The BLOODHOUND Project

Vehicle Technical Specification

Release Date: 9 August 2010
Vehicle Config ref: Configuration 10

SUMMARY

This document is to provide a top-level (vehicle level) source of design specification, targets, design assumptions and design status for the BLOODHOUND Project.

It is intended to provide a common source of data for the engineering team and to provide a means of monitoring design maturity at various stages of the project.

The document is not intended to replace system or sub-system specifications, but it is meant to encapsulate or refer to them.

This is intended as a reference document only.

DISCLAIMER

CONTENTS

1 REGULATIONS

The regulations laid down Land Speed Record authorities are to be adhered to. Permission to depart from the regulations below should be obtained from the Design Team Meetings. Applications to the FIA or other authorities for departure from the rules will be facilitated via the Design Team Meetings.

Future issues of the VTS will refer to timing regulations laid out by the appropriate Authority upon final selection of a Record location.

Federation Internationale de L'Autombile (FIA) Article 216 Appendix D regarding record attempts available from http://www.fia.com/en-GB/sport/records/Pages/Introduction.aspx.

Please visit the web site regularly as rule corrections are posted on the web site.

2 EXTERIOR DIMENSIONS

2.1 Length

SAE	Definition	unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
L101	Wheelbase	mm	8900	8900			
L103	Overall Length	mm	12864	13470			
L104	Overhang Front	mm		3429.75			
L105	Overhang Rear	mm		1140.25			
L128	Front wheel centreline (Design)	x	7000	7000			
	Front wheel centreline (Design)	z	635	635			

2.2 Width

SAE	Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
W101	Front Track	mm	1000	800			
W102	Rear Track	mm	2300	1760			
W103	Max. Vehicle Width	mm	2500	1900			
	Turning Circle	m		120			

2.3 Height

SAE	Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
H101	Vehicle height (design condition)	mm		3000			
	Ground clearance at front wheel centre (design)	mm	200	130			
	Ground clearance at rear wheel centre (design)	mm	200	130			

3 INTERIOR DIMENSIONS

3.1 Occupant Package

SAE	Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
L31	Seating reference point	X mm	8210	8313			Hip point
W20	Seating reference point	Y mm	0	0			Hip point
H70	Seating reference point	Z mm	705	643			Hip point
L40	Back Angle	°		39.4			
	Driver front vision, side view down angle	°	4	4			

4 GEOMETRIC DATUMS

X, Y, Z co-ordinates for the position of Major Components/Assemblies*:

Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Parachutes	mm					
Rear Wheels/suspension	mm		15900,880,635			WHEEL CENTRE ,X,Y,Z
Rear Stabiliser	mm					
Rocket engine & casing	mm		16436.95,0,737.3808			REAR FACE OF ROCKET NOZZLE X,Y,Z ROCKET 2 DEGREES NOSE DOWN
Eurojet EJ200	mm		12406.75,0,1570			FRONT FACE OF JET X,Y,Z
CHASSIS COCKPIT SPLIT	mm		X=10080			
TOP AND BOTTOM CHASSIS SPLIT	mm		Z=1001			
Rear structure and skins	mm					
EJ200 intake structure	mm					
APU Assy	mm					
HTP Tank	mm					
Driver/cockpit structure	mm					
Front wheels	mm		7000,400,635			CENTRE OF WHEEL X,Y,Z
Front stabiliser	mm					
APU Cooling system	mm					
Nose Structure	mm					

*__All X,Y,Z coordinates refer to vehicle datum as per BLOODHOUND Design Office Standards:__

__x=0 at 7000mm ahead of front axle centreline__
__y=o at mid-point of wheel track__
__z=0 at 200mm below ground level__

5 PACKAGE CAPACITIES

Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
EJ200 Fuel Tank Capacity	Litres		500			Jet fuel max requirement 500 ltrs (400kg) inc safety margin, idling reserve and ullage.
APU Fuel Tank Capacity	Litres		40			
APU Engine Oil Tank Capacity	Litres		9.5			
APU Transmission Oil Tank Capacity	Litres		N/A			
APU Cooling Tank Capacity	Litres		125			Total for both tanks
Hydraulic Oil Tank Capacity	Litres		?			
Falcon Rocket HTP Tank Capacity	Litres		963			
Nitrogen Tanks	Litres		?			2 tanks, volume TBC
Rocket Fuel System Purge Tank (De-ionised Water)	Litres		25			

6 VEHICLE OPERATING ENVIRONMENT

6.1 UK

Definition	Unit	Status	Comment
Venue	-	TBD	
Max. Ambient Air Temp	℃	30	UK Summer
Min. Ambient Air Temp	℃	0	UK winter
Elevation	m (ft)	0-152 (0-500)	Venue TBD
Ambient Air Pressure range	mb	970-1040	Typical limits of UK surface pressure

6.2 South Africa

Definition	Unit	Status	Comment
Venue	-	Hakskeen Pan	
Max. Ambient Air Temp	℃	40	Based on Upington and Rietfontein annual maxi ma (and assuming a personnel limit of 40℃)
Min. Ambient Air Temp	℃	0	Based on Upington and Ri etfontein annual averages
Elevation	m (ft)	794 (2600)	Altitude above sea level
Ambient Air Pressure Range	mb	915-940	Typical limits of SA surface pressure
Max. Density Altitude	m (ft)	1829 (6000)	Based on 40℃ and 915mb

7 VEHICLE MASS PROPERTIES

7.1 Mass Overview

Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Vehicle Mass at (Design Condition Full with fluids and driver)	kg	<6422	6422			
Vehicle Mass (Empty and driver)	kg	<4738	4738			
Driver Mass	kg	92	92			Andy Green estimate of his mass plus kit
Mass of Fluids	kg	?	1752?			Fuel, lubricants and coolants
Sprung Mass Pitch Inertia (Design Condition Full with Fluids and Driver)	$kg.m^2$		72964			

Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Sprung Mass Pitch Inertia (Empty and Driver)	$kg.m^2$		56211			
Yaw Inertia (Design Condition Full with Fluids and Driver)	$kg.m^2$		98485			
Yaw Inertia (Empty and Driver)	$kg.m^2$		86792			
Roll Inertia (Design Condition Full with Fluids and Driver)	$kg.m^2$		3669			
Roll Inertia (Empty and Driver)	$kg.m^2$		2698			

Note: Design Condition is defined as the mass at start of run at zero speed. i.e. with driver and fluids.

7.2 Mass Breakdown

Definition (Major Assy)	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Parachutes	kg		90			
Rear Wheels/suspension	kg		500			
Rear Stabiliser	kg		70			
Rocket engine & casing (Design Condition/Empty)	kg	?	500 / 319			
Eurojet EJ200	kg		1000			
Fin Structure	kg		75			
EJ200 fuel and tanks (Design Condition/Empty)	kg		460 / 60			
Rear structure and skins	kg		1300			
EJ200 intake structure	kg		70			
APU Assy	kg		270			
HTP Tank (Design Condition/Empty)	kg		1083 / 120			
Driver/cockpit structure	kg		500			
Front wheels/suspension	kg		500			
Front stabiliser	kg		90			
APU Cooling system	kg		165			
Nose Structure	kg		200			

8 VEHICLE CENTRE OF GRAVITY

8.1 C of G Overview

Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Centre of Gravity Height from ground (Design Condition/Empty)	mm	827 / 830	844.2/794.4			
Proportion of vehicle weight on front axle (Design Condition/Empty)	%	52 / 52	46.58/44.30			
Proportion of vehicle weight on Rear axle (Design Condition/Empty)	%	48 / 48	53.42/55.70			

8.2 C of G Breakdown

X, Y, Z co-ordinates for the CofG of Major Assemblies*:

Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Parachutes	mm		15809,0,1136			
Rear Wheels/suspension	mm		15541,0,634			
Rear Stabiliser	mm		15900,0,2897			
Rocket engine & casing	mm		14492,0,669			
Eurojet EJ200	mm		13825,0,1506			
Fin Structure	mm		15000,0,2430			
EJ200 fuel and tanks	mm		13825,0,860			
Rear structure and skins	mm		12000,0,1112			
EJ200 intake structure	mm		10680,0,1721			
APU Assy	mm		10711,0,550			
HTP Tank	mm		9356,0,879			
Driver/cockpit structure	mm		8695,0,980			
Front wheels/suspension	mm		6892,0,632			
Front stabiliser	mm		6000,0,660			
APU Cooling system	mm		7823,0,839			
Nose Structure	mm		6414,0,600			

***All CofG x,y,z coordinates refer to vehicle datum as per BLOODHOUND Design Office Standards:**

x=0 at 7000mm ahead of front axle centreline

y=o at mid-point of wheel track

z=0 at 200mm below ground level

VEHICLE SAFETY

Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Driver air supply	min	>45				To supply at least 20 min at the end of 2 runs
Fire Extinguishing		?				
Driver Seat Restraint/Harness		?				
Head Restraint		?				
HTP Leak Detection System		?				

Further safety system specifications to be added at a later date.

9 VEHICLE PERFORMANCE

9.1 Acceleration / Velocity

Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Velocity av. of 2 runs in opposite direction over measured mile.	mph	>1000				To FIA regulations.
Acceleration distance	mile	<4.5				Total track distance 10 mile
Max Velocity (Vmax)	mph	1050				Or as appropriate to achieve the above average speed

9.2 Vehicle Braking

Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Available Track Braking Distance	Miles	≥5.5	5.5			Hakskeen Pan: 10 mile track plus 1 mile of over run at each end
Nominal distance: Vmax to 0 mph		4.5	?			'chute solution TBD
Airbrake						
Max Deployment Speed	mph	800	800			
Max Deceleration	g	3	3			Progressive deployment to maintain g for as long as possible
Braking Distance	miles	4.5	>4.5			Airbrake-only braking dist, no chutes

Parachute						
Number of Parachutes		2	2			Target: 2 identical chutes, chute 2 as spare for chute 1
Parachute 1 (fully reefed)						
Max Deployment Speed	mach	0.9	0.9			Max strop load TDB
Max Deceleration	g	3	3			
Parachute 2 (unreefed)						
Max Deployment Speed	mph	400	?			TBD
Max Deceleration	g	3	3			

Definition	**Unit**	**Target**	**Status**	**Status Package Freeze**	**Status Drawing Release**	**Comment**
Friction Brake						
Application speed	mph	<250				Modified twin rotor DieselMax brake to be verified against the targets
Pedal Effort @ 1g	N	<500				
Pedal Travel @ 1g	mm	<100				
Brake Fade (Increase in effort)	%	<5				
Deceleration (g)	g	1 (Tarmac) 0.3 (Alkali)				

9.3 Aerodynamics

Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Frontal Area	m^2		1.937			
M=0.5 Coefficient of Drag Area	Cda	0.5	1.10			
M=0.7 Coefficient of Drag Area	Cda	0.7	1.13			
M=1.0 Coefficient of Drag Area	Cda	<1.3	1.28			
M=1.4 Coefficient of Drag Area	Cda	<1.3	1.32			
M=0.5 Coefficient of Lift	Cl		-0.38			
M=0.7 Coefficient of Lift	Cl		-0.08			
M=1.0 Coefficient of Lift	Cl		0.30			
M=1.4 Coefficient of Lift	Cl		0.30			
Yaw Static Margin at M=1.3	%	3% - 5%	?			
Front downforce percentage of static contact patch force	%	0 to 5				
Rear downforce percentage of static contact patch force	%	5 to 10				

10 AUXILIARY POWER UNIT (APU) AND HTP DELIVERY SYSTEM

Definition	Unit	Target	Status	Status	Comment
10.3 HTP Pump Specification					
Pump Configuration	Stentor large pump with improved volute				
Power Requirement (Design)	shp	665	665		
Peak Pump Speed (Contingency)	rpm	12,000	12,000		
Pump Speed (Design)	rpm	11,000	11,000		
Pump Torque (Design)	Nm	430	430		
Pump Flow Rate (Design)	kg/sec	47.6	47.6		
HTP Inlet Pressure	MPa	0.165	0.165		
HTP Delivery Pressure (Design)	MPa	7.58	7.58		
Volute and Bearing Housing	-	Aluminium			
Pump Shaft, Impeller & Inducer	-	Stainless Steel			
Front/rear Bearing Type	-	Roller/Ball Race			
Pump Cooling	-	Self cooling with HTP			
Pump Mass	kg		34		
10.4 HTP Tank Specification					
Tank Configuration	TBC				
Total Tank Volume	litres	810	963		
Dimensions	mm	TBC	TBC		
Material		Aluminium	Teflon/Carbon filament wound		

Working Pressure	MPa	0.165	0.165		
Max. Working Temperature	˚C	As low as possible	?		
Test Pressure	MPa	TBC	TBC		
Baffle Configuration	Horizontal and vertical plates with 114mm diam holes				
Outlet Diameter	mm	108	108		
Pressurising Gas		Nitrogen	Nitrogen		
Vent Valve diameter	mm	100-150	100-150		Needs rubber hose connection
Combined fill and drain	mm	?	?		Situated on top of tank – internal pipe extending from top to bottom
Water Port	mm	?	?		For tank flooding in an emergency
Leak Mitigation Mechanism	Tank covered in external plastic jacket to contain small leaks				

11 VEHICLE STABILITY TARGETS

Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Static Stability Index (Design Condition full with Fluids and Driver)	G	>1	1.025			
Static Stability Index (Empty and Driver)	G	>1	1.021			
Dynamic Stability Index (Design Condition full with Fluids and Driver)	G	>0.83	0.75			a.b/k^2 . where a & b are distance to axles from C of G, k is radius of gyration
Dynamic Stability Index (Empty and Driver)	G	>0.83	0.75			a.b/k^2 . where a & b are distance to axles from C of G, k is radius of gyration
Yaw Static Margin Aerodynamic (Design Condition full with Fluids and Driver)	%	3 to 5	?			Percentage of wheelbase
Yaw Static Margin Aerodynamic (Empty and Driver)	%	3 to 5	?			Percentage of wheelbase
Static Margin Vehicle Dynamic (Design Condition full with Fluids and Driver)	%	5 to 10	5 est			Percentage of wheelbase

Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Static Margin Vehicle Dynamic (Empty and Driver)	%	5 to 10	0 est			Percentage of wheelbase
Yaw Velocity Overshoot	%	4	?			
Roll Gain	deg/g	<4	2.64			
Rollover Resistance	G	≥0.8				Target supported by CFD study of Thrust SSC lateral G scenario using current CFD code.

12 CHASSIS SYSTEM TARGETS

12.1 CHASSIS FRAME

Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Static Bending Stiffness	N/mm	>10,000	CAE REQ			
Static Torsion Stiffness	Nm/deg	>10,000	CAE REQ			
First Torsion Mode (fully trimmed with vehicle masses)	Hz	30	CAE REQ			
First Bending Mode (fully trimmed with vehicle masses)	Hz	32	CAE REQ			
Local attachment Point stiffness	N/mm	>25,000	CAE REQ			

Wheels

Definition Design Condition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Wheel Diameter	mm	900	900			
Wheel Width	mm	150	150			
Wheel Rolling Diameter	mm	870	870			
Rim Profile						“V” profile – 30 degrees
Wheel Weight	kg	<100	149.3			Base Design Al.
Wheel Rotating Inertia	kg.m^2	<5	6.901			Need to review options for carbon epoxy composite and CFMMC wheel
Peak Wheel RPM at 1050 mph	rpm	10,304	10,304			
Specific surface loading (kg mass / mm wheel width)	kg/mm	<13	11.2			

12.2 Front Suspension

Definition Design Condition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Static Geometry						
Suspension Type	Double wishbone – Spring Damper to LCA					
Ride Height Adjustment	mm	None within Suspension				
Bump Travel	mm	100	50			
Rebound Travel	mm	100	50			
Total Travel	mm	200	100			
Static Camber	deg	0	0			
Static Castor	deg	6	5.99			
Kingpin Inclination	deg	8	8.04			
Hub Offset	mm	60	61.29			
Ground Offset	mm	2	-0.19			
Mechanical Trail	mm	100	99.29			
Roll Centre Height	mm	0	0.04			
Roll Centre Vertical Migration (To Ground)	m/m	1	n/a			Target not achievable with current suspension design (parallel wishbone)
Anti Dive	%	0	0			
Anti Lift	%	0	0			

Definition Design Condition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Kinematics Characteristics						
Toe Change	deg/m	0 to 0.1 toe out	0			
Camber Change	deg/m	0	0			
Castor Change	deg/m	0	0			
Longitudinal Wheel Centre Change	m/m	0	0			
Spring Characteristics						
Suspension Rate	N/mm	200 to 300	250			
Wheel Hop Frequency	Hz	12 to 20	12			Assuming 2000N/mm ground stiffness
Parasitic rate	%	<10	?			
Suspension Frequency (Design Condition full with Fluids and Driver)	Hz	2 to 3	2.301			
Suspension Frequency (Empty and driver)	Hz	2 to 3	2.773			
Damper Ratio	mm/mm	<1.4:1	<1.363:1			
Spring Ratio	mm/mm	<1.4:1	?			
Front Roll Stiffness from springs	Nm/deg		2181			

Definition Design Condition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Compliance Characteristics	Targets to be checked by FE and verified by compliance rig test					
Parallel Lateral Force						
Toe Compliance	deg/kN	0.1 toe out	CAE REQ			
Camber Compliance	deg/kN	0.001	CAE REQ			
Parallel Lateral Force 30mm Trailed						
Toe Compliance	deg/kN	0.1 toe out	CAE REQ			
Longitudinal Braking						
Toe Compliance	deg/kN	0.001	CAE REQ			
Caster Compliance	deg/kN	0.001	CAE REQ			
Torque About Vertical Axis						
Aligning Torque Compl.	deg/kN m	0.0005	CAE REQ			

12.3 Steering system

Definition Design Condition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Kinematic Characteristics						
Overall ratio – Steering Wheel Angle (SWA) / Road Wheel Angle	deg/deg	25:1 to 30:1	30:1			
Ackermann @ 5 deg	%	Undefined	0			Previously had 100%, now have 0%. Target needs defining as design progresses
Velocity Ratio Wheel to Pinion	%	<1% over 5deg SWA 3% over rest				
Compliance Characteristics						
Torsion Bar Compliance	deg/Nm	∞				PAS without torsion bar required
Total Steering Compl.	deg/Nm	<0.25				
Column Backlash	deg	<0.25				
Rack Mounting Compliance	mm/kN	<2				
Steering Torque						
Max Steering Effort	Nm	15				
Column Friction	Nm	0.2				
Torque gradient – Single Wheel Braking	Nm/kN	<0.00005				

12.4 Rear Suspension

Definition Design Condition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Static Geometry						
Suspension Type	Double wishbone – Pull rod and rocker to spring over damper					
Ride Height Adjustment	mm	None within Suspension				
Bump Travel	mm	100	50			
Rebound Travel	mm	100	50			
Total Travel	mm	200	100			
Static Camber	deg	0	0			
Static Castor	deg		11.22			
Kingpin Inclination	deg		2.85			
Hub Offset	mm	<60	41.24			
Ground Offset	mm	<40	18.86			
Mechanical Trail	mm	-20 to 0	-10			
Roll Centre Height	mm	0	0.05			
Roll Centre Vertical Migration (To Ground)	m/m	0.9 to 1.1	n/a			Target not achievable with current suspension design (parallel wishbone)
Anti Dive	%	0	0			
Anti Lift	%	0	0			

Definition Design Condition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Kinematics Characteristics						
Toe Change	deg/m	0 to –0.05 toe in	0			
Camber Change	deg/m	0	0			
Castor Change	deg/m	0	0			
Longitudinal Wheel Centre Change	m/m	0	0			
Spring Characteristics						
Suspension Rate	N/mm	200 to 300	250			
Wheel Hop Frequency	Hz	12 to 20	11.9			Assuming 2000N/mm ground stiffness
Parasitic rate	%	<10	?			
Suspension Frequency (Design Condition full with Fluids and Driver)	Hz	2.5 to 3	2.72			
Suspension Frequency (Empty and driver)	Hz	2.5 to 3	3.11			
Damper Ratio	mm/mm	<1.4:1	?			
Spring Ratio	mm/mm	<1.4:1	?			
Front Roll Stiffness from springs	Nm/deg		12462			

Definition Design Condition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Compliance Characteristics	Targets to checked by FE and verified by compliance rig test					
Parallel Lateral Force						
Toe Compliance	deg/kN	0.05 toe in	CAE REQ			
Camber Compliance	deg/kN	0.001	CAE REQ			
Parallel Lateral Force 30mm Trailed						
Toe Compliance	deg/kN	0.05 toe in	CAE REQ			
Longitudinal Braking						
Toe Compliance	deg/kN	0.001	CAE REQ			
Caster Compliance	deg/kN	0.001	CAE REQ			
Torque About Vertical Axis						
Aligning Torque Compl.	deg/kNm	0.0005	CAE REQ			

ELECTRICAL / CONTROL SYSTEMS SPECIFICATION

13 ELECTRICAL SYSTEM OVERVIEW

Item	Specification
Main Battery	12V, 10A
APU System battery	12V, 30A
Parachute System Battery	?
Fire System Battery	?
System Voltages	5V (sensor outputs) , 12V (car systems), 28V (EJ200 DECU)
System ethos	Analogue Conventional Wiring
Alternator	12V
Instrumentation	
Wiring loom	Lightweight, Analogue wiring, thin wall insulation
Power protocol	Negative earth
Data Logging	
Sensors	Ref: List of Sensors V4.1.xls by JD
Data Transfer	Intel WiMAX
Electromagnetic Compatibility (EMC)	
Fuse blow tests	
Load current tests	
Voltage drop test	

Switch gear	Tactile, light and to driver ergonomic requirements
Quiescent drain	Sub 20 ma

13.1 Control System Architecture

Item	**Specification**
Hardware Format	PC104
Programming Language	Mathworks Simulink
Processors	3 off Intel Atom controlled via Diamond Systems Neptune Processor1: APU / Falcon Rocket Processor 2: EJ200 DECU (via MIL-STD-1553) and Cockpit displays/controls Processor 3: Vehicle Functions
Data Storage	Via 1 off Diamond Systems Pluto, HDD size TBC, Windows CE based
Vehicle Communications	Intel WiMAX via 1 off Diamond Systems Pluto, Windows CE based
Data Acquisition	5 off Diamond Systems Diamond –MM-32X-AT Channels: 32 off Analogue Input (16 bit) 4 off Analogue Output 12 bit 24 off Digital Input/Output 250,000 sample/sec total

14 HYDRAULIC SYSTEM SPECIFICATION

14.1 Hydraulic System Overview

Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Number of Pumps	-	2	2			Parker Hannifin F1 Spec Variable Displacement
Number of Accumulators	-		TBC			
Hydraulic Oil Grade	-		TBC			
Max. Operating Pressure	bar		300			
Normal Operating Pressure	bar		200			
Airbrake Pre-charge Pressure	bar		220			

14.2 Hydraulic Pump Specification

Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Pump speed	rpm	3,000-10,000	3,000-10,000			Safe working speed up to 10,000rpm
Pump Flow Rate	kg/s		0.236			NB this is @ 7,000rpm
Hydraulic Oil Cooling	-					
Pump Mass	kg		0.8			
Pump Drive Mechanism	-	Gear-driven off APU	Gear-driven off APU			

15 PROPULSION JET

15.1 Rolls Royce EJ200 Specification

Item	Unit	Condition	Comment
Max. Thrust (wet)	kN	90	
Max. Thrust (dry)	kN	60	
Fuel Type	-	Jet A or JP8	
Power Supply Requirement	V	28V	
Power Take Off	-		
Fuel Usage at Max Thrust (wet)	kg/s	4.23 – 4.41	Specific Fuel Consumption 47-49g/kNs with reheat Fuel usage = (47*90)/1000 - (49*90)/1000
Fuel Usage at Max Thrust (dry)	kg/s	1.26 – 1.38	Specific Fuel Consumption 21-23g/kNs without reheat Fuel usage = (21*60)/1000 - (23*60)/1000
Fuel Usage at Idle	kg/s	0.25	
Fuel Pressure	Bar		
System Mass (dry)	kg	1000	
Fuel Mass Required	kg	353.43	5min idle, 10sec max thrust dry, 43sec max thrust wet, 5min cool down. DOES NOT INCLUDE ULLAGE
Diameter	mm	740	
Length	mm	4000	

15.2 EJ200 Intake Duct Specifications

Item	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Intake Area	m^2	0.28 – 0.38	0.35			
Aspect Ratio	-	1.5 – 2.6	2.0			
Offset Ratio	-	0.23	0.23			
Area Ratio	-		0.8			
Length	mm		3.75			

16 PROPULSION ROCKET

16.1 Falcon Hybrid Rocket

Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Hybrid Rocket Motor						
Average Thrust	kN	111	111			
Max Thrust	kN	133	122			
Total Impulse	kN.sec	2,230	2,230			
Specific Impulse	sec	200	200			Hope to increase
Total Propellant Mass	kg	1,130	1,130			
Mixture Ratio (Oxidant:Fuel)		5.25:1	5.25:1			
Initial System Mass	kg	TBC	TBC			
Oxidant Feed Mechanism		Pump	Pump	Pump		
Oxidant						
Oxidant Type	-	HTP (H_2O_2)	HTP (H_2O_2)	HTP (H_2O_2)		
Mass	kg	963.0	963.0			(includes 10-15% ullage to prevent pump running dry)
Volume	m^3	0.696	0.696			
Tank Mass Fraction		0.85				
Tank Pressure	MPa	0.165	0.165			
Density	kg/m^3	1,370	1,370			
Flow rate	kg/sec	47.6	47.6			
Delivery Pressure	MPa	7.58	7.58			
Fuel						

Fuel Type		HTPB	HTPB	HTPB		
Mass	kg	181	181			
Combustion Chamber						
Diameter	mm	457	457			
Length	mm	3.78	3,780			
Mass Fraction		TBC	TBC			
Catalyst Pack Type	Silver-Plated Nickel Gauze					Mk 2

16.2 Falcon Monopropellant Rocket

Definition	Unit	Target	Status	Status Package Freeze	Status Drawing Release	Comment
Monoprop. Rocket Motor						
Average Thrust	kN		44.5			
Max Thrust	kN					
Total Impulse	kN.sec		890			
Specific Impulse	sec		117			
Run Duration	sec		20			
Initial System Mass	kg		TBC			
Propellant						
Fuel Type	-	**HTP (H_2O_2)**	**HTP (H_2O_2)**	**HTP (H_2O_2)**		
Mass	kg		776			
Density	Kg/m^3		1,630			
Volume	m^3		0.566			
Delivery System	-					
Tank Pressure	MPa		0.165			
Flow Rate	Kg/sec		38.8			
Delivery Pressure	MPa		5.52			
Combustion Chamber						
Diameter	mm		457			
Length	mm		707			
Mass	kg		155			

Mass Fraction			TBC			
Catalyst Pack Type	Silver-Plated Nickel Gauze					Mk2

17 OPERATING PROCEDURES

Item	Specification	Comments
Transport to site	40ft Container with side loader	
Tow Point	Rigid bar mounting point behind front nose section (front section of nose removed during towing)	
Front Jacking Point	?	Will also be used as bolt down points (for transportation & tie-down tests) and axle stand points
Rear Jacking Point	?	Will also be used as bolt down points (for transportation & tie-down tests) and axle stand points