



K4A PLM-ENFORCED APPROACH TO DESIGN AND CERTIFICATION OF ENGINES AND LIGHT HELICOPTERS

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An introduction to K4A

- K4A was founded in 2005 by Engineers and Businessmen with the ambitious goal of playing a significant role in the innovation of personal transportation by means of Light Piston Engine Rotorcrafts (2-4 seats).
- It is currently headquartered with production facilities in Naples, within an important district for aerospace engineering and production in Italy
- Although K4A was incorporated in 2005, its experience in designing and manufacturing light helicopters goes back to 1996 when the experimental model of the L221 helicopter was designed and manufactured with several major technical innovations and successfully completed the initial flight testing (100 hours)



The L221 Experimental Helicopter in flight, Sept. 1998



The Design Path



The former model Within the program ALH-01 (1996-2000), Mr. Lidak designed and carried out the project of the helicopter L221, up to testing it in flight. This helicopter was the first one on which some technologies had been successfully experimented, such as:

- single-blade main rotor
- tail rotor with VSHDTR[®] system (Variable Speed Helicopter Tail Rotor Hydrostatically Driven)
- installation of two Moto Guzzi 750 cc twin-cylinder injection engines, with air cooling.

The actual project

In 2006 K4A s.r.l. started the program ALH-02 that leads to the development and carrying out of the light helicopter KA-2HT, certified in accordance with CS-27.



- Two-Blade Main Rotor with homocinetic head and elastomeric hinges ®
- Tail Rotor with variable speed, fixed pitch and hydrostatically drive VSHDTR®
- Powerplant based on two piston engines with Electronic Injection and Air Cooling
- Lattice helicopter main structure
- Structural Composite Tail Boom
- Composite Shell Cabin



An introduction to K4A

- Since its foundation K4A has been aimed to creating a breakthrough in ٠ light helicopters technology, knowing in the same time that introducing strong innovations in today's aviation is a very hard task.
- The project has been involving Italian and European Universities, • Research Centers, Industries and Agencies for 6 years up to now with a total investment of about 6 M Euro.
- K4A is now running the "build and fly" phase of the 2-seat helicopter project.
- The project has been recently founded by some Italian and international • investors. International agreements are currently underway for the industrialization phase (Joint Ventures).







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(Italian Aerospace Research Center)



(Parts, Goods and Services Network)



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K4A - 2HT 2-Seats Helicopter Model



KA-2HT (2 seats)

- KA-2HT is a 2-seat helicopter.
- K4A is currently implementing the «Build and Fly» program, that will enable the first prototype of this model to fly by the end of 2015. Then the KA-2HT will go through final Certification process
- It is equipped with two piston engines working in a parallel way, so that the failure of one engine is never a fatal failure.
- It will be the first light helicopter:
 - Provided with two piston engines working in a parallel way thereby will apply to certification to fly over built-up areas in Europe and other countries where strict regulations do not allow single engine light helicopters to fly.
 - Able to fly using automotive gasoline instead of the Avio gas, with lower consumptions and pollution.



K4A - 2HT Performance Data



	A/EC	
PU		

K4A V2400 - A2HT 2 Engine Modules - Four Cylinders

De-rated at 104 kW at 1,753 RPM

Automotive Fuel (MoGas) min. MON 85 RON 95

WEIGHTS			
	Parameter	Unit	Value
	Design Gross Weight	Kg	650
MEW	Empty Weight (Estimated)	Kg	443
	Max Payload Weight (Estimated)	Kg	207
	Fuel	Kg	53

PERFORMANCES (Estimated)					
	Parameter	Unit	Value		
VH	Maximum Air Velocity in Level Flight	KTS	95		
VNE	Velocity Not to Exceed	KTS	105		
BRA	Best Range Airspeed @ Sea Level	KTS	68		
BEA	Best Endurance Speed @ Sea Level	KTS	44		
OGE	Hovering Ceiling out of Ground Effect	FT	5,800		
IGE	Hovering Ceiling in Ground Effect	FT	10,200		
	Maximum Operating Altitude	FT	12,000		
	Max Rate of Climb	FT/MIN	1,600		
	Endurance @ BEA (5% Fuel Reserve)	Н	4		
	Range @ BRA	NM	330		
	Rate od Descend in Autorotation @ BEA	FT/MIN	1,400		
	Temperature Range	°C	-20 ÷ +50		

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K4A - 2HT Main Rotor (Patented Homokinetic Joint)

Main Rotor Features			
Parameter	Unit	Value	
Diameter	[m]	7,60	
Number of Blades	-	2	
Constant Chord	[m]	0,225	
Solidity	-	0,0377	
Blade Twist (unlinear)	[deg]	14	
Shaft Tilt FWD	[deg]	2	
Tip Speed	[m/s]	201,4	
Shaft RPM (100%)	[rpm]	506	
Power ON RPM Range (97% - 104%)	[rpm]	490.1 ÷ 526.2	
Power OFF RPM Range (90% - 110%)	[rpm]	455.4 ÷ 556.6	

- The main rotor is a gimballed twin blade type, rigid in plane with fly bar
- The rotor head is connected to the mast by 2 semi-spheric hinges and by other components that ensure homokinetic motion transmission: this class of rotors will be useful in UAV platforms and for tilt rotor machines, due to its inherent stability
- The blades grip are fitted to 2 Pitch hinges that allow the feathering motion



K4A V2400-A2HT Engine

The engine (V2400-A2HT) is constituted by two modules each of which is:

- two cylinders reciprocating engine, horizontally 90° V •
- four valves per cylinder
- air cooled by a centrifugal fan and oil cooled with an ٠ independent cooling pump

Centrifugal Blowers

- one injector per cylinder •
- single ignition.

Engine Type	2 x 2 Piston 90° "V"
Displacement [cm 3]	2302
Power [kW]	104 at 1753 rpm (min 1685 rpm - max 1806rpm)
Torque [Nm]	591 at 1685 rpm – 556 at 1806 rpm
Fuel	MoGas min. MON 85 RON 95

- Each module has an independent Engine Control ٠ Unit.
 - The ECU limits the engine rpm at 108% (6,994 rpm) of the nominal value (6,476 rpm).
 - A speed reducer connects the two modules and transmits their motion to the engine drive shaft





K4A - 2HT Hydraulic Tail Rotor System



The tail propeller is a five-blade, with fixed pitch, and is obtained with CNC milling by a single block of laminated maple wood. It is coated with carbon fiber, and has metallic protection on the leading edge and on the trailing edge. This system is backed with another one based on an electric motor not shown here



The Company Road Map

- **D** Engine and helicopter development
- POA and DOA achievement
- □ Engine and helicopter TCs achievement (in compliance with CS-E and CS-27)
- Development and consolidation of the know-how and of the company assets





Helicopter and Engine Type Certification Process Approach

ASSUMPTIONS

- Helicopter design and its certification will be strongly oriented to one specific starting configuration (e.g.: Trainer)
- The Certification Process will be carried out in parallel with the Critical Design Review Phase

MAIN STEPS (CHRONOLOGICAL ORDER)

- a. Detailed Description of the Operation, Features and Systems of the Helicopter
- b. Preliminary parts and equipment classification
- c. Ground and Flight Loads Analysis/Calculation
- d. Functional Hazard Assessment
- e. Systems and Assemblies Certification Process Orientation
- f. Supplier Selection
- g. Compliance Methods Selection
- h. Compliance Means Generation
- i. Ground and Lab Certification Tests
- j. Flight Development/Experimental/Certification Tests

<u>"THE MOST USED" COMPLIANCE METHODS</u></u>

- ✓ Calculation/Analysis
- ✓ Ground Tests on A/C
- Tests on Test Articles
- ✓ Design Review (CoDR, PDR, CDR, etc.)
- ✓ Flight Tests
- Equipment Qualification



Design Organization Approval (DOA) Process Approach

ASSUMPTIONS

Two main aspects shall lead this process:

- a. the common occurrence with TC process;
- b. the start-up phase of the company.

MAIN POINTS

In order to satisfy the needs regarding procedural flexibility and light organization, the DO System will have the following features:

- 1. the elaboration of procedures will be carried out mainly by viewpoint of limited steps execution;
- 2. resources will be involved to only one product line;
- 3. some main design activities will be performed by subcontractors.

GENERAL PLAN

Preparation and issuing of procedures and organization chart improvement follow up a close link with helicopter development and certification path. Following the main steps:

- i. Definition of the Organization Outline and Guiding Principles regarding DO-PO coordination;
- ii. Design Documentation Management;
- iii. Management of Experimental and Prototype Activities;
- iv. Subcontractor and Supplier Management;
- v. Configuration Management;
- vi. Ground/Lab Certification Tests;
- vii. Flight Certification/Experimental Tests;
- viii. Other Procedures regarding post Type Certification.

K4A-2HT Helicopter & V2400 Engine Programs ITC & PLM System Engineering Program Enablers

DRIVERS & CONSTRAINS

- Complexity of the Business Model
- Changing Environment
- Partnerships (also across geography)
- Need to follow entire product life-cycle from initial concept phase to final product disposal

Managing Flexible & Variable Organizations

Small lean product development organization have to cope with many different constraints which may determine changes in the organization while keeping focus on the project timeline.

Collaboration Desktop has proved to be a reliable tool when dealing with these kinds of issues.

Keeping pace with the virtual enterprise model

K4A has adopted since the beginning a model of networked enterprise with in-house design and development and distributed manufacturing of required parts.

Today this model is challenged by several partnership with regional focus for the production of machines.

PLM and Collaboration Desktop are, without doubt, a key enabler of such a distributed organization and provide reliable tools for everyday operations.

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