Quest Aircraft Kodiak 100

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Index

Real world

The Quest Aircraft Kodiak 100 is a 10-seat turboprop aircraft manufactured in Sandpoint, Ohio, USA. The aircraft is available with wheels or amphibious floats, and features an all-glass Garmin G1000 cockpit. The aircraft was designed as a backcountry utility aircraft.

Mission-oriented conceptual design

> "*From the very beginning our underlying mission at Quest has been to design and manufacture a backcountry / utility aircraft specifically suited to the needs of the mission and humanitarian aviation organizations which provide access to the most remote regions of the world and the isolated people groups who live in them*."[1]

According to a Quest Aircraft press release of October 22, 2007 the main visionary behind the Quest Kodiak 100 is the late Bruce R Kennedy, who is also the founding chairman of Quest Aircraft. Mr Kennedy held top positions at the Alaska Air Group, and in 1991 left that company to pursue humanitarian efforts. One of these efforts was to design an aircraft specifically tailored to the needs of humanitarian flying in challenging locations. The "Co-visionary", as stated by Quest Aircraft, is Thomas S Hamilton. Mr Hamilton is a veteran of aircraft design, having designed the Glasair series of aircraft and the Aerocet composite floats.

The conceptual design was made in cooperation with a large number of humanitarian organizations who regularly employ small aircraft to deliver cargo and passengers to remote and unimproved airstrips. The technical design was made at Quest Aircraft. The main focus of the technical design was to make the aircraft perform safely in its intended operating environment.[2]

The company Quest Aircraft LLC was founded in 1998. Six years later the first pre-production prototype Kodiak 100 made it's maiden flight on October 16. Another three years later, on March 16 2007 the first production aircraft took off. Just 2½ months later the type received FAA certification. The certification includes single pilot operation for VFR/IFR and day/night operations.

The Kodiak in its intended environment. In the bush, on a mission.

[1] www.questaircraft.com/index.php?filename=mission.php, retrieved at September 10, 2010
[2] www.questaircraft.com/uploads/videos/03.wmv, retrieved at September 10, 2010

Technical design for safe operation

Quest Aircraft marketing emphasizes four factors that enable safe operation in adverse environments. These are STOL capability, turbine power, high useful load and rugged construction.

STOL capability

The Kodiak wing has something called a "Fixed Discontinuous Outboard Leading Edge Extension"[3], and it is just what it sounds like. The outer half (roughly) of the wing has a different cross-section than the inner half, with a longer chord. This longer chord portion will stall at a lower speed than the inner half, thereby giving the ailerons the possibility to retain control at low speeds. To separate the effective airflow around the outer wing from the possibly stalled airflow of the inner wing, the wing leading edge has a so-called "dogtooth", a sharp kink in the leading edge of the wing. The dogtooth creates a vortice "fence" in the direction of the airflow, effectively separating the differences in airflow along the wing, making it harder for a stall to spread outwards and reaching the ailerons. This design enables the Kodiak to retain aileron control at near-stall airspeeds, such as a slow approach.

Turbine engine

The Kodiak is powered by a Pratt & Whitney PT6A-34 free turbine, producing 750 horsepower. Variants of this engine power the Cessna 208 (PT6A-114) and the Beech 1900 (PT6A-65/67). Pratt & Whitney lists 65 aircraft types using variants of the PT6A engine.[4]

The power-to weight ratio of 9,67lbs/hp of the Kodiak allows for rapid acceleration on a short runway. It also allows a steep climbout or tight turns after takeoff. This contributes to the STOL capability of the aircraft.

Being a turbine, the PT6A is less sensitive to water-fouled fuel than a piston engine. This improves safety because the fuel quality in the Kodiak's intended areas of operation may vary. Jet fuel is also apparently easier to get by than avgas, in many locations.[5]

High useful load

Having lots of cargo in an aircraft is not improving safety by itself, but having lots of cargo on one flight means less need for another flight. This reduces the amount of flights needed for a certain task, thereby increasing safety by reducing aircraft movements.

Rugged construction

Since the intended operating environment is unimproved airstrips, the Kodiak landing gear was designed to deal with rough surfaces and occasional gopher holes and stumps. The interior is described as "hose down"[6], and a Quest Aircraft engineer compares the construction of the Kodiak to a dirt bike, which is designed to take all

[3] en.wikipedia.org/wiki/Leading_edge_extension, retrieved at September 10, 2010
[4] www.pwc.ca/en/engines/pt6a, retrieved at September 10, 2010
[5] www.maf.org/kodiak, retrieved at September 10, 2010
[6] www.questaircraft.com/uploads/pdfs/questebro.pdf, retrieved at September 10, 2010

sorts of abuse, but since it is designed to do just that, it is not really abuse but within the operational parameters.[7]

Current utilization

The Quest Aircraft website lists a number of customers currently operating the Kodiak. Among these are several humanitarian assistance organizations. Below is a list of the operators made public by Quest Aircraft.

Operator	**Comment**
Spirit Air, Salmon, Idaho.	First Kodiak delivered.
Spokane Turbine Center.	Flight and maintenance training
Rhine Army Parachute Association (RAPA)	s/n 005
Jungle Aviation and Radio Service (JAARS)	s/n 008
Mission Aviation Fellowship (MAF)	s/n 0011, 0020
US Fish & Wildlife Service	Total of nine ordered
Samaritans Purse	s/n 0015
New Tribes Mission	Total of 14 ordered

The Federal Aviation Administration (FAA) lists a total of 39 Kodiaks registered in the United States[8]. At least one more, s/n 005 is probably registered outside the US. The FAA further list one known accident involving the type, where a float equipped Kodiak crashed at touchdown on water, fortunately without fatalities.[9]

[7] www.questaircraft.com/uploads/videos/03.wmv, retrieved at September 10, 2010
[8] registry.faa.gov/aircraftinquiry/AcftRef_Results.aspx?Mfrtxt=QUEST&Modeltxt=KODIAK&PageNo=1, retrieved at September 11, 2010
[9] http://www.ntsb.gov/ntsb/GenPDF.asp?id=ERA10LA408&rpt=p, retrieved at September 11, 2010

Future of the company and the aircraft

Quest Aircraft LLC

According to the company website, Quest Aircraft LLC has expanded from a modest 14 employees in 2001 to a peak of over 300 employees in 2009. Currently the company employs 215 people. A press release of January 31 2008 states "Customer orders have exceeded expectations and the company has a 3-year backlog, which it is working to bring down as production ramps up."[10]

Quest Kodiak 100

The aircraft was designed from the start to take floats and became certified to use Wipline 7000 amphibious floats in 2010. An external cargo compartment and wing deicing system became available both on new aircraft and as a retrofit to already procured aircraft, also in 2010, and the aircraft received FAA approval to operate at a max gross weight of 7255 instead of the original 6750lbs. Quest Aircraft has not announced any upcoming further developments.

The Mission Aviation Fellowship states that it is very satisfied with how the Kodiak works, and that it plans to replace many of its Cessna 206 aircraft with Kodiaks.[11]

The Kodiak taking off on Wipline 7000 amphibious floats.

[10] www.questaircraft.com/index.php?filename=press_releases.php&article=164, retrieved at September 10, 2010

[11] www.maf.org/kodiak, retrieved at September 10, 2010

Technical specifications, Quest Kodiak 100[12]

Weights & Loadings

Max. Ramp Weight	7,305 lbs
Max. Takeoff Weight	7,255 lbs
Base Aircraft Empty Weight	3,770 lbs
Base Aircraft Useful Load	3,535 lbs
Fuel Capacity	320 gal
Max. Wing Loading	30.1 lbs/sq ft
Max. Power Loading	9.67 lbs/hp

Range & Endurance

(With 45 min. Reserve)
Max Cruise - At 172 ktas, at 12,000 ft, fuel consumption is 335 lbs/h
yielding 979 nm over 5.7 hr
Max Range Cruise - At 137 ktas, at 12,000 ft, fuel consumption is 228 lbs/h
yielding 1,113 nm over 8.1 hr

Propeller

Manufacturer	Hartzell
Type	Constant speed, feathering, reversible
Blades	4
Diameter	96 in
Tip Clearance	19 in

Powerplant

Manufacturer	Pratt & Whitney
Model	PT6A-34
Takeoff Power @ 2,200 RPM	750 hp
Max Continuous Power	700 hp

Performance

Stall Speed Vs1 (flaps up)	77 kcas
Stall Speed Vs0 (flaps down)	60 kcas
Rate of Climb (max. cont. at SL)	1,371 ft/min
Rate of Climb (10,000 ft)	867 ft/min
Takeoff Ground Roll	1,001 ft
Braked Roll (w/o reverse)	705 ft
Certified Ceiling	25,000 ft
Cruise Performance	183 ktas

[12] www.questaircraft.com/index.php?filename=specs.php, retrieved at September 10

Landing gear

Type	Fixed, faired leg, no pants
Main Gear	8.50 x 10 Cleveland, spring steel
Nose Gear	6.50 x 8 Cleveland, air-oleo, steer

Fuselage

Cabin Width	54 in
Cabin Height	57 in
Cabin Length	190 in
Cargo Volume	248 cu ft
Overall Length	34.2 ft
Seats	1-10
Doors	3
Door Sill Height	38 in
Cargo Door (LH side)	49.25x49.25 in
Cockpit Doors (both sides)	31x51 in

Flight surfaces

Area	240 sq ft
Span	45 ft
Airfoils	Custom
Dihedral	3°
Flap Type	Fowler, single-slotted
Horizontal Span	20 ft
Overall Height	15.3 ft

Optional equipment

Cleveland Large Main Tires (29 x 11)
Cleveland Large Nose Tire (22 x 8)
Quest Cargo Pod (2010)
Quest PAX Seats (up to 8)
Quest 10 Place Oxygen
TKS Ice Protection
Quest Tundra Interior
Quest Timberline Interior
Garmin SkyWatch/Stormscope Package
Garmin XM Infotainment
Garmin Synthetic Vision
S-Tec 55X Autopilot
Hartzell Propeller Pitch Latch
Artex C406-N ELT-GPS Locator
Quest Turndown Stacks
Quest RGB Chip Detector
Garmin Chart View Enable Card

Base price

Base price for the KODIAK is $1,111,000.

Simulation

Lionheart Creations (www.lionheartcreations.com) has made a factory authorized simulator version of the Quest Kodiak 100. The latest release to date is version 2.6 and includes both the wheeled and the amphibian version of the aircraft. The underbelly cargo pod is optional on both types of airframes. Two different passenger interiors are provided as well as a cargo, an ambulance, and a completely empty interior. Several different paint schemes are included and allow for a wide variety of combinations. The Garmin G1000 avionics are included and retains a high degree of functionality. The S-Tec Five Fifty autopilot is included and coupled to the G1000.

A sample flight

Today's flight is a special operations charter in Liberia, western Africa. The Kodiak is stationed at Spriggs Payne airfield (GLMR) outside Monrovia. At lunch, office receives a phone call from a group of NGO workers in the vicinity of a village called Nathalbli. They have had their car batteries stolen and one of their associates has to be in Monrovia to catch a flight in a couple of hours. Nathalbli is deep in the Liberian jungle. There are no airfields. But there is a road passing by the village, and the NGO workers supply us with GPS coordinates to their current position.

At GLMR the weather is rain and thunder, 10 miles visibility with ceiling at 1400 and light winds from the south. Temp is 25 degrees and dewpoint is 23. Hot and humid, that is. The preflight check reveals 1072 lbs of fuel remaining. With me, my gear and two new 12-volt car batteries aboard, the gross weight is 4692 lbs.

Startup procedure is master switch on, avionics bus on. The G1000 flickers to life and the GPS starts listening for satellites. Check flight controls and prop pitch control, everything moving. Parking brakes set, check. Next is fuel valves open, conditioner set to low, prop & engine RPM to low, igniter on, toggle starter switch. With a whine and a puff of grey smoke the PT6A-34 starts and the Hartzell prop turns to a blur.

The Kodiak enroute in a 165 kts cruise at 3500 ft. We are still VFR, right?

Tune GLMR ground & request taxi to the active. When close to runway, tune tower and ask for takeoff clearance. The aircraft is light, so 10 degrees of flaps, 70% power and off we go at 75 kts, after a roll of just a few hundred feet. Flaps up at 95 kts.

Set 65% power, 1900 rpm on the prop and climb to 3500 to get out of the clouds, all the while turning to the northeast. The ground has disappeared under a blanket of low clouds, so I set autopilot to follow the GPS course at 3500 ft. When at cruise altitude I set prop rpm to 1650 to achieve a speed cruise of 163 kts IAS. There's a plane to catch, right? The G1000 estimates 9 minutes to reach the coordinates supplied by the NGO workers.

Finding the ingress point, the crossroads south of Nathalbli, in deteriorating weather.

Minutes later, 8 miles out. Power back to idle, autopilot off. I make a 2000 ft/min descent and enter clouds and rain at 1800 ft. I start looking for the 4-way intersection that I will use as ingress point to find the NGO people and their vehicles. Cloud ceiling is at 1300 ft with heavy rain below. Not very good visibility. Power to 70% and 10 degrees of flaps to achive 90 kts at 1000 ft and looking hard for the intersection. Maybe I should have brought a spotter?

I spot the intersection a few seconds later. The NGO people should be just to the north. The G1000 tells me there is a 5 kts crosswind as I spot two vehicles by the roadside ahead of me. Select full flaps, adjust power to achieve 70 kts. Mind the trees. Touch down on the gravel road, immediately full reverse power and then apply brakes at 40 kts. The Kodiak stops hard, with gravel and wet leaves flying. Unload two batteries. Load one soaked passenger and baggage.

I use pedals, differential brakes and reverse power to turn the aircraft around without getting stuck in the mud beside the road. Align with “runway”, 20 degrees flaps, stand on the brakes and max everything, then release brakes as the aircraft starts to skid. The aircraft accelerates quickly down the road and we take off at 75 kts, still minding the trees.

Taking off from the road at Nathalbli, minding the trees.

I climb manually to 500 ft, then select the next GPS leg, which will take us to GLRB on the G1000 and engage autopilot. Set power and RPM for speed cruise, which should cover the remaining 25 miles in 10 minutes. I call up GLRB (Roberts Intl) info on the G1000, and tune to their tower on COM1 and ILS on NAV2. Tower says runway 22, straight in.

At 5 miles out I cut power to idle and start a 1800 ft/min descent. Tower says cleared runway 22 and the G1000 says 7 kts headwind. Having the ILS pointer together with the GPS on the main display lets me fly the approach nice and clean despite the visibility being quite bad. The runway lights come into sight at 3 miles, straight ahead. Still at idle power I drop 10 degrees of flaps and

decelerate to 90 knots over the threshold. I flare and touch down on the tarmac at 80 kts and 300 ft/min descent, which gives me enough speed to coast to the next exit. Switch to ground, taxi to gates.

The NGO person takes off for the terminal and I turn the Kodiak off while checking the fuel panel. 166 lbs of fuel used in 50 minutes. Plus my paycheck and company profit margin, please. And hey, it has stopped raining!

Impressions of the simulated Kodiak

To date I have logged a little over 100 hours in the Lionheart Creations Kodiak, and I find it to be a most enjoyable aircraft to fly. It is not the fastest, nor the most heavy-hauling. But it will take me anywhere and back with ease and comfort. The low stall speed and robust gear makes landing and takeoff possible in really tight places. For example, I have flown the FSX "Denali Base Camp Charter" mission with the Kodiak and I found it a lot easier to complete, despite the Kodiak being a lot larger than the Maule M7.

Pilots office in the simulated Kodiak. Both pilot and copilot have primary flight displays.

Besides the ruggedness and STOL performance I find the avionics are what sets this aircraft apart from other "bush" aircraft. Having a complete package with GPS moving map, autopilot and neatly organized digital instruments makes IFR navigation a breeze.

A Kodiak at max weight will taxi at about 15 kts at 15% power. At lower weights, I select about 7% power and stay ready to brake before turning to avoid skidding. Takeoff is achieved between 75 kts for a lightly loaded aircraft, and 85 kts for an aircraft at max takeoff weight. I set flaps to 10 or 20 degrees depending on gross weight. If a very rapid climbout is required immediately after takeoff, I leave flaps up to achieve a quick takeoff roll, leave power at 90 to 100% and adjust speed by pitching up. A fully loaded Kodiak will climb at 93 kts and 1500 ft/min at 98% power.

For speed cruise, I select 65% power and 1650 RPM on the prop. This gives a fuel consumption of about 335 pounds per hour at 3000 ft. If I climb to 10'000 feet, I get a speed increase of just 2-4 kts.

The instrumentation is really helpful with fuel calculation, and displays not only pounds per hour, but also nautical miles and time remaining. In-flight management of fuel is therefore a simple matter of comparing distance to go on the primary flight display, with the numbers on the fuel section of the secondary display, and selecting the appropriate power and prop settings.

Once I have got where I had to go, the low-speed handling of the Kodiak lets me put the wheels down right where I want them. The stall warning of a max weight Kodiak

comes on at 85 kts. Below that the aircraft may wobble just a little and the nose drops ever so slowly. If I keep power up, it sorts itself out, begins to stall again, and repeats. If I take power off and let the aircraft stall, it will remain roll responsive way below 60 kts. It is still falling like a rock, but a quite controllable rock.

A controlled approach with a max weight aircraft is possible at about 85 kts, with full flaps and 75% power. Less weight means lower possible speed, all the way down to 60 kts. At such a low speed the nose has to be pitched up to about 10 degrees which makes it quite hard to see where I am going. I usually remedy this by making the approach steep enough to maintain a moderate pitch-up attitude and raising the simulated chair until I can see over the long nose of the Kodiak.

After touchdown, the Kodiak offers 25% reverse thrust. In conjunction with wheel brakes the aircraft will stop almost immediately. I have on occasion landed across the runway at a major airport, just to show the capabilities of the aircraft.

Tuning the Kodiak

The aircraft.cfg file that comes with the Kodiak build 2.6 does not take into account the increased gross weight certification. Nor does it offer the possibility to distribute payload any other way than at the center of gravity.

I have modified my aircraft.cfg in the following way, to account for the above mentioned issues;

[WEIGHT_AND_BALANCE]

max_gross_weight = 7255

empty_weight = 3770

reference_datum_position = 0, 0, 0

empty_weight_CG_position = 0, 0, -1

// CG_forward_limit = 0

// CG_aft_limit = 1

max_number_of_stations = 14

station_load.0 = 170, 0, 1.1, 0, Pilot

station_load.1 = 170, 0, -1.1, 0, Co-pilot

station_load.2 = 0, 3.1, 1.1, 0, Seat 1l

station_load.3 = 0, 3.1, -1.1, 0, Seat 1r

station_load.4 = 0, 5.3, 1.1, 0, Seat 2l

station_load.5 = 0, 5.3, -1.1, 0, Seat 2r

station_load.6 = 0, 7.5, 1.1, 0, Seat 3l

station_load.7 = 0, 7.5, -1.1, 0, Seat 3r

station_load.8 = 0, 9.8, 1.1, 0, Seat 4l

station_load.9 = 0, 9.8, -1.1, 0, Seat 4r

station_load.10 = 0, -5, 0, 0, Cargo main

station_load.11 = 0, -14, 0, 0, Cargo aft

station_load.12 = 0, 3, 0, -1.5, Cargo pod forward

station_load.13 = 0, -3, 0, -1.5, Cargo pod aft

The positions of each seat and cargo station is a rough estimate based on the stated cabin dimensions in the technical specifications section. The changes I made to the file enables the passengers and payload to interfere with the aircraft center of gravity.

Bibliography

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Pratt & Whitney Canada, www.pwc.ca
Mission Aviation Fellowship, www.maf.org
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National Transportation Safety Board, www.ntsb.gov

Software

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