

System Blueprint: The Hydrostatic Tail-Sitter Cargo UAS

Core Operational Architecture

- **Platform Type:** Autonomous tactical Group 3 Lift+Cruise tail-sitter cargo aircraft.
- **Target Mission:** 300-mile out and back autonomous runway-free delivery of an 80lb medical/critical payload over unmaintained terrain.
- **Powertrain Setup:** Symmetrical twin-opposed 9,600-Watt (21 HP total) modular free-piston core modules weighing 54 lbs total.
- **Vibration Mechanics:** Mirrored dual-engine balancing running at an identical 50 BPM capacity each to achieve perfect inertial cancellation of the 1.4 lb sliding tungsten masses.



A) Sizing, Mass, & Takeoff Fluid Weight Allocation

- **Total Gross Takeoff Mass:** 253.7 lbs total.
- **Fixed Operational Weights:** 80.0 lbs payload + 60.0 lbs liquid hydrocarbon fuel (JP-8/diesel).
- **Structural Hardware Weights:** 54.0 lbs combined dual-engine core + 32.2 lbs expanded carbon-fiber lifting skin shell (inclusive of high-pressure loops, fluid manifold headers, and auxiliary pumps).
- **Takeoff Hydraulic Bounds:** 100 BPM total pump frequency cycling a customized 2.057-inch cylinder bore diameter (P_{Chyd}). This outputs a combined continuous fluid flow of 41.43 L/min at a steady loop line pressure of 268.4 Bar (3,936 PSI), perfectly matching the 13.23 Nm takeoff shaft torque limits.



B) Physical Configuration & 3D Spatial Clearances

- **Airframe Form Factor:** 9.8-foot total wingspan by 4-foot length using an AH 80-140 aerodynamic lifting wing profile tapered to a 2-foot wide bulbous central structural cargo fuselage bay.
- **Landing Configuration:** Vertical "penguin leg" aft-mounted base plates designed for direct vertical takeoff and landing out of rough forest or jungle clearings without launch rails or towing infrastructure.
- **Propeller Distribution Matrix:** Hybrid 6-propeller separation splits vertical lift authority away from forward cruise workloads.
- **X-Axis Width Spacing:** Inner cruise propeller centerline fixed at 26 inches from fuselage center; outer VTOL propeller centerline fixed at 60 inches (5 feet) right at the wingtips.
- **Y-Axis Length Spacing:** Outer 42-inch props mounted symmetrically 23 inches forward and 23 inches backward from the wing's main edge.
- **Blade Collision Protection:** Horizontal 1-inch flat line gap expanded via the 23-inch Y-axis split into a 23.02-inch true 3D diagonal clearance zone, ensuring zero blade strike vectors under heavy structural wing flex.



C) Cruise Flight Aerodynamics & Hydraulic Gearing

- **Flight Altitude Baseline:** 6,000 feet altitude cruise moving at 88 ft/sec (60 mph steady level flight) at an 8.00-degree optimized wing Angle of Attack (AOA).
- **Aerodynamic Balance Matrix:** 226.82 lbs of active lift force balancing out against 46.17 lbs of total atmospheric drag.

- **The Self-Trimming Mechanical Lift:** Turning the blunted 2-foot central fuselage section upside down creates a natural positive pitching moment ($\backslash(+C_{\{m\}}\backslash)$), perfectly neutralizing the negative twisting torque of the wings to allow hands-free level flight without drag-inducing tail surfaces or external mechanical wing flaps.
- **The Cruise Gear Transition:** Shutting down the four outer 42x14" fixed-pitch props during forward cruise and locking them in place via zero-leak center-stop valves. Fluid volume is concentrated directly to two front-mounted, fixed-pitch 24x24" dual-blade cruise propellers.
- **Cruise Shaft Torque Balance:** Sizing down the cruise diameter to 24 inches drops individual drive hub resistance back to 11.71 Nm, allowing system operating line pressure to drop back down to its stable 248.6 Bar (3,605.6 PSI) envelope.



D) The Triple Zero-Signature Matrix

-  **Acoustic Signature:** Spreading the level cruise power across two active cores at a half-speed 50 BPM frequency outputs a quiet low-frequency fluid thumping that blends perfectly into ambient wilderness wind levels.
-  **Thermal Signature:** Utilizing incremental fuel micro-injection cuts peak internal combustion spikes down to a flat 380°F before a massive adiabatic expansion coast drops terminal gas inside the cylinder down to 125°F. Venting this gas across copper counter-current intercoolers drops exhaust down to an ambient 73–74°F baseline, hiding the drone from thermal tracking systems.
-  **Radar Signature:** A fully sealed internal piston cycle with zero exposed rotating turbine compressor blades removes all localized doppler frequency flashes from hostile ground radar screens.



E) Long-Range Mission Capabilities Ledger

- **Brake Specific Fuel Consumption:** High-pressure hydrostatic engine loop efficiency achieves a solid 0.55 lbs/BHP·hr consumption target.
- **Thrust Power Draw:** Overcoming the 46.17 lbs of cruise drag at 60 mph requires a continuous output load of 9.76 Brake Horsepower (7,278 Watts), utilizing just 46% of the powerplant's 21 HP maximum threshold.
- **Continuous Flight Endurance:** Fuel burn rate sets a highly efficient 5.37 lbs of fuel usage per hour, yielding an absolute operating limit of 11 hours and 10 minutes of air time on a full 60-lb fuel load.
- **Jungle Logistics Profile:** Completing a 300-mile non-stop round-trip route requires exactly 5 hours of level transit time. Pushing through the loop burns 26.85 lbs of fuel, allowing the drone to lift off with an 80lb payload, touch down autonomously in a remote jungle clearing on its penguin base plates, drop its medical packs, and fly back to base with a highly resilient 33.15 lbs (over 55%) fuel safety reserve.

