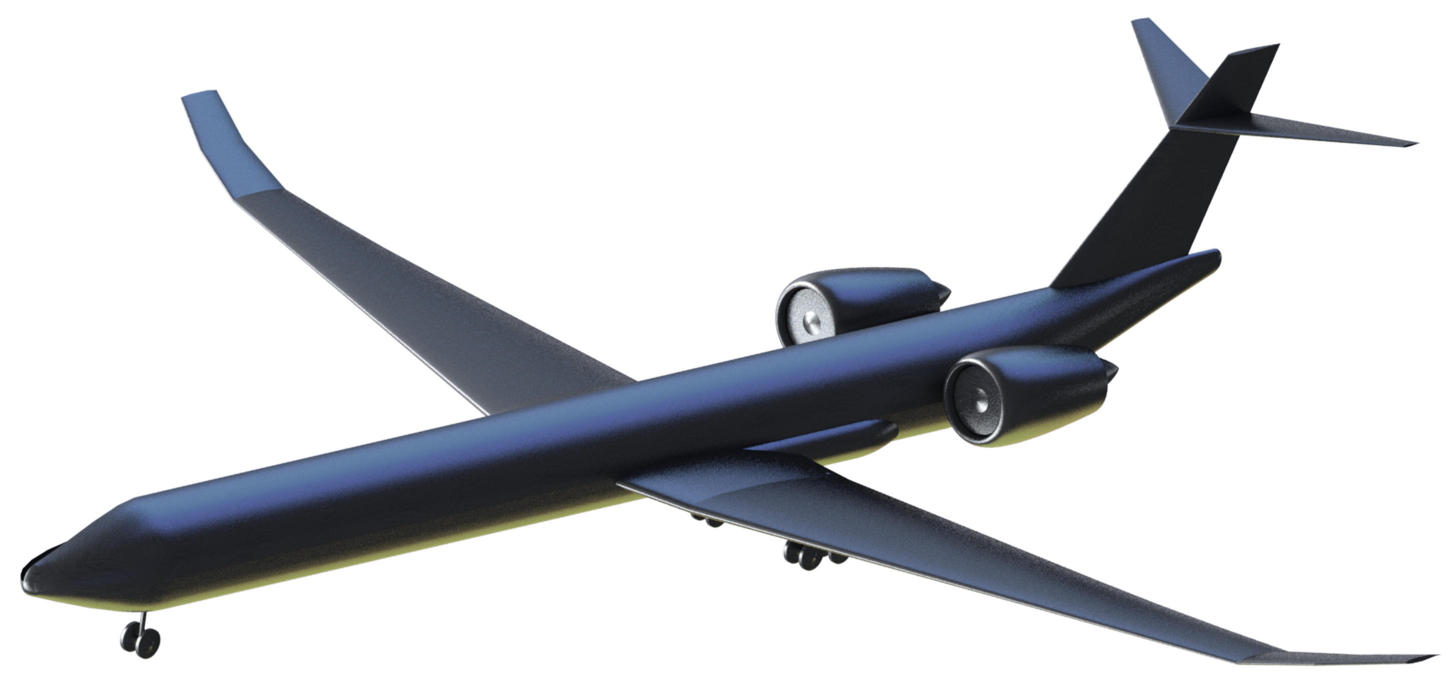


Fig. 3: SRHC-530G - Kerosene (2)

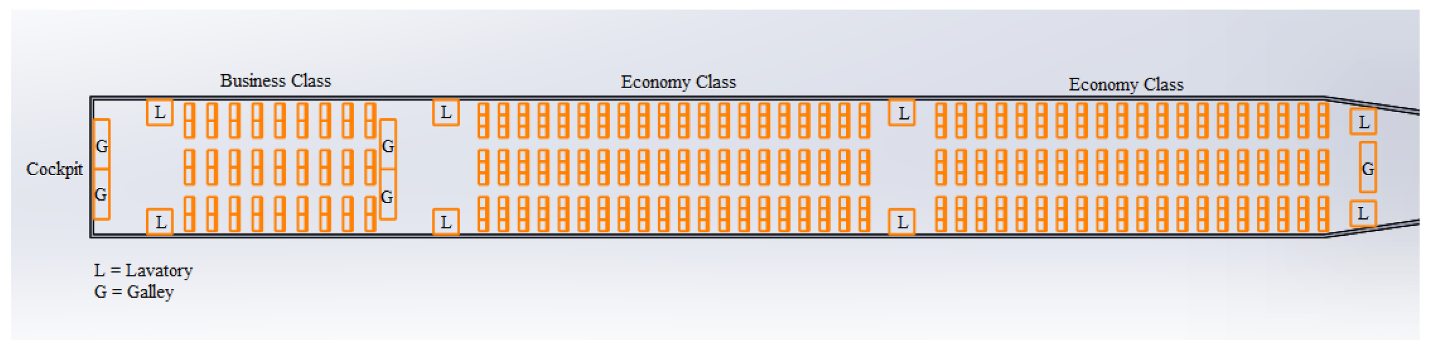


Fig. 4: Kerosene Variant Cabin Layout Offering Twin-Isle 3-3-3 Seating Style(Economy)

Variants

Two variants for the SRHC exist, the first will be a Kerosene variant which will accommodate more seating and rely solely on the use of Jet Fuel/ Kerosene as a propellant. The hydrogen variant will include reduced seating to accommodate liquid hydrogen storage tanks in the front and rear of the fuselage. Main effect of which is a higher OEW but a lower MTOW.

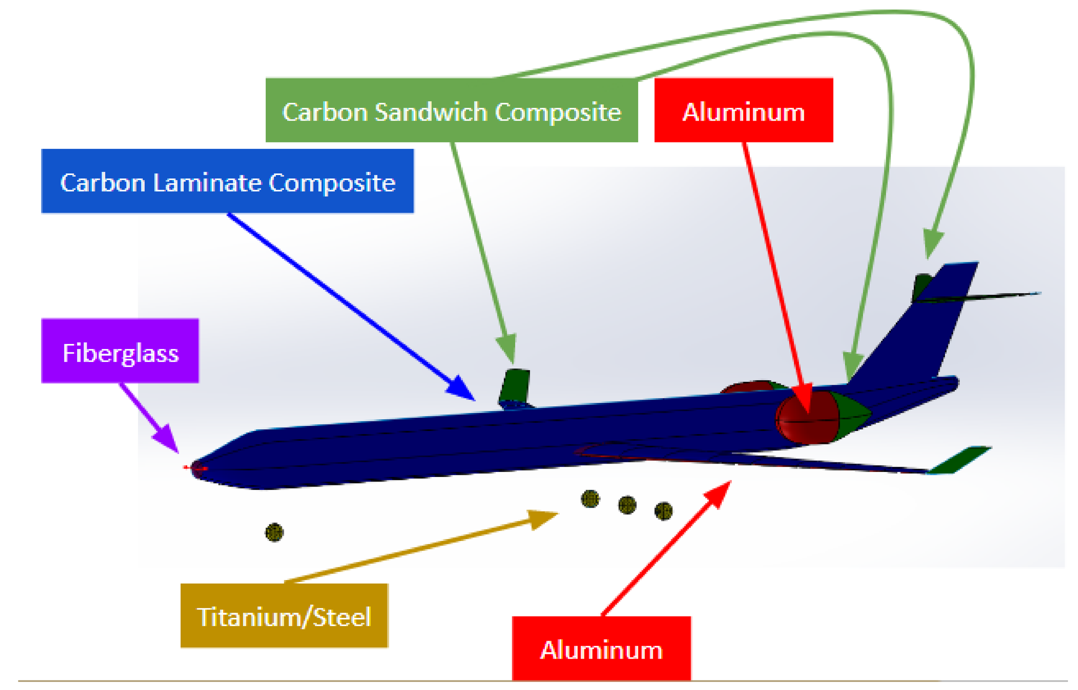
The benefits of transitioning to a hydrogen propelled aircraft is evident, per the RFP the cost of using Kerosene breaks down to $ 6 per gallon including carbon tax. Furthermore emissions from the use of pollutant fuel need to be mitigated as requirements by the EPA and ACARE.

Performance and Comparison

Specification	Boeing 777-200	Boeing 777-300ER	SRHC-530G
Flight Crew	2	2	2
Capacity	400 (2-class)	451 (2-class)	414 (2-class)
Length	209.1 ft	242.3 ft	239.8 ft
Wingspan	199.9 ft	212.6 ft	233.2 ft
Wing Sweep Back	31.6°	31.6°	24.0°
Wing Area	4605 ft^2	4702 ft^2	4717 ft^2
Cabin Width	19.3 ft	19.5 ft	18.2 ft
Fuselage Width	20.3 ft	20.3 ft	19.3 ft
Empty Operating Weight	297,300 lbs	370,000 lbs	296,000 lbs
Maximum Take-off Weight	545,000 lbs	775,000 lbs	566,000 lbs
Cruise Speed	Ma = 0.84	Ma = 0.84	Ma = 0.80
Maximum Range	5,240 nmi	7,930 nmi	3,787 nmi
Takeoff Distance at MSL	8,300 ft	10,500 ft	7,450 ft

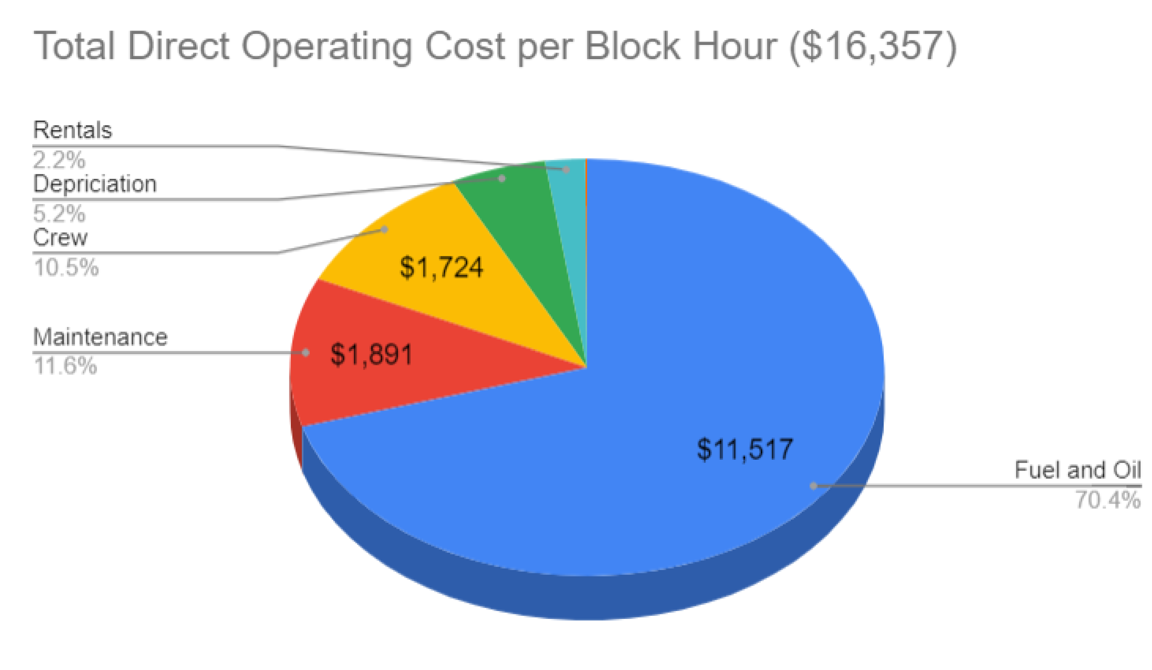
Material Selection

The design will use a combination of carbon sandwich, carbon laminate, and fiberglass composites. Major structural sections of the aircraft will use carbon laminate composites, such as the fuselage, wing box, and stabilizer boxes. Secondary structures will use carbon sandwich composites such as the rudder, elevators, wingtips, and nacelle cowling. Fiberglass epoxy laminates will be used for the wing fairings, stabilizers, radome, and the wing-to-fuselage fairings. The aircraft interiors will use graphite composites in the floor panels, main deck side walls, ceiling panels, and overhead stowage bins.



Business Case

The pie graph below shows the total operating cost breakdown per hour.



Reference Mission	700 nm	3500 nm
Average Speed	Ma 0.8	Ma 0.8
Flight Time	1.62 hours	8.10 hours
Total Block Hours	1.97 hours	8.45 hours
Total Direct Operating Cost	$32,210	$138,149
Cost per Available Seat Mile	$0.1111	$0.0953

References

Senior Design Course Professor - Case van Dam
Course Teaching Assistants - Jared Sagaga, Ryan Han
(1) Roskam, Jan. "Preliminary Sizing of Airplanes". DARcorporation, 2005.
(2) NASA Open Vehicle Sketch Pad. http://openvsp.org/
(3) Guerrero, Joel Sanguineti. (2019). "Variable cant angle winglets for improvementof aircraft flight performance."