

SPIRIT TANDEM HELICOPTER

CONSTRUCTION MANUAL



SERIAL N° :

ENGINE N° :

DATE :

The purpose of this manual is to be a construction guide for the SPIRIT TANDEM helicopter.

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CICARE S.A.

Acceso Augusto Cicaré 5300 – 7260 – SALADILLO – Bs. As. – ARGENTINA
+54 2344 454548 – www.cicare.com.ar – info@cicare.com.ar

CICARE SPIRIT TANDEM HELICOPTER CONSTRUCTION MANUAL

We are really grateful to you for trusting in CICARE S.A. and choosing our SPIRIT TANDEM helicopter.

We are proud to present to the world market this product after more than a half of century of work developing light helicopters.

We are committed to quality improvement in all those aspects in relation to performance, comfort and safety of the aircraft for our customers and CICARE's followers.

The CICARE SPIRIT TANDEM is part of the great work done by Augusto Cicaré, his talent, creative spirit and experience accumulated around flying machines.

This helicopter kit was developed so that the user could fulfil their dream to build and fly their own helicopter. In the design of the kit, the most difficult and complicated assembly procedures have been minimized, to reduce the possibility of error during construction. For this reason we provide critical components such as the main rotor gear box and tail rotor gear box already assembled and tested in the factory.

It's time to start to construct your own helicopter. We ask you to take special care during the whole process and follow this manual step by step.

Private helicopter license flight training, as a minimum, is necessary for your own safety and for the safety of others.

To perform safe flight in any kind of aircraft, it's very important to know their normal conditions of use and their limitations. To ensure this, CICARE has developed a Flight Manual and Maintenance Manual that are provided with the kit and must be carefully studied before the first engine start.

Everyone at CICARE S.A. wishes you success in the construction of your helicopter and will provide you with support to accomplish this achievement.

Fly safe!!!

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INFORMATION ABOUT THE CONSTRUCTION MANUAL

The manual is divided into three parts:

Part 1: introduction to the SPIRIT TANDEM and to the construction process.

Part 2: construction process.

Part 3: Annexed information-Glossary

In **Part 1** the CICARE SPIRIT TANDEM is described, including all the general recommendations that must be kept in mind during the construction of the kit.

In **Part 2** each one of the construction phases are described in logical order, estimated times, and precautions to take. Also information about the maintenance and rigging is included.

In **Part 3** there is important information to consider during the whole construction process and before the first flight of the helicopter.

It is recommended to first read the entire manual to familiarize you with it, reading each phase before commencing building it and strictly following the order of the construction sequence set by CICARE, so that the construction process will be done in an efficient and safe way.

It is also suggested at this time to make any necessary notations in the manual so they will help you to achieve a better understanding of it.

Notate anything that you are not sure about and then consult with our representative in your area or directly with us before commencing construction.

1- INTRODUCTION

This construction manual is designed with the objective to technically assist anyone who wants to build a real helicopter. It will increase your knowledge of this type of aircraft and the care that must take into consideration to minimize any type of risk.

A great effort has been made to make this manual easy to read and understand, and to pass on part of our experience in the fine art of constructing helicopters.

To comply with the quality that you and CICARE aspire, it is recommended to pay special attention in each step in every single phase of the manual. It's very important to observe each recommendation to advance in the construction process the best way possible. Remember you will be building, step by step, the quality that we all wish to achieve.

CICARE is committed, through their official representatives, to give all the required counselling requested during the whole construction process and at first start up of the helicopter.

1.1 - GENERAL DESCRIPTION OF THE AIRCRAFT

The CICARE SPIRIT TANDEM is the result of 22 years of work and constant innovation in the development of light helicopters. It is the evolution of the model CH-6 and CH-7, both recognized throughout the world by their innovative control system.

The design utilizes aviation materials and the result is a safe helicopter with great performance.

On your first flight you will evaluate the real behaviour of the helicopter. Its agility in flight, design, weight, power and responsive capabilities during high demanding moments are the ones that will allow you to confirm that your construction job has been done correctly.

Airframe

The SPIRIT TANDEM airframe is aircraft quality welded SAE 4130 chrome-molly steel tube. The first protective paint coating is an epoxy primer and then a polyurethane colour coat is then sprayed on to seal it.

Landing Gear

This is made of aircraft-grade tubing. The cross tubes are constructed of 1-5/8" diameter SAE 4130 steel tube. The Skids are made of 1-3/4" diameter 6061 T6 aluminium tube.

Tail boom and stabilizers

The Main Tail Boom Tube is 6061 T6 aluminium. The Boom Struts are 2024 T3 aluminium. The Rear Stabilizers are made of 2024 T3 aluminium.

Cabin

The cabin consists of a set of composite parts and comes with a four point safety harness. It is painted with a polyurethane coating. The bubble and door windows are acrylic.

Transmission System

The lower drive pulley which delivers the power of the engine to the Main Rotor Gearbox is equipped with a centrifugal clutch. This facilitates starting the engine, so it is not under the load of the transmission system.

The free wheel clutch is in the top drive Pulley on the Main Rotor Gearbox input shaft that also connects to the tail rotor. In case of emergency, this clutch disconnects the drive system from the engine.

The intermediate transmission system is connected by V-belts, which transmit the engine power to the Main Rotor Gearbox and tail rotor system through the free wheel.

The main transmission is a crown wheel and pinion which provides power to the main rotor.

Power to the tail rotor is transmitted by the Tail Rotor Drive Shaft and a 90° Tail Rotor Gearbox.

Main and Tail Rotor Controls

The Cyclic Stick and Collective Pitch Lever have a friction mechanism that hardens or softens their operation. They help the pilot to maintain the attitude of the helicopter, and/or allow him/her to have greater control sensitivity in case of need.

Main Rotor and Tail Rotor Blades

Both the main and the tail rotor blades are constructed of composite materials.

Power plant

The engine is a four stroke ROTAX 914, horizontal boxer four-cylinder, cooled by a mixture of liquid and air. Is an engine specially developed for experimental aircraft. It delivers a maximum power of 115 HP.

It uses AVGAS 100 LL fuel or premium ULP gasoline (refer to the ROTAX manual).

Fuel System

This consists of two 24 litres tanks. The system has an engine driven mechanical pump and an electrical fuel pump.

Electrical System

The electrical circuit is powered by a 12V 24 A / h battery in combination with the engine alternator. All circuits are system ground return.

Switches are used to control the various equipment and are positioned at the bottom of the instrument panel. The system includes protective circuit breakers for the electrical circuits.

The kit wiring is supplied in looms with identification numbers.

The majority type of cable used is:

Electrical cable P / N MIL-W-22759/16-20

Electrical cable P / N MIL-W-22759/16-18

Instruments

The panel has the following instruments:

1- Altimeter 0-20000 Ft
2- Air Speed Indicator - 0-120 Kt
3- Vertical Speed Indicator -3000 +3000 Feet per second
4- Dual RPM Gauge - Engine / Main Rotor
5- Manifold pressure
6- Compass
7- Flight hour meter
8- Engine Oil pressure 0-80 PSI (0 – 5,5bar)
9- Engine Oil temperature 0-300 °F (0 – 149° C)
10- Cylinder head temperature - 0-250 °F
11- Engine Coolant temperature - 0-250°C
12- Fuel level indicator

1.2 – GENERAL PRECAUTIONS

We recommend the following precautions during the construction process:

1- Be organized, take some time to plan the work to be done, this will result in optimizing the assembly time of the kit.

2- Do not remove any parts from their packaging if they are not going to be used immediately. In case you do, keep them in a safe, clean and dry place. For painted components, keep them inside the protection provided by CICARE or protect them from shock and / or scratching and or from improper handling.

3- Keep the hardware, aluminium alloy fittings and similar components dry in plastic bags, removing only those required at the time is needed.

4- The main and tail rotor gearboxes **do not contain oil**. Be sure to fill them, as shown in the maintenance manual. If these components are not used in the short term, keep all the orifices closed (they are closed in factory) and keep them in a clean and dry place.

5- Do not construct your helicopter when you are tired. The lack of clarity or concentration may cause damage or incur serious errors that can discourage you, damage parts and / or result in high-risk accidents on land or in air.

6- Make a visual check on the condition of appropriate parts and other components before starting a step or a phase. Also verify that all tools and materials are available at the required time.

7- If you start a step, it is recommended to complete the operation described. Do not leave a half step which can then lead to problems in the progress of the construction process.

8- Before you remove the packaging from any part or parts of the helicopter whose position or placement may be confused or delayed, identify and record where it is to be fitted in the helicopter (e.g. with the packaging label) for proper installation. This will ensure that each piece is installed in its proper place, interfaced with other systems and subsystems of the aircraft.

9- When any threaded joint has one or more washers or spacers to be fitted, follow the order indicated in the manual to achieve an optimal fit. If for any reason you are not satisfied with the fit achieved after you have installed a part, consult with the CICARE representative in your area.

10- In no case may you disassemble critical CICARE components assembled in the factory, these are: blade grip, main and tail rotor gearbox. If you notice any abnormality in any of these (or other) parts, immediately inform CICARE (or the regional representative) to take appropriate action as soon as possible.

11- Whenever you need to ground handle the helicopter, the main rotor blades must be oriented fore and aft, and the tail rotor blades vertically oriented. Remove the main rotor blades whenever the helicopter is transported on truck or trailer – refer to Maintenance Manual. The main rotor and tail rotor blades are the "soul" of the helicopter and very fragile, so they require an extra care and attention from any incident or accident that you or others might cause.

12- Follow the directions given throughout the Construction Manual and periodically reread this first part of the manual. This recommendation also applies to the Flight Manual and Maintenance Manual.

13- The sizes and dimensions outlined in this manual are in metric units (mm or m) unless indicated otherwise.

1.3 – GENERAL INFORMATION ABOUT THE CONSTRUCTION PROCESS

To achieve building your quality CICARE SPIRIT TANDEM helicopter, you must during the entire build process, carefully observe and consider the Construction Manual **Control Points** and **Interface Points**. Remember that the final quality of the helicopter and it's safe operation will be in the hands of the person who meets this requirement.

Our regional CICARE product distributors will have the responsibility to support you through the construction process and assist you to tune the helicopter when you need assistance.

Working Area

The working area must be **large and safe** to move around easily and to preserve the parts and other components the best way a possible (well lit, free of moisture, grease, dust, etc.) and also to minimize any risk of accident.

It is also important to maintain the **order and cleanliness** of the working area. These factors have a direct relation to the final quality of the helicopter.

Remember that the **conditions of the working area** where you plan to construct the helicopter are essential to work in a safe orderly fashion, and to responsibly enjoy this experience.

Finally, your **working attitude** - including keeping good working conditions during the construction process - will be reflected in your completed SPIRIT TANDEM.

Personal Protection

It's recommended to use personal protection according to the task you are doing – especially take care of your hands and eyes. For this use protective **goggles and glasses**.

Necessary tools

At the beginning of each phase the tools to complete the task are shown with the corresponding steps. It's recommended to check that you have the necessary tools before starting each phase.

In general the tools to be used are standard type and can be acquired in any tool shop in your area.

The Airframe utilises imperial spanners and sockets, while the engine utilises some metric tools.

There are a few special tools that you may require which are provided by CICARE with the kit, or you will find the corresponding drawings to build them yourself.

Other necessary materials

Other material that may be necessary during the constructive process will be described at the beginning of each phase, after the necessary tools. If the material listed is not available in your area it's recommended to search for other alternatives keeping in mind similar or better quality characteristics.

Manual notations

The followings notations will be used along the whole manual to indicate a special procedure or manipulation.

WARNING

An operation, practice, procedure, etc. which, when it is not correctly performed may result in personal harm or loss of life.

CAUTION

An operation, practice, procedure, etc. which, if it is not strictly observed, may result in damage or the destruction of the equipment.

NOTE

An operation, practice, procedure, etc. which is recommended for an optimum result.

1.4 – TECHNICAL RECOMMENDATIONS

Torque and adjustments

If it's not indicated otherwise, use the torque values listed in Table 1.4.1 to tighten common hex nuts. For *self locking nuts*, add 10% to the values in Table 1.4.1.

If it's not indicated otherwise, tighten the PAL locknut with the torque values listed in Table 1.4.2.

If it's not set otherwise specified, use the settings shown in Table 1.4.3 and 1.4.4 for threaded hex steel bolts into aluminum alloy bodies.

Apply torque slowly to the indicated value – do not exceed!

For extra safety reasons, self locking nuts have been used in critical areas, and in some other special cases, stainless steel locking wire or special nuts have been used.

Bolts used in structural components and command

TORQUE TO BE APPLIED ON HEX NUTS		
THREAD	Lbft.	Nm.
10 - 32 (AN3)	2.3	3.1
¼ - 28 (AN4)	5.8	7.8
5/16 - 24 (AN5)	12.5	16.9
3/8 - 24 (AN6)	19.2	26,0
7/16 - 20 (AN7)	39.2	53,0
½ - 20 (AN8)	58.3	79.0

Table 1.4.1

TORQUE TO BE APPLIED ON PAL LOCKNUTS		
THREAD	Lbft.	Nm.
10 - 32 (AN3)	0.5 – 1.3	0.7 – 1.8
¼ - 28 (AN4)	1 – 2.1	1.4 – 2.9
5/16 - 24 (AN5)	1.7 – 3.3	2.4 – 4.5
3/8 - 24 (AN6)	2.4 - 5	3.2 – 6.8
7/16 - 20 (AN7)	3.3 – 7.1	4.5 – 9.6
½ - 20 (AN8)	4.5 – 9.2	6.0 – 12.5

Table 1.4.2

HAND TIGHTENING OF THREADED HEX BOLTS INTO ALUMINUM ALLOY BODIES (boom)	
THREAD	Angle (°)
10 – 32 (AN3)	25

Table 1.4.3

TORQUE TO BE APPLIED ON THREADED HEX BOLTS INTO ALUMINUM ALLOY BODIES		
THREAD	Lbft.	Nm.
10 – 32 (AN3)	2	2.7
¼ – 28 (AN4)	3	4.0

Table 1.4.3

Bolts adjustment procedure

1. The thread of screws, bolts and nuts must be *clean and dry*.
2. Turn the nut, never the bolt to avoid scratching the cadmium protection on the bolt.
3. Install the nut and adjust it, applying the necessary torque slowly, until you reach the indicated torque, using a *calibrated* torque wrench.
4. With the torque wrench set the specified torque, tighten the nut.

General adjustments – nuts and bolts

Any Nyloc nut which screws on a thread by hand with low resistance should be replaced immediately.

Never install Nyloc nuts that have been used. Whenever you install a Nyloc nut, it can only be used once. Any Nyloc nuts used must be set aside or destroyed to prevent, by mistake, to be used again in the aircraft.

A minimum of two threads and a maximum of four should protrude on the outside of the nut on all joints. If the threads that stand out are less than two there is no assurance that the nut is properly locked, whereas if there are over four threads the nut may have reached the end of the thread and the bolt may not be properly tightened.

CAUTION

Never replace bolts provided by CICARE with other of dubious origin.

Safety Paint for joints

In some joints safety paint marks are applied to verify that there is no loss of adjustment force that is considered of critical importance.

This must be applied over the nut and the exposed part of the bolt. If there is any kind of relative rotation between them it will be shown at a simple visual inspection.

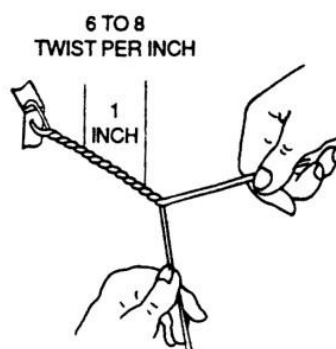
Safety wiring

NOTE

The following paragraph contains information on the safety wire technique. For more information on this method it is recommended to consult the F.A.A AC 43.13 1B section 7 or an equivalent standard.

The term safety wiring is the process of ensuring through the use of one or more types of stainless wire, that a nut, bolt or part cannot become detached.

There are two wiring methods, using a double wire (commonly used) and the simple wire, at the same time there are two techniques, one using the tool to generate the helix (twisted wire) and one generating the twist by hand, both are acceptable. Manual wiring requires 6 to 8 turns of wire per inch as shown in the picture.



On the CH7-B helicopter the elements that have safety wire are the bolts or pins designated with an ANH part number (H designates a hole) and in all cases requires the double wire method (double twist method). The simple wiring method should not apply to the parts involved and should only be used in areas of difficult access or limited space where notated.

When safety wire is applied to any threaded elements, such as bolts, it should be noted that in the process the wire has to be taut and oriented in the correct direction of rotation. Below is an image with examples of application of safety wiring, followed by photo of the Tail Rotor Gearbox as an example.

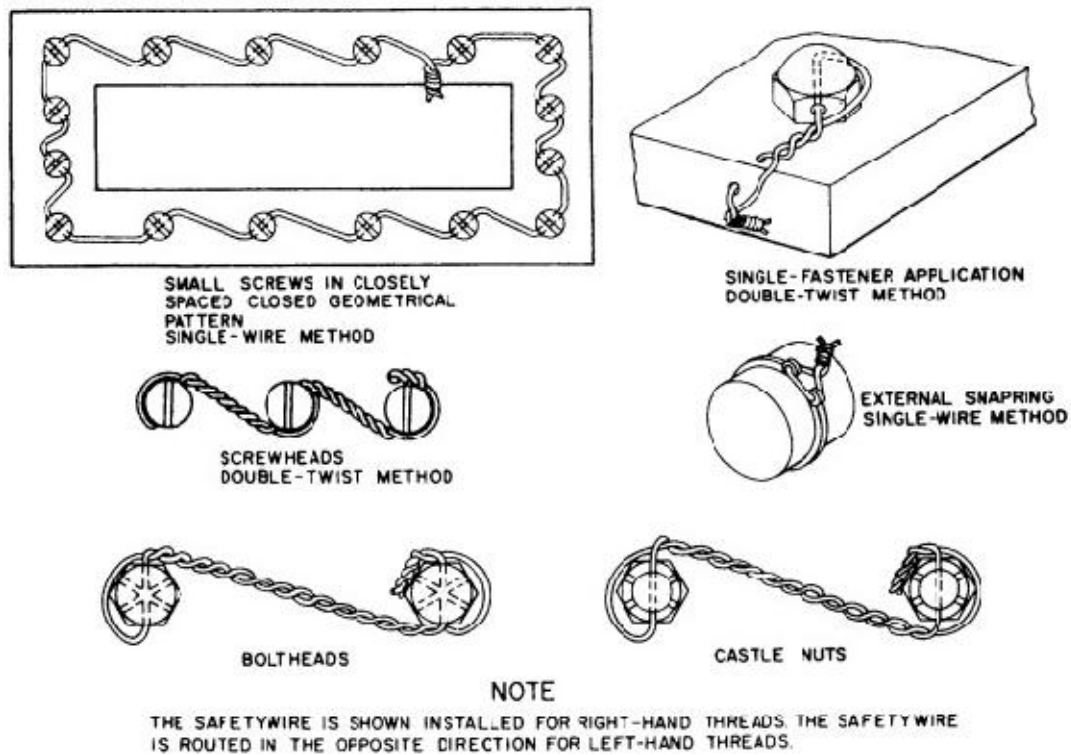


Fig. 1

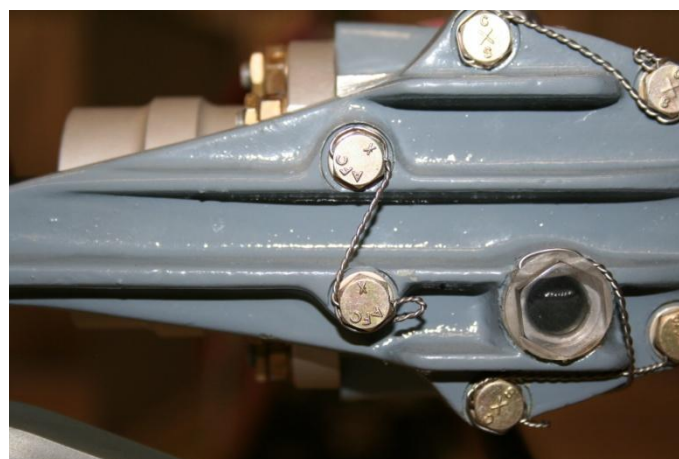


Fig. 2

1.5 – CONSTRUCTION PHASES AND ESTIMATED TIMES

The following chart shows the assembly phases of the CICARE SPIRIT TANDEM kit and the estimated times of construction for each one of them. The total estimated time is 280 hours depending on the ability, knowledge and experience of the builder.

Construction phases	Name of construction phase	Estimated Time (hours)
1	Assembly of Landing Gear to Airframe	12
2	Tail boom installation	27
3	Tail rotor control system installation	12
4	Main Rotor Gearbox installation	8
5	ROTAX 914 engine and accessories installation	23
6	Main control systems installation	18
7	Cabin installation	65
8	Intermediate transmission installation	11
9	Main rotor installation	10
10	Fuel system installation	14
11	Engine and Main Rotor Gearbox coolant system installation	16
12	Electric system installation	13
13	Panel and instruments installation	34
14	Tail rotor gearbox installation	5
15	Rigging – Calibration	12
Total Estimated time to Completion:		280 hours

You must take into account the preparation time needed to start the building process of the CICARE SPIRIT TANDEM kit that should be added to the estimated time in each of the steps listed above.

We also recommend taking extra time for verification and control of parts and other accessories, group by group, so that all parts needed in the construction process are present. (SEE: List of Part by Groups).

NOTE

The above construction phases are for general use. If you have your engine on hand at the beginning of the build process, you may change the build process by not installing the tail boom until after the engine is installed. This saves time in that you do not have to walk or work around the installed tail boom and this also helps those who are building in a smaller workshop.

As well, it is often easier to fit the Cab and – after alignment - drill the location holes in the attach bracket on the Main Rotor Gearbox and remove the Cab until the time the cyclic stick controls are fitted.

1.6 – GENERAL INFORMATION ABOUT THE MAINTENANCE OF THE AIRCRAFT

Like all the CICARE's helicopters, the SPIRIT TANDEM has a **Maintenance Manual** provided so that you can follow the instructions to carry out the programs of inspection and preventive maintenance required by CICARE.

It is the responsibility of the pilot to observe and comply with the information it describes. Do not take unnecessary risks in this regard that may threaten the life of the pilot or others in air or on land.

Besides the builder, our exclusive representatives, through their team of qualified technicians or Civil Aviation Authorized maintenance personal from that country, are the only ones authorized by CICARE to perform maintenance indicated in this manual according to the flight hours the aircraft has accumulated.

1.7- NORMAL OPERATION OF THE AIRCRAFT - LIMITATIONS

It is most important to consider and respect the SPIRIT TANDEM normal conditions of operation and to understand its limitations to minimize any type of risk.

It's the pilot's responsibility to read and understand the requirements of the **Flight Manual** supplied with the CICARE SPIRIT TANDEM helicopter kit.

GLOSSARY

Fitting / Mounting: putting something in its place

Install: put something in their place and link to related systems.

Build / Fabricate: produce, make or invent a material object or material.

Assembly: unite, join together and adjust the components of an object or system.

Connect: link together parts or systems so that they can flow between something material or immaterial.

Preparation: have something in such a way that meets specific purpose.

Control, regulating, alignment, calibration, tuning.

**ENJOY THIS EXPERIENCE WITH SPECIAL CARE AND FLY RESPONSIBLY TO
MINIMIZE ANY RISK.**

WE WISH YOU ENJOYABLE AND SAFE FLIGHT!