Aircraft Division

McCULLOCH MOTORS CORPORATION

REPORT S-140

DETAIL SPECIFICATION

MC-4C HELICOPTER

LOS ANGELES 45, CALIFORNIA

A w B

McCULLOCH MOTORS

CORPORATION

AIRCRAFT DIVISION

9775 AIRPORT BLVD. LOS ANGELES 45, CALIFORNIA

TITLE

DETAIL SPECIFICATION

FOR

MODEL MC-4C HELICOPTER

REPORT NO. S-140

October 9, 1951

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A. APPLICABLE SPECIFICATIONS

A-1 The following publications of the issue specified herein are applicable to, and form a part of this specification.

Rotorcraft Airworthiness CAR-06.

Airplane Airworthiness CAR-03 & -04. (whenever applicable).

All applicable A-N, NAS Aeronautical Standards.

ANC-1 Ground Loads Handbook.

Engine Manufacturer's Model specification No. 19284 dated February 9, 1951.

Appendix A POWER PLANT

Appendix B ARMAMENT

Appendix C INSTRUMENTS

Appendix D ELECTRICAL EQUIPMENT

Appendix E DESIGN FEATURES

B. TYPE

B-1 This specification with its appendices embodies the requirements for the design and construction of the herein described helicopter intended for liaison, training observation, rescue work and transportation of light cargo.

B-1A Type Designation:

Model No. MC-4C
Number of places; 2
Number of engines: 1

B-2 This helicopter shall be powered with the following engine:

Franklin Aircooled 6A4-200-C6

B-3 This helicopter shall be equipped with two tandem mounted lifting rotors of same diameters, more fully described in paragraphs E-2e (1) of this specification.

C. MATERIAL AND WORKMANSHIP

C-1 Material and workmanship shall be in accordance with applicable C.A.A. Specifications.

D. GENERAL REQUIREMENTS

D-1 The helicopter described in this Specification shall be constructed in accordance with applicable C.A.A. specifications.

E. DETAIL REQUIREMENTS

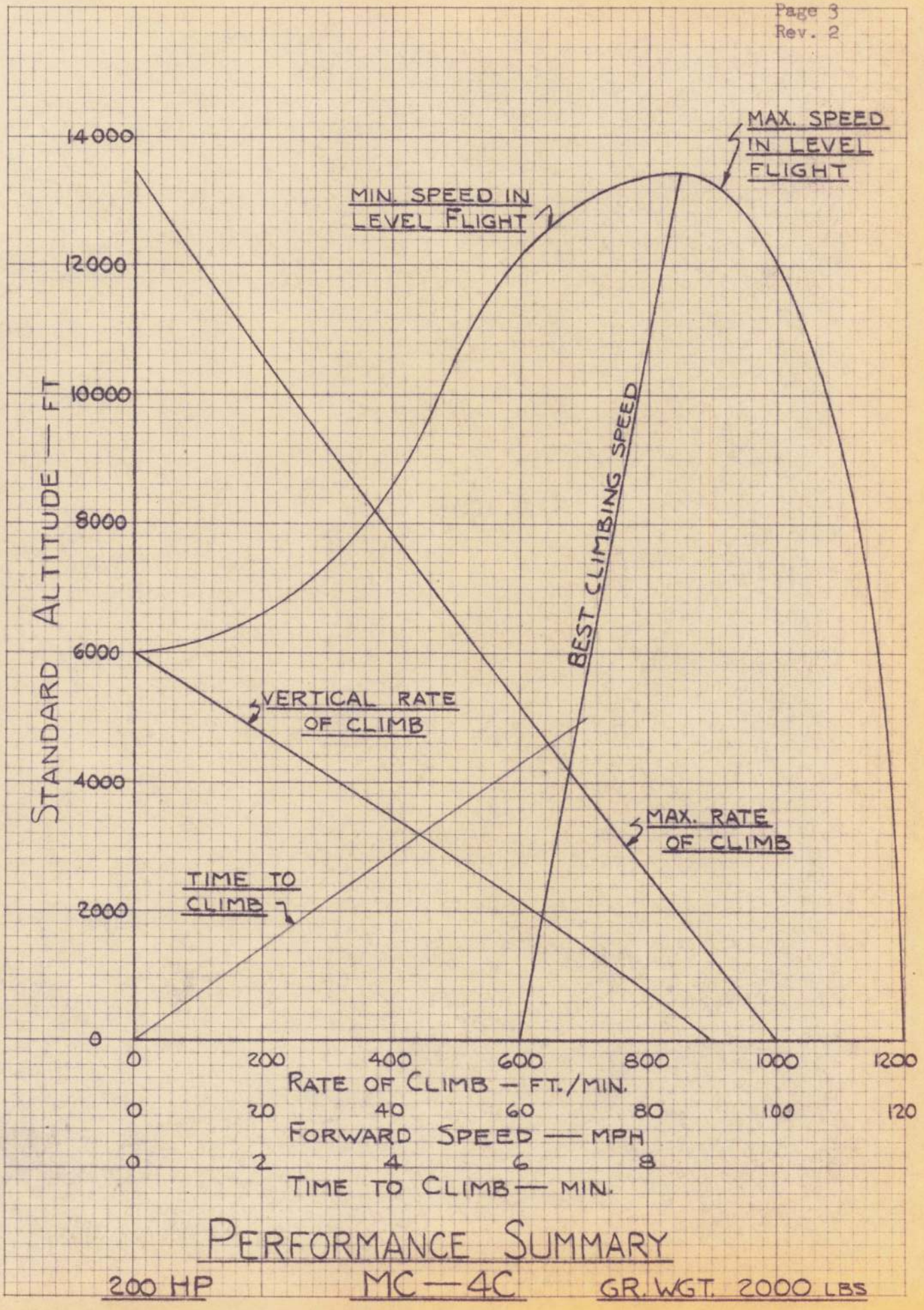
E-1 The performance, crew, equipment, and furnishings of this helicopter shall be as follows:

E-1a Performance with rated power of 200 HP and gross weight of 2000 lbs.

	Estimated Performance
High Speed, Sea Level (MPH)	120
Operating Speed, Sea Level (MPH) at 75% Power	90
Service Ceiling (Ft)	12,000
Hovering Ceiling (Ft)	6,000
Vertical Rate of Climb (Sea Level) FPM)	900 ⚠
Maximum Rate of Climb S.L. (FPM)	1,000
Time to Climb 5,000 ft. (Min.)	7
Range at Operating Speed (Miles)	200
Maximum Endurance (Hours)	4.1
Landing Speed (MPH)	0

E-1b Crew: Crew shall consist of a pilot and one assistant pilot or passenger.

E-2 Helicopter: The helicopter covered by this specification shall be a land type two place rotating wing aircraft having two lifting intermeshing rotors displaced in tandem. Each rotor consists of 3 blades of the same diameters. Both rotors are driven through suitable gear reduction units, belts and shafts. The main cabin for the crew and baggage is located on the front half of the fuselage.

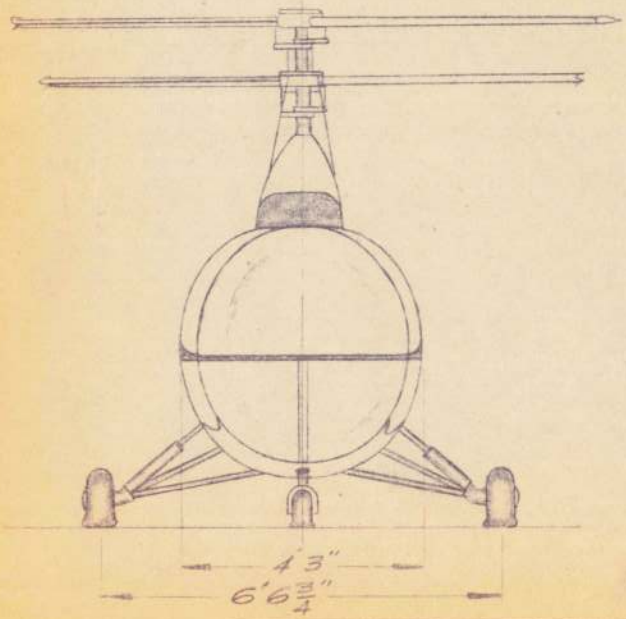


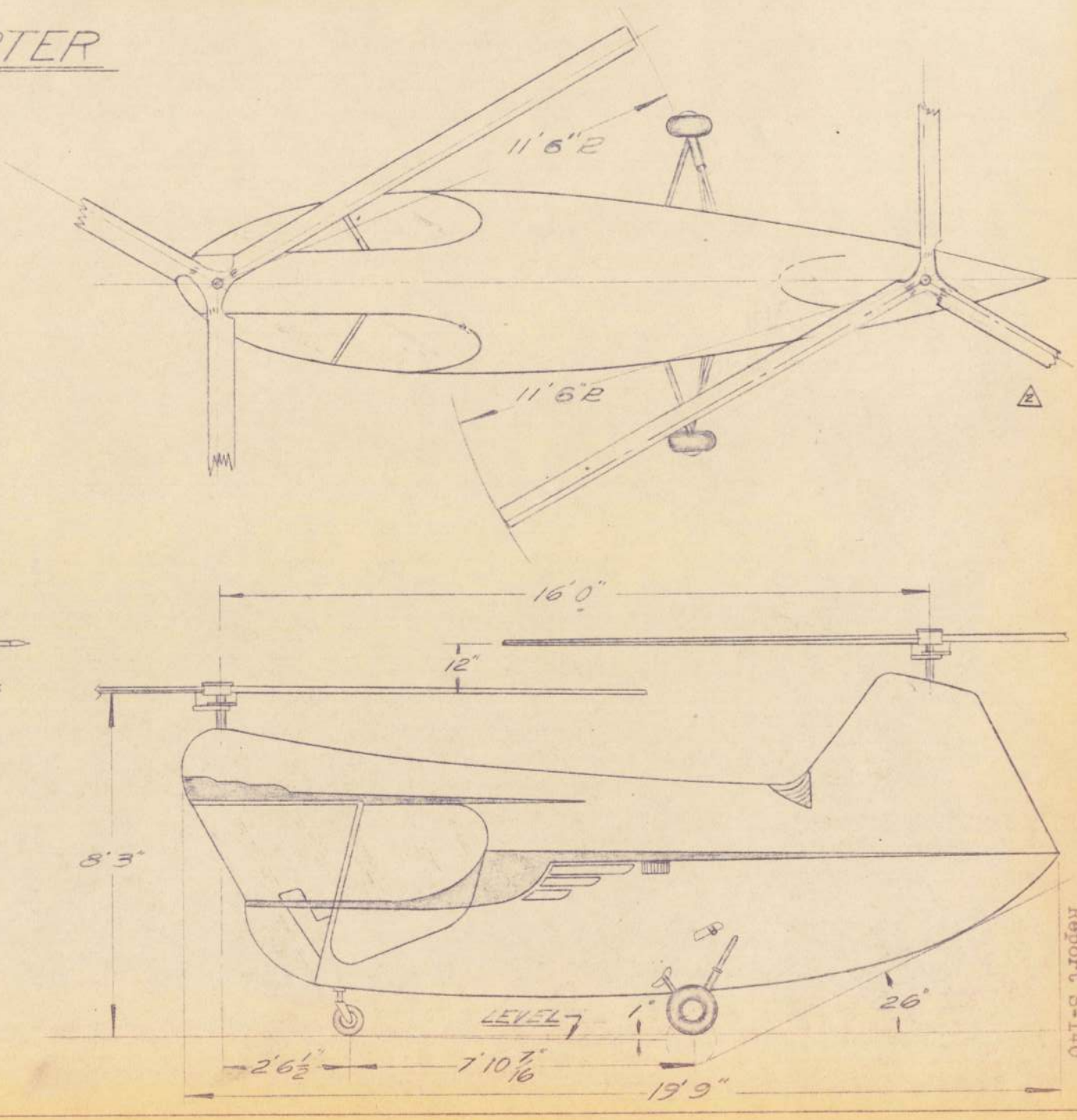
PERFORMANCE SUMMARY

200 HP MC—4C GR. WGT. 2000 LBS

MC-4C HELICOPTER

THREE VIEW





The basic structure is of tubular steel construction with suitable fittings and supports for the structural components and equipment.

The pilots enclosure shall be covered with transparent plastic material to provide good visibility for the members of the crew. Large entrance doors are provided on right and left sides of the cabin for rapid ingress and egress.

The engine section located in the rear part of the fuselage shall be designed to facilitate inspection and replacement of the engine and engine components.

E-2a Helicopter Weight and Balance

E-2A(1) Design loading: See group weight statement page 6 of this specification.

E-2A(2) Alternate Loading - None

E-2a(3) Design Gross weight: 2300 lbs. (For Stress Analysis Purposes)

E--2a(4) Balance:

Design Gross Weight C.G. Location:

2.9" Forward of the rotor median plane *

28.9" above the C_L of the lower fuselage main longeron.

Minimum Flying Weight:

1.2" aft of the rotor median plane *

31.1" above the C_L of the lower fuselage main longeron.

* Note: Rotor Median Plane is at Structural Station 98.5

GROUP WEIGHT STATEMENT

ROTOR GROUP	(174.4) ⚠1
Blades	97.0 ⚠1
Hinge	60.0
Hub	10.5
Brake	6.9
TAIL GROUP	(10.0)
BODY GROUP	(270.9)
ALIGHTING GEAR	(65.0)
Main Landing Gear	53.0
Auxiliary Gear	12.0
ENGINE SECTION	(24.0)
POWER PLANT GROUP	(627.7)
Engine	305.0
Engine Accessories	20.0
Power Plant Controls	4.0
Rotor Drive	42.6
Transmission	90.4
Transmission Drive	20.0
Transmission & Clutch Controls	3.5
V Belt Drive	55.2
Starting System	20.0
Cooling System	26.0
Lubrication System	16.0
Fuel System	25.0
FIXED EQUIPMENT	(285.0) ⚠2
Instruments	17.0
Flight Controls	115.0
Electrical System	115.0
Furnishings	38
WEIGHT EMPTY	1457 ⚠

USEFUL LOAD	(843) ⚠
Crew (2)	400
Fuel (30 gal.)	180
Engine Oil	18
Transmission Oil	6
Cargo	239 ⚠
GROSS WEIGHT	2300

DESIGN INFORMATION

Length-Max.	32'5"	Taper Ratio	
Height-Max.	8'10"	(Root Chord/Tip Chord)	1.0
Span	23' (2)	Length Root Chord	6.759"
Thickness Root Chord	1.013"	Length Tip Chord	6.759"
Thickness Tip Chord	1.013"	Max. Fuselage Depth	5'4"
Rotor Area Swept (EFF)	752 sq.ft. (3)	Max. Fuselage Width	4'3"
Load Factor - Ultimate	4.40 (1)		

Gross Weight For Stress Analysis 2300#

E-2b FLIGHT REQUIREMENTS

E-2b(1) General. This rotorcraft shall have such general performance and flight characteristics as to provide reasonable safety during the execution of any maneuver appropriate to, or necessary for, the aircraft during steady flight at any weight, center of gravity position, speed, and power within the ranges for which the aircraft is certificated. Compliance with all performance requirements shall be demonstrated by suitable flight tests conducted by the applicant and witnessed by a representative of the Administrator of Civil Aeronautics or, at his discretion, conducted by that representative.

E-2b(2) Landing. It shall be possible to make a safe landing with all power off.

E-2b(3) Ground handling. The rotorcraft shall demonstrate satisfactory ground resonance characteristics.

E-2c Flight Test

E-2c(1) Flight tests prior to acceptance of the helicopter shall be conducted in accordance with C.A.A. procedure.

E-2d Structure

E-2d(1). Criteria for Design

E-2d(1)a LIMIT Flight Load Factors

E-2d(1)a(1) Limit Maneuver Load Factors

Positive 3.5 Negative 1.0

E-2d(1)a(2) Limit Gust Load Factor: The effect of a vertical gust of 30 ft./sec. shall be calculated and considered in conjunction with various flight conditions and flying weights.

E-2d(1)b Limit Landing Factors:

To be determined by Drop Test

E-2d(1)d Ultimate Load Factor 4.4 ⚠

E-2e Detail Design

E-2e(1) Rotor Group

E-2e(1)a Airfoil Sections

NACA - 0015

E-2e(1)b Dimensions

Individual Rotor diameter	22'- 6"	⚠
Total disc area (effective)	751 sq. ft.	⚠
Total blade area (theoretical)	38.8 sq. ft.	⚠
Total solidity (effective)	.0517	⚠
Total number of rotors	2	
Total number of blades	6	
Root Chord	6.759	
Tip Chord	6.759	

E-2e(1)c Rotor Blades

The blades shall be of the cantilever type and straight in plan form and thickness. The blades include extruded spar leading and trailing edges and covering. The spar leading edge shall be made of 24 St aluminum alloy extrusion extending to 37% of the chord and shall form the nose contour of the airfoil as well as providing proper chordwise balance of the blades. The trailing edge shall be of pregwood. Blade covering consists of an 0.025 24 St aluminum sheet. All blade components shall be bonded by means of thermo-setting phenolic base adhesive under pressure and heat.

Root retention fittings shall be of 24 St aluminum alloy plates attached to the outer surfaces of the blades by means of bolts.

The tip end rib shall contain a lead ballast weight, located at 25% of the blade chord, as needed to attain proper spanwise balance.

The leading edge shall have suitable anti-abrasion protection.

E-2e(1)d Rotor Hub

Each rotor shall be supported by the rotor hubs and respective component parts. The blades are held by the bearing housing through the lag pins, which allow the movement of the blades in the plane of rotation. Blade centrifugal and radial loads are transmitted from the

Bearing housing to a set of blade knuckles by means of tapered roller thrust bearings, which allow the blades freedom about their own axis for the purpose of pitch change. Blade knuckles are horizontally pivoted to the rotor hub allowing the blades to cone and flap.

Suitable friction lag dampers are installed to restrict the frequency of the blades in their planes.

Rotor hub proper is made of chrome molybdenum steel and the bearing housings are made of 24 St aluminum alloy. Hubs are attached to rotor shafts by means of bolts in shear.

Suitable stops are provided to limit blade travel in the air and on the ground.

E-2e(1) e Transmission

Power transmission consists of an over-running clutch, Vee-belt central drive, drive shafts, and two gear reduction units.

E-2e(1)e(1) Central Drive and Clutch

The central drive consists of upper and lower Vee-belt pulleys, made of phenolic fabric material, and an idler pulley, and a set of 12 Vee-belts. The upper pulley houses the over-running clutch of the cam and roller type. Clutch operation is affected by the action of an idler pulley which is controlled from the cockpit.

E-2e(1)e(3) Gear Reduction Unit

Each unit consists of a spiral bevel gear and pinion gear, housing and covers, shafts, and tapered roller bearings. The reduction ratio of the gear reduction units is 4.44:1.

The gear reduction units are connected to the gear drive shafts by flexible couplings thereby eliminating the transfer of fuselage deflections to the gear cases.

E-2e(2) Control Surfaces

E-2e(2)a Vertical Tail Surfaces

E-2e(2)a(1) The fin shall be an integral part of the rear rotor pylon and will serve as a vertical tail surface.

E-2e(3) Flight Controls

E-2e(3)a General

Flight controls include: Azimuth blade pitch control, rudder control, pitch control, differential pitch control, and necessary movable supports.

The flight control system shall be smooth in operation and shall not require excessive operational effort by the pilot.

Cockpit controls shall be installed in accordance with CAA specifications. ⚠

Suitable panels and doors shall be provided for easy inspection of all flight controls.

E-2e(3)b Rotor Controls

Rotor controls consist of the swash plate and its allied mechanism. The swash plate contains a universally mounted set of roller bearings. The structure which contains the outer race of this bearing rotates with the rotor head and is provided with three control arms connecting directly to the blade pitch control horns. The inner race of the swash plate bearing is mounted on a shaft and is provided with two non-rotating arms which are connected to the cockpit controls. This shaft is universally mounted on a sliding member permitting the vertical movement of the entire assembly. Inclination of the swash plate on the universal causes azimuthal periodic blade pitch change, and up and down motion of the swash plate causes unison variation of blade angle.

E-2e(3)c Azimuth Blade Pitch Control

A set of standard sticks are provided in the cockpit for pilot and co-pilot for the azimuthal operation of swash plate.

Longitudinal control is obtained through a push-pull system.

Lateral control, being originated at the stick operates both swash plates in the same direction by means of a cable system.

E-2e(3)d Rudder-Directional Control

A set of rudder pedals are provided in the cockpit for pilot and co-pilot for the purpose of changing direction of the helicopter. This is obtained by over-riding the motion of the lateral control, i.e., inclining swash plates in the opposite directions. The interconnection is by means of cable and chain system.

E-2e(3)e Unison Pitch Control

The unison pitch control is accomplished by changing the angle of all the blades simultaneously. The connection to the swash plate is by means of a cable and chain system. Suitable friction devices are provided to vary the operational effort and to lock the stick in the desired position in flight. There shall be unison pitch control sticks for both the pilot and co-pilot.

E-2e(3)f Unison Differential Control

Interconnection is made to allow differential unison pitch change between the front and rear rotor simultaneously with the action of the longitudinal control. A trim wheel is provided in the cockpit to adjust the relative setting of unison pitch between rotors.

E-2e(5) Body Group

The body group consists of a fuselage, cockpit enclosure, and provision for equipment.

E-2e(5)a Fuselage

At maximum cross-section: Height 5'4", Width 4'3". The fuselage includes the fuselage proper and provision for equipment. The fuselage proper is divided into two main parts. The fore section, housing the crew, cargo, and fuel tank, extends to the fire wall and shall be of tubular steel construction. The primary structure members shall be made of 4130 and secondary and cabin enclosure frames of 1020 steel.

The cabin enclosure shall be constructed chiefly of non-inflammable transparent sheet plastic and shall provide vision in every direction except directly aft and up. Emergency exit from the cabin may be accomplished through the doors.

Suitable baggage compartment, measuring 3' x 3' x 2'6", shall be provided in the main compartment behind the passenger compartment.

Provision shall be made for the installation of communicating equipment in front of the instrument panel.

Main entrance doors measuring 44 inches by 28 inches shall be provided on both sides of the ship. The doors shall be as air and water tight as practicable.

The aft part of the fuselage houses the engine, accessories and Vee-belt drive. It consists of a steel tube frame, the fairing, and cowling. A close fitting stainless steel fire wall of .012 inches thickness shall be provided between the engine section and the cabin.

The rotor pylons support the rotor shafts, transmission, and rotor controls and are detachable.

Aluminum covering and fairing shall be used throughout the fuselage.

E-2e(6) Engine Mounts, and Cowling

A detachable steel tubular-type engine mount shall be used. Rubber vibration isolators shall be incorporated in the engine mount.

E-2e(6)b Cowling

Removable aluminum cowlings shall be provided on the engine section and in the vicinity of the exhaust collectors.

E-2e(7) Alighting Gear

The alighting gear includes supports, shock absorber units, wheels, controls, tires, tubes, nose wheel assembly, and also includes pins, bolts and nuts or connections necessary for attachment to the aircraft. The landing gear shall be of tricycle-type and non-retractable.

E-2e(7)a Main Landing Gear

The alighting gear is equipped with oleotype shock absorbing units. The supports consist of two Vee struts with axles, and oleo struts extending from the fuselage outboard to the base of axle fittings.

Wheel Tread 6' -6 3/4"
Tire Size 5.00 - 5 rib all weather tread

A suitable landing brake shall be used in both main wheels, the operation of which is accomplished by the action of the rudder pedals. This brake may be locked for parking.

E-2e(7)b Auxiliary Gear

A full swiveling non-steerable cantilever nose wheel shall be provided. The wheel fork is directly attached on the vertically mounted shock strut.

Tire size 10" smooth contour.

E-3 Propeller Installation (Not applicable)

E-4 Power Plant Installation

The design tendency of the power plant installation in this helicopter has been to achieve a package power unit as far as practicable, also to provide rapid access to the power plant components and engine accessories. Being located behind the firewall and far in the rear, the noise level reaching the pilot shall be decreased.

E-4a The MC-4C Helicopter shall be equipped with one Aircooled Motor 6A4-200-C6 engine, conforming to Aircooled Motors Specification No. 19284 dated February 9, 1951.

E-4b Lubrication System

The lubricating system is included with the engine.

Oil cooling shall be accomplished by means of a Harrison (8518115) cooler ducted to the engine cooling fan housing. The oil cooler is fitted with an automatic control and check valve of approved type.

E-4c Cooling System

The cooling system consists of a centrifugal type cooling fan mounted on the engine, and a shroud with suitable air deflectors. The cooling system shall be designed to meet the temperature requirement specified in Aircooled Motors specification 19284 and CAR 06.

E-4d Fuel System

The fuel system shall consist of a fuel tank, all fuel piping exterior to the engine shut-off cock, strainer, and pipe fittings and connections. Careful consideration shall be given in the design of the fuel system to its relation to other associated items such as engine primer, carburetor, or other metering devices, fuel pressure guages etc. The fuel system shall be developed and tested in accordance with CAA Specification. A gravity fuel system shall be used. The head shall be sufficient to

supply fuel to the carburetor at all times during the flight The capacity of main fuel tank shall be 37 gallons. The fuel reserve supply shall be 20% of the total capacity required for the specified range. The tank shall be of welded aluminum alloy construction, tested in accordance with CAA Specification and shall be located in the fuselage near the center of gravity. The tanks shall be vented to the atmosphere at the highest point. Suitable sumps and drains shall be provided in accordance with approved standards. All drains shall be led to the bottom part of fuselage. All fuel lines from the tank to the carburetor shall not be less than 3/4 inch outside diameter with .035 inch wall thickness. A suitable fuel quantity guage shall be provided. No dump valves shall be provided. There is a drip shield around the bottom of the fuel tank which is vented to the outside of the fuselage. This prevents the leakage of fuel into the baggage compartment.

E-4e Engine Control System

Engine controls include throttle controls, mixture control, and carburetor heat control and shall be in accordance with CAA Specifications.

The starter control switch is located on the central control panel and is within easy reach of the pilot and co-pilot and adjacent to the ignition switch so that both switches may be operated simultaneously with one hand. The location shall be such as to eliminate accidental movement.

The carburetor air heat control shall be of flexible shaft type.

E-4f Exhaust System

Suitable exhaust manifolds, made of stainless steel, shall be provided. The exhaust shall be discharged behind the engine section and directed rearward.

The engine cooling air shall be discharged through a sufficiently wide opening directly below and on each side of the engine.

E-4g Engine Air Intake

Engine cooling air is supplied through an opening on the top of the fuselage below the fin.

Carburetor cold air is supplied by a duct of ample cross-section connecting the carburetor with the air scoop-air filter located on the left hand side of the fuselage.

Carburetor hot air is admitted from the exhaust heat exchangers. Suitable air control box shall be attached to the carburetor and is controlled from the cockpit by means of locking type flexible control.

E-6 Equipment Installation

E-6a Instruments and Navigation Equipment

Instruments shall be installed in accordance with approved CAA Specifications. Correct operating range shall be marked, where necessary, for the most efficient utilization of the aircraft.

E-6a(1)(a) Instrument Panel Installation

The instrument panel shall be located centrally and conveniently for both pilots. All instruments are mounted on one panel, there is a separate panel for switches, radio controls and circuit breakers.

E-6a(1)(b) Flight Instruments

Include: Compass, Altimeter (sensitive), Airspeed Indicator.

E-6a(1)(b)(1) A pitot tube shall be installed near the forward rotor hub.

E-6a(1)(b)(2) Engine Instruments

Include: Dual Tachometer (for engine & rotor), Fuel Quantity, Oil Temperature, Oil Pressure Gauge and Manifold Pressure Gauge, Carb. Air Temperature Gauge.

E-6a(2) Miscellaneous Instruments

There shall be no instruments other than those included in the appendix "C".

E-6b Electrical Installation

E-6b(1) Generator - one Pierson 82450, 50 AMP (AN1042-6A Voltage Regulator).

E-6b(2) Battery - one Exide AN 3151.2 (24 volt-24 Amp. Hr.)

E-6b(3) Starter - Delco Remey - 24 volt (3)

E-6b(7) Switches

Standard AN or CAA approved switches shall be used in required number.

E-6b(9) External Power Receptacles

A standard AN 2552 receptacle may be installed in the vicinity of the engine on the left hand side of the fuselage for connection of the external power supply.

E-6c Miscellaneous Equipment Installation

E-6c(4) Cabin Heating and Ventilating

Provision shall be made for heating the cabin. Controllable openings shall be made in the cockpit enclosure for ventilating.

E-6c(7) Covers for Cockpit and Rotor Hub

Rotor Hub, engine air intakes, and enclosures shall be furnished with covers.

E-6c(8) Special Tools

One set of special engine and helicopter tools shall be provided.

E-6c(9) Flight Report Holder, Map Case and Data Case

Flight report holder, Map case, and Data case shall be incorporated in a fabric container and attached to the side of the pilot's seat.

E-6c(10) Airplane Check List Holders

An airplane check list holder shall be installed within easy reach of the pilot.

E-6c(11) Jacking

Four jack pads shall be installed on the fuselage, two at the firewall bulkhead and two at structural section 30.0.

E-6c(12) Hoisting, Provision, and Equipment

A hoisting ring shall be provided on the top of each rotor hub for hoisting the helicopter.

ANALYSIS
PREPARED BY W. B. Manning
CHECKED BY

E-6c(13) Towing Provision and Equipment

The nose landing gear axle shall be extended to permit attachment of towing devices.

E-6c(14) Mooring Provisions

Suitable mooring rings shall be provided on the basic fuselage structure.

E-6e(2) Parachutes

Pilots and co-pilots seats shall accommodate standard seat type and back type parachutes.

E-6e(3) Safety Belts

Standard Safety belts of approved type shall be installed for the members of the crew.

E-6e(4) Aircraft Cushions

Back and seat type cushions shall be provided in case the parachutes are not used.

E-6e(5) Seats

Non-adjustable seats shall be installed for pilot and co-pilot.

F. Method of Inspection and Tests

The method of Inspection and Tests shall be in accordance with requirements of C.A.R. Paragraph 06.011.

G. Packing and Marking

Packing and marking shall be in accordance with accepted commercial practice for transporting aircraft.

H. Notes

H-1 Explanatory Information - None

H-2 Additional Information - None

H-3 Equipment and Furnishings

APPENDIX A

Manufacturer's Specification S-140
Dated October 9, 1951

Quantity Minimum	Item		Dwg. No. or Spec. No.	Weight Pounds
1	POWER PLANT	Aircooled Motors	6A4-200-C-6	281.01
1	Carburetor	Marvel	MA-4-5	5.0
2	Magnetos	Scintilla	S6RN-21	11.04
1	Ignition Wiring	Breeze Shielded		5.5
12	Spark Plugs		AC-LA-47	2.3
1	Starter	Delco-Remy 24V	(3)	19.0
1	Oil Cooler	Harrison	8518115	7.75
		TOTAL		331.6

APPENDIX B

Manufacturer's Specification S-140

Dated October 9, 1951

ARMAMENT

Quantity Minimum	Item	Dwg. No. or Spec. No.	Weight Pounds

NONE

APPENDIX C

Manufacturer's Specification S-140
Dated October 9, 1951

INSTRUMENTS

Quantity	Item		Dwg. No. or Spec. No.	Weight Pounds
1	Airspeed Indicator	Pioneer	X-27916 (3)	.50
1	Altimeter	Kollsman	671BK-010	1.20
1	Compass	Airpath	AF-27471 (3)	1.20
1	Oil Pressure		AN5771-2 (3)	.41
1	Oil Temperature	Autolite	AN5790-6 (3)	1.00
1	Dual Tachometer	McCulloch	27825 (3)	1.59
1	Manifold Pressure	U.S. Gage	AN5770-1A	1.06
1	Fuel Quantity	Liquidometer	EA-102	.75
1	Carb. Air Temp.	Lewis	47AC3E (3)	1.00
		TOTAL		8.81

APPENDIX D

Manufacturer's Specification S-140

Dated October 9, 1951

ELECTRICAL EQUIPMENT (3)

Quantity	Item		Dwg. No. or Spec. No.	Weight Pounds
1	Battery		AN3151-2	56.00
1	Generator	Pierson	B2450	23.00
1	Voltage Regulator		AN1042-5	3.33
1	Reverse Current Cutout	Hartman	BuAer E-1600-1	2.56
1	Magneto Switch		NAF1125-10	.45
1	Master Switch (3)		AN3023-3B	.13
1	Landing Light Switch		AN3022-2B	.08
1	Position Light Switch		AN3022-2B	.08
1	Instrument Light Switch		AN3022-2B	.08
1	Dome Light Switch		AN3022-2B	.08
1	Generator Field Circuit Breaker		AN3161P10	.16
1	V-A and Warning Light Breaker		AN3161P10	.16
1	Radio Circuit Breaker		AN3161P20	.16
1	Instrument Circuit Breaker		AN3161P10	.16
1	Position Light Circuit Breaker		AN3161P10	.16
1	Landing Light Circuit Breaker		AN3161P25	.16
1	Landing Light	Grimes	D3150-9	1.85
1	Volt-Ammeter Shunt	Weston	NAF1091	.17
1	Battery Relay	Leach	7202-24	1.85
1	External Power Relay	Leach	7202-24	1.85

APPENDIX D (cont'd)

Manufacturer's Specification S-140

Dated October 9, 1951

ELECTRICAL EQUIPMENT (3)

Quantity	Item		Dwg. No. or Spec. No.	Weight Pounds
1	Battery Disconnect Strip		AN3436-4-4 (3)	.09
1	Instrument Disconnect Strip		AN3436-4-7	.16
1	LH Instrument Light		AN3034-2	.04
1	RH Instrument Light		AN3034-2	.04
1	Fuel Quantity Warning Light		AN3157-6	.05
1	Dome Light (cockpit)		AN3049-1	.16
1	Cargo Compartment Light		AN3049-1	.16
1	Generator Warning Light		AN3157-6	.05
1	Oil Temp. Transmitter		AN5525-1	.10
1	Tachometer Generator (engine)	Kollsman	1001G-01	1.50 (3)
1	Tachometer Generator (rotor) (3)	Kollsman	1001G-01	1.50 (3)
1	LH Position Light		AN3033-3	.19
1	RH Position Light		AN3033-4	.19
1	Tail Position Light		AN3158-1	.19
1	Volt-Ammeter (0 to 60a) (0 to 30$_v$)	Weston	NAF1091A-60	.63
1	Warning Light Disconnect Strip		AN3436-4-7	.16
1	Warning Light Dimming Relay		AN3304-1 (3)	.10
1	Utility Circuit Breaker		AN3161P20	.16

APPENDIX D (cont'd)

Manufacturer's Specification S-140

Dated October 9, 1951

ELECTRICAL EQUIPMENT (3)

Quantity	Item		Dwg. No. or Spec. No.	Weight Pounds
1	Instrument Light Circuit Breaker		AN3161P10	.16
1	Utility Receptacle		NAF1077	.06
1	Carb. Air Transmitter		AN5525-1	.10
2	Plug		AN3106-12S-3S	.04
5	Plug		AN3106-14S-1S	.05
2	Plug		AN3106-14S-2S (3)	.04
2	Plug		AN3106-14-3S	.05
1	Plug		AN3106-16-12P	.10
1	Plug		AN3106B-24-28P	.10
2	Receptacle		AN3100A-14-3P	.04
1	Receptacle		AN3100A-16-12S	.10
1	Receptacle		AN3100A-24-28S	.25
1	Receptacle-External Power		AN2552-3A	.63
1	Gear Case Temp. Warning Light		AN3157-6 (3)	.08
2	Gear Case Thermostat Switch	Fenwal	12411 (3)	.30
1	Grounding Jack		An3117-1 (3)	.10
1	Fuel Quantity Transmitter	McCulloch	22576 (3)	1.10
			TOTAL	101.81 (3)

APPENDIX E

Design Features

GENERAL

The MC-4C Helicopter more fully described in the Detail Specification embodies many design features that are believed to be the necessary imporvements toward an efficient aircraft of this type.

1. Tandem rotors

This rotor arrangement has been chosen because it indicates, and has in many instances, proven the following advantages:

a. Eliminates auxiliary anti-torque propeller

b. Smaller rotors

High speed rotors of small diameters are easier to balance, easier to maintain and produce lower forces in the control system and drive.

c. More lifting capacity for given horsepower. It is readily shown that in this helicopter more lift is gained by the elimination of torque balancing losses, such as tail propeller.

d. Reduction of cyclic vibration on pilot's stick. The blade periodic control forces become equalized in the inter-rotor controls so that the resultant forces reachin g the stick are of small amplitudes.

e. Reduction of rolling moments.

In forward flight or under the influence of side gust, all the extreme forces that will unbalance one rotor are counterbalanced by the other, leaving the fuselage undis-trubed.

f. Simplified piloting

Due to the lack of the anti-torque propeller, there is no need to coordinate the movements of rudder pedals and unison pitch control. During the variation of unison pitch control there is no resultant change in torque on the fuselage, since it is counter-balanced by the rotors. Also, the operation of the rudder pedals does not alter the power in the rotors and total thrust remains the same.

APPENDIX E

g. Safe Rotor Height

Both rotors are sufficiently high above ground to eliminate danger to ground crew.

2. Intermeshing rotors

By intermeshing the rotors the following advantages are obtained:

a. Reduction in structural weight

b. Reduction in drive shaft lengths and elimination of intermediate shaft supporting bearings and joints.

3. Differential rotor height

In this helicopter, the rear rotor is higher than the front one resulting in:

a. Reduction of downwash effect of the front rotor in forward flight, so that the flow through the rear rotor is not altered.

b. Less danger of interference between the blades even though the rotors are intermeshing, the height of the rear rotor is sufficient so that under designed flight conditions the planes of the blade tips do not intersect.

4. Six blades

Additional smoothness of rotor operation and reduction of vibrations both on the helicopter and the pilot's stick is obtained by using three blades in each rotor.

5. Flexibility of Design

a. Variation of gear ratio may be easily affected by changing the size of belt drive pulleys.

b. Variation of rotor height may be readily obtained on the rear rotor by changing the pylon and rotor shaft and four control pushrods.

6. Rotor Safety

The vital rotor components such as blades and hub attachments which are subject to constant fatigue loads are designed in

APPENDIX E

6. Rotor Safety (cont'd)

such a way that loads may be transmitted through secondary structure in case a failure of a primary structural member occurs. This safety feature permits ample flight control for emergency operation after such failures.

7. Large Tail Clearance

In flared autorotational landing, the helicopter attitude is tail down and for that reason a 26° tail clearance is provided.

8. New Blade Construction

The three piece construction of the rotor blades eliminates the many ribs and attachments used in typical conventional designs. Not only are points of fatigue failure eliminated, but also the application of a sturdy aluminum alloy sheet covering maintains a high dimensional stability of the airfoil contour and torsional rigidity under operating loads, affording superior aerodynamic efficiency.

Very low initial cost of this type of blade permits a more frequent replacement schedule and the attendant higher factor of operating safety.