Sikorsky S-64: Lifting the Impossible

CLASS: ARO 3011 – Fluid Mechanics & Low speed Aerodynamics

Section # 02

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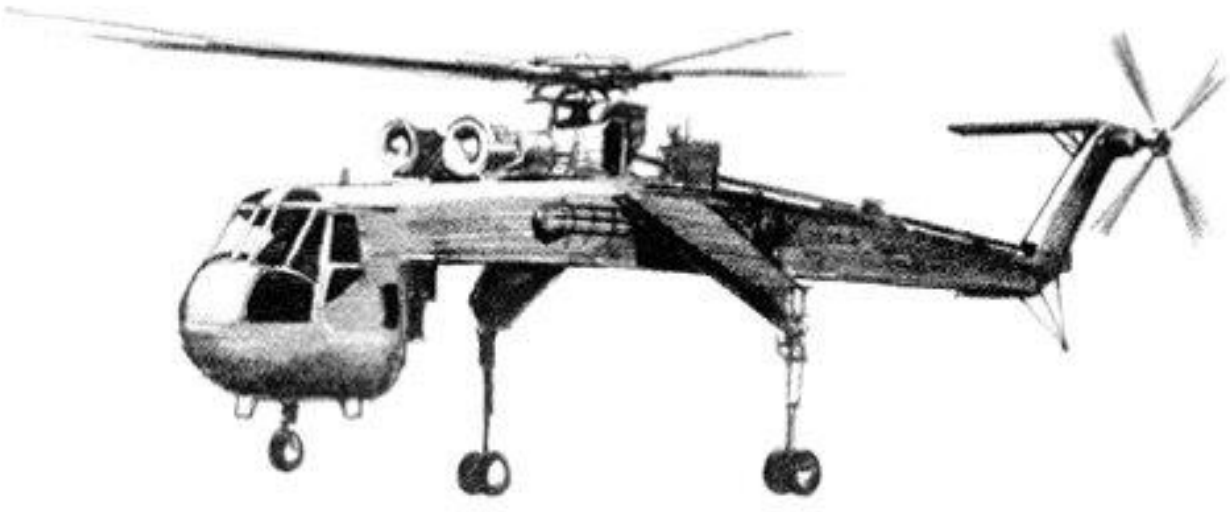

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Abstract

The Sikorsky S-64, a versatile aircraft designed for heavy cargo transport, delivers a remarkable blend of speed, safety, and efficiency. With a 38,000-pound maximum take-off weight, 190-mile range, 117 mph cruising speed, and 10,500-foot service ceiling, it excels in adhering to tight schedules and FAA regulations. Constructed from steel, aluminum, and composites, it ensures both strength and lift capacity. Powered by two Pratt and Whitney JFTD-12A-1 engines, its performance surpasses its predecessor, the S-60. The S-64's impact extends from military to civil applications, inspiring future heavy-lift helicopters.

1.0 Introduction

The Sikorsky S-64 stands out as a finely engineered aircraft, purpose-built for the rigors of heavy cargo transport. It strikes a delicate balance between speed, safety, and efficiency, all while excelling in confined spaces. Initially designed for military use, the S-64 has since found its place in civilian applications. To fulfill its intended roles, the S-64 boasts a set of key features:

- A maximum take-off weight (MTOW) of 38,000 pounds,
- A range of 190 miles
- A top cruising speed of 117 mph
- A service ceiling of 10,500 feet
- A hover ceiling (in ground effect) of 9,700 feet,

Achieving the 38,000 MTOW requirement is crucially important, as the core of the S-64's design revolves around lifting heavy payloads. As mentioned earlier, the aircraft's capacity for quick, safe, and efficient turnaround times depends on its range and cruise speed, enabling it to meet tight schedules with ease. Additionally, the service ceiling and hover ceiling are crucial factors to consider, given the S-64's role in carrying heavy payloads while adhering to the Federal Aviation Administration's (FAA) regulations. This helicopter is still in service and is still being utilized in the industry of construction, fire suppression, and logging.

2.0 Configuration Description

2.1 Three View Drawing

The three figures listed below resemble three different views of the Sikorsky S-64. Some key designs of these drawings to notice are that there is no cargo in the fuselage allowing for heavy load attachments to fit. Also, from these drawings you can notice the long rotor blades and as well as the tail motor which are all important features of the aerodynamics of this aircraft.

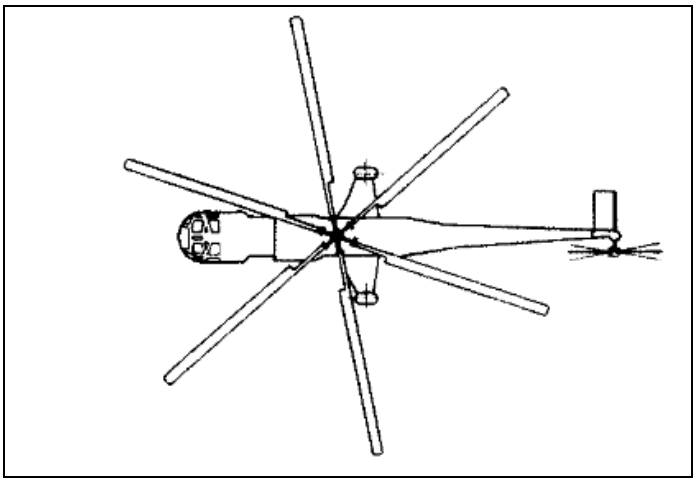

Figure 2.1: Top View

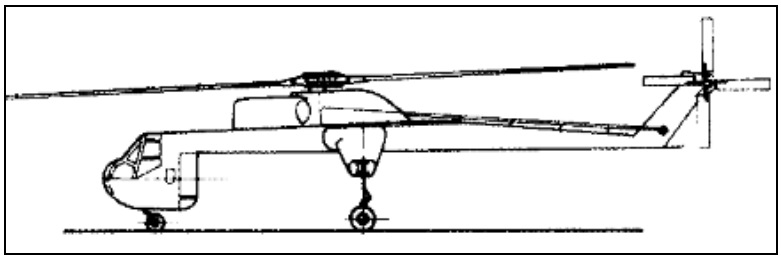

Figure 2.2: Side View

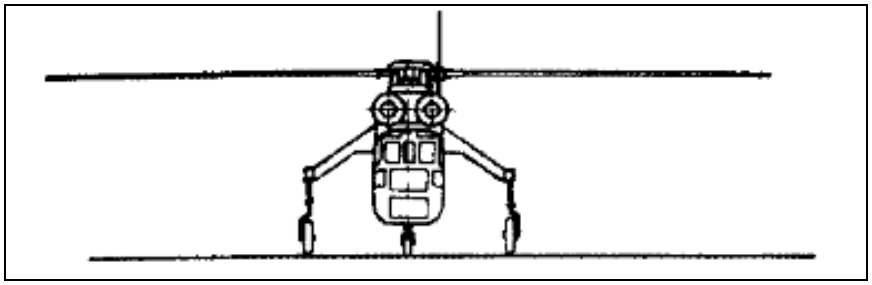

Figure 2.3: Front view

2.2 Unique or Key "Low-Speed" aerodynamics/propulsion design attributes

This aircraft utilized very specific aerodynamic/propulsion design attributes such as large rotor blades, a tail rotor, and a tilted transmission and cockpit. The large rotor blades are crucial for this aircraft to be able to achieve its main goal to lift heavy payloads. The tail rotor is implemented to counteract the torque produced by the large amount of torque produced by the main rotor blades. The transmission is tilted at 3 degrees to the left and this resulted in the cockpit needing to be rotated to the right to maintain stability with hovering when picking up heavy payloads.

2.3 Structures and Materials Design

The Sikorsky S-64 was manufactured out of different types of metals such as steel, aluminum, and as well as composite material. Some components throughout the aircraft are made from steel and aluminum but the rotors are engineered with composite materials. These specific choices of material help the aircraft be able to withstand the amount of payload being attached to the helicopter as well as being able to produce enough lift to fly.

2.4 Propulsion system

The propulsion system of this aircraft utilizes 2 Pratt and Whitney JFTD-12A-1 engines. This specific propulsion system configuration was applied to be able to produce enough thrust for the aircraft in flight. Given that the maximum take of weight is 38,000 pounds, a large amount of horsepower will be necessary to have a functioning aircraft.

3.0 Performance

3.1 Mission description

The Sikorsky S-64 was designed in the early 1960's to be a heavy lifting aircraft. This aircraft was first mainly used to transport military equipment but then was later used for civil use such as construction, logging, and fire suppression. This specific aircraft uses the missing fuselage to load containers, attach a water snorkel, attach heavy loads to the cargo hook, plus many other applications.

3.2 Performance Characteristics

Table 3.1 provides a comparative analysis of the Sikorsky S-64 and its predecessor, the Sikorsky S-60, both of which are heavy lifting helicopters. The S-64, derived from the S-60, exhibits similar performance attributes; however, it stands out as the superior heavy payload helicopter, primarily owing to its impressive Maximum Take-Off Weight (MTOW) and advanced propulsion design. These characteristics are possible mainly due to the larger 6 rotors which allows for a large amount of lift to be produced and a great amount of thrust allows for the cruise speed.

Performance Characteristic	Sikorsky S-64	Sikorsky S-60
Maximum Take Off Weight	38,000 pounds	34,500 pounds
Empty Weight	17,240 pounds	19,613 pounds
Maximum Cruise Speed	116 knots	100 knots
Power Plant	Two Pratt and Whitney JFTD-	R2800 Engine

	12A-1	
Type of Engine	Turbine Engine	Piston Engine

Table 3.1: Comparative Analysis between S-64 & S-60

4.0 Design and Manufacturing

The design of the Sikorsky S-64 began in April 1961 and finished in May 1962. The company that designed the helicopter was Sikorsky Aircraft Corporation which is funded by Lockheed Martin. The unit cost of an S-64 is $30 million and has an operational life cycle 1962 – present. Figure 4.1 showcases the assembly line of the Sikorsky S-64 in production.

Figure 3.1: A showcase of the Sikorsky S-64

5.0 Impact of the Sikorsky S-64 Conclusions

5.1 Mission capability achieved

The Sikorsky S-64's mission capabilities consist of both military application and as well as civil use. During the cold war, this aircraft was utilized for troops, logging, construction, and as well as fire suppression. With there not being a cargo, this allows the aircraft to attach crates, a water snorkel, and as well as picking up payload with the cargo hook allowing for a variety of missions utilizing the S-64.

5.2 Impact on Future Designs

The Sikorsky S-64 was a groundbreaking aircraft that motivated future different versions of the S-64 such as the S-64A, CH-54A, and the CH-54B. All of these consists of the same architecture as the base model of the S-64 but with simple tweaks and these are represented in Figure 5.1. Also, the utilization of the S-64 was an eye opener for the civil industry by realizing a new world of transportation

heavy payloads in a new way. This is such a remarkable piece of engineering as it motivated a new generation of heavy lifting helicopters.

	S-64A	S-64E CH-54A	S-64F CH-54B
Design Gross Weight	38,000 lbs	38,000 lbs	47,000 lbs
Overload Gross Weight	41,000 lbs	42,000 lbs	N/A
Weight Empty	17,240 lbs	19,120 lbs	19,700 lbs
Useful Load	20,760 lbs	22,880 lbs	27,300 lbs
Payload	16,000 lbs	20,000 lbs	25,000 lbs
Rotor Diameter	72 ft	72 ft	72 ft
Blade Chord	1.97 ft	1.97 ft	2.167 ft
Blade Twist	-13°	-13°	-14° nonlinear*
Tail Rotor Diameter	16 ft	16 ft	16 ft
Tail Rotor Chord	1.28 ft	1.28 ft	1.28 ft
Length	88 ft 6 ins	88 ft 6 ins	88 ft 6 ins
Height	25 ft 5 ins	25 ft 5 ins	25 ft 5 ins
Powerplant	Two P&WA JFTD-12A-1	Two P&WA JFTD12A-4A	Two P&WA JFDT12A-5A
Engine Power	4,050 hp	4,500 hp	4,800 hp
Transmission Limit	5,400 hp	6,600 hp	7,900 hp
Crew	3	3	3
Maximum Cruise Speed	102 knots	115 knots	104 knots
Range	166 nm	217 nm	208 nm
Hover Ceiling, In Ground Effect	9,700 ft	10,600 ft	
Service Ceiling	10,500 ft	13,000 ft	
Rate of Climb	1,400 ft/min	1,700 ft/min	

Table 5.1: A comparison of different S-64 versions

6.0 References

[1] "Leading the S-64 Aircraft into the Future: Introducing S-64F" - airmedandrescue.com

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