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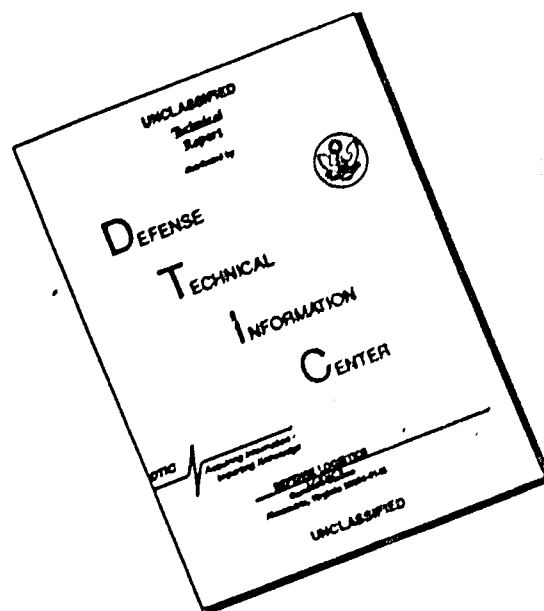
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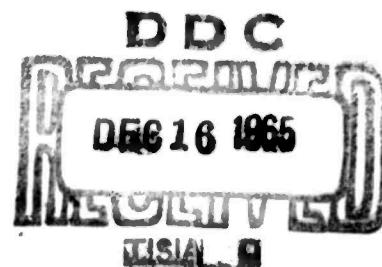
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MAXIMUM CARGO CAPABILITIES
OF TRANSPORT VEHICLES (U)

Part V - Combat Zone Transportation - Helicopters
(Interim)

by

Pfc Thomas H. Sarks



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MAXIMUM CARGO CAPABILITIES OF TRANSPORT VEHICLES (U)

**Part V - Combat Zone Transportation - Helicopters
(Interim)**

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Pfc Thomas H. Starks

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LIBRARY ABSTRACT

This report gives the cargo-carrying capabilities of helicopters available for use during the period 1956-1960, and forecasts the capabilities of those which will likely be available in the 1960-1970 period. Emphasis is given to external loading, with comments on the possibility of increasing tonnage and carrying capabilities by use of multi-helicopter lift over short radii of operation.

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MAXIMUM CARGO CAPABILITIES OF TRANSPORT VEHICLES

Part V - Combat Zone Transportation - Helicopters

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MAXIMUM CARGO CAPABILITIES OF TRANSPORT VEHICLES

FOREWORD

To comply with military characteristics for missiles and rockets, it has become necessary to consider configurations and weights in excess of those encountered in previous antiaircraft and artillery ammunition. This creates a need for establishing maximum configuration and weight of a single item that can be handled by all modes of transportation so that the design of a weapons system is not in excess of transportation capabilities. Should the transportation and handling capabilities be exceeded, the tactical employment of such a system becomes infeasible.

This report, when completed, will establish the maximum size of a single package that can be handled by all modes of transportation. As a result of inquiries made upon the Office, Chief of Transportation, and other agencies, the Department of Defense became interested in establishing limitations within which design of weapons must stay for effective transportation and handling in tactical employment. It has directed that criteria be established on a uniform basis for all services. However, prior to availability of Department of Defense standard criteria, information that is presently available will be published for interim guidance to the designer of ordnance equipment. This information will be labeled Interim on the title page until superseded by Department of Defense criteria.

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In order to disseminate information as it becomes available,
this report will be published in six Parts:

- Part I Air Transportation (published 29 Aug 1955, Rpt 5R3P)
- Part II Water Transportation
- Part III Rail Transportation
- Part IV Road Transportation
- Part V Combat Zone Transportation
- Part VI Summary of all Modes of Transportation

Part V - Combat Zone Transportation - Helicopters

INTRODUCTION

This report outlines maximum cargo tonnages that may be transported internally and externally by helicopters and establishes approximate dimensions that may be transported by internal loading during the period 1956-1970. Information presented was obtained from Bell Aircraft Corporation, Hiller Helicopters, Hughes Tool Company, McDonald Aircraft Corporation, Piasecki Helicopter Corporation, Sikorsky Aircraft, and from the Air Force Brown Book of Standard Aircraft Characteristics.

Since the Brown Book criteria are the approved and accepted specifications for the using services, these maximums for weights, ranges, etc., were used for the helicopters for which they were obtainable (i.e., H-19D, H-21C, and H-34A). Standard Aircraft Characteristics are not available for the H-37A and helicopters being designed by industrial manufacturers for the 1960-1970 period. Information received from the various manufacturers concerned with

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these helicopters has been used to predict what could be available should an agency within the Department of Defense see fit to further the development and production of these craft.

Maximum rectangular package sizes and weights that may be loaded internally are included for craft where this information could be obtained. When maximum package size is given, it means that the actual package plus any loading device used cannot be larger than the stated size. Non-rectangular packages may, in some instances, exceed the size limitation by small percentages. It is suggested, for non-rectangular items, that templates of cargo craft and packages to be transported be utilized to establish final maximum dimensions.

The possibility of utilizing vertical take-off and converter planes in supplement to or replacement of helicopters was considered. The Kellett Aircraft Corporation has a design for a tilting wing craft for which they predict a carrying capability of 30,000 pounds. Since this craft and other versions of cargo-carrying, vertical take-off and converter planes are in such an early development stage, this report will not attempt to predict the possibilities these craft will offer during the period 1960-1970.

DISCUSSION

Both internal and external loading of helicopters will be discussed in this report. External loading offers the following advantages:

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1. Packages of larger dimensions may be transported.
2. Pick-up and sling devices reduce the loading time required, as compared to the time required for internal loading.
3. For short radii of operation the tonnage-carrying capacities of the helicopter can be increased by approximately the amount of weight saved in the removal of the fuselage of the craft. For this to be done the design of the airframe must be such that members supporting the external load will withstand the additional stresses created by this type operation.

When longer radii (50 to 100 miles) are being considered, some of the weight advantage will be lost due to the additional fuel required to compensate for the parasitical drag of externally suspended items. The exact amount of penalty to be paid will vary with the prevailing conditions, i. e., the amount of parasitical drag will be proportional to the configuration of the package being transported and the velocity of the helicopter. The net amount of weight advantage to be gained in the 50 to 100 mile radius by external loading was estimated by the companies queried. These estimates varied from 0 to 25%, with the average estimation being 6%. Again it is noted that the aerodynamic properties of the package being towed will directly affect the net weight gain, and before an accurate estimate can be made, the configuration and dimensions of the package to be transported must be known.

Since the Air Force Brown Book of Standard Aircraft

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Characteristics gives consideration only to internal loading in its payload vs range curves, this report will assume that the payload-range curves will be the same for external and internal loading.

A survey of the helicopter industry was made to determine the planning of the industry with respect to future helicopter development, as well as to determine the capacities of craft presently in production. From this survey it was found that four cargo helicopters determine the maximum capabilities of helicopters in the period 1956-1960. Also, it was found that four new cargo helicopters are being planned and, if accepted and purchased by the Department of Defense, could be available in the 1960-1970 period.

A multi-lift type cargo movement has been proposed by Piasecki Helicopter Corporation. The method which they envision for this type operation was included in a proposal to the Transportation Corps. It appears from information contained in this proposal that three H-21C's could carry a load of approximately 6 tons over a short distance (see Fig 1). Using a similar system with five H-16B's, a load of approximately 30 tons could be transported over a short distance. The Marine Corps has tested a multi-lift method at Quantico, Virginia; however, final reports of the success of this activity, or any statistical information regarding tonnages, radii of operation, etc., had not been compiled at the writing of this report. Should multi-lift operations prove

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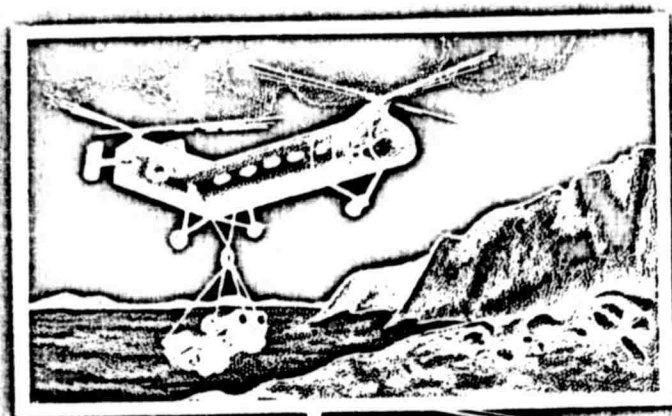
feasible, the capabilities of present and future helicopters would be substantially increased.

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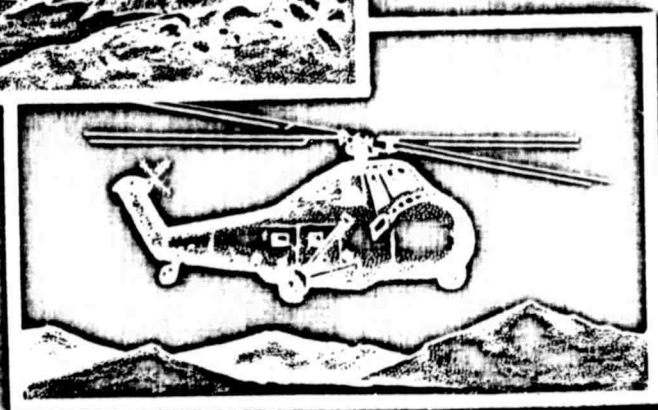
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Cargo Helicopters

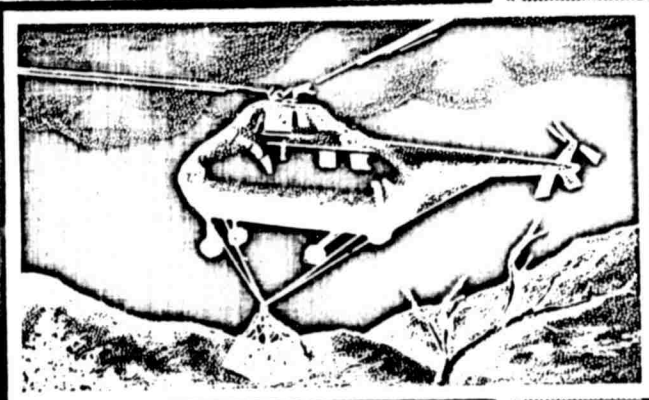
1956
1960



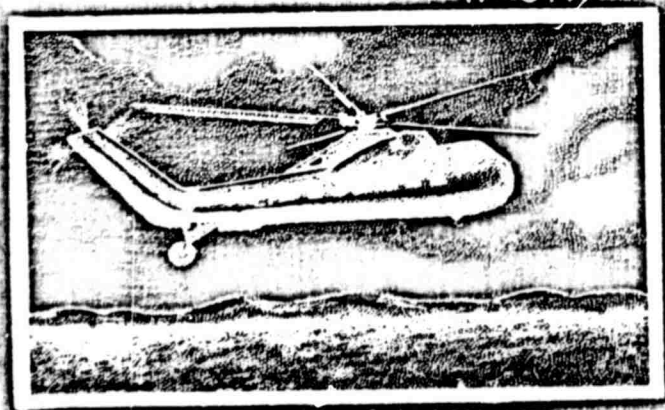
H-21C



H-34A



H-19D



H-37A

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Period 1956-1960

H-19D: The principal mission of the H-19D is the transportation of cargo and assault troops. This craft has a single lift rotor and a small anti-torque rotor in the rear.

The main cargo entrance is 4 feet by 4 feet and is on the side of the helicopter. The cargo compartment is 10 feet long, 5.5 feet wide, and 6 feet high. An external cargo sling capable of carrying 2,000 pounds is provided.

Fig 2 shows payload-range and hovering capabilities of this helicopter.

H-21C: The principal mission of the H-21C is to provide air transportation for troops and cargo. It is tandem rotored, with a single engine, and has an automatic pilot and instrument arrangement for blind flying.

Fig 3 shows payload-range and hovering restrictions. The table below gives the maximum size packages that can be loaded internally in the H-21C.

Depth	53 ← → 53														59 ← → 59									
Width	46	40	38	36	34	32	30	28	26	24	22	20	18	34	32	30	28	26	24	22	20	18		
Length	25	42	44	56	59	61	63	67	72	80	85	93	95	59	59	64	64	64	75	78	89	91		

The H-21C has structural provisions in its fuselage for installation of an external cargo sling capable of carrying approximately 5,000 pounds.

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The resultant change in center of gravity due to swaying of the external load is negligible from a control standpoint. The sling features a quick release mechanism, operable from either the cockpit or cargo compartment. The release mechanism opens the sling's cargo hook to enable dropping a suspended load at any time during flight or for instantaneous unloading while hovering.

H-34A: The principal mission of the H-34A is also the transportation of cargo and personnel. The H-34A is a single-engine helicopter using a single main lifting rotor and a single anti-torque tail rotor.

The cargo door, measuring 4 feet by 4 feet 3 inches, is on the side of the fuselage. The cargo compartment is 13 feet 6 inches long, 4 feet 9 inches wide, and 5 feet 10 inches high. There are provisions for a cargo sling capable of holding 2 tons of bulky equipment.

Fig 4 gives the payload-range and hovering capabilities of this helicopter.

H-37A: The principal mission of the H-37A is the transportation of cargo and personnel. It has one lift rotor and a small anti-torque rotor. This helicopter is a modification of the Navy model XHR2S-1 which had its first flight in January 1954. The H-37A should have its first flight in March 1956.

The helicopter is equipped with an external cargo sling capable of holding 10,000 pounds. The main cargo entrance is through the

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clamshell doors in the nose. The cabin contains a 2,700 pound capacity monorail for use in loading. With the monorail in position the cabin clearance is only 69 inches; otherwise the maximum clearance is 80 inches. Fig 5 shows the cargo compartment and entrance.

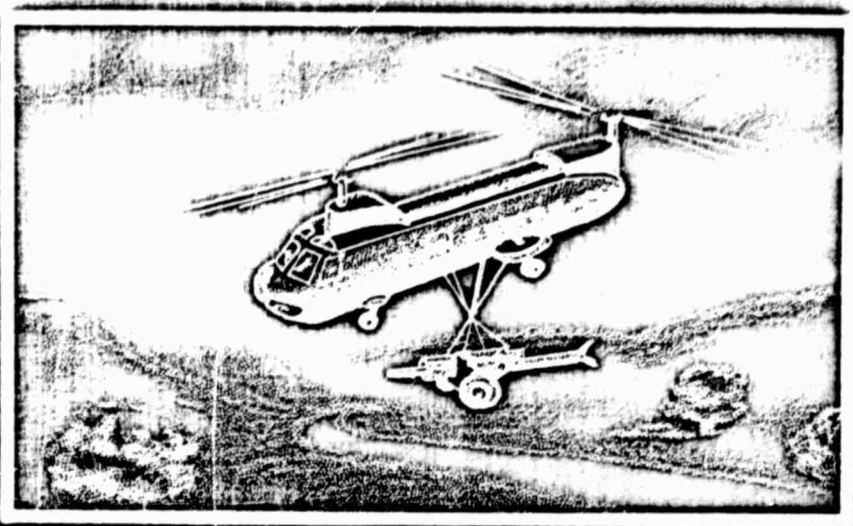
The H-37A will be able to carry a 6,000-pound package over a 100 mile radius and has a hovering ceiling of 6,400 feet with this load on a standard day.

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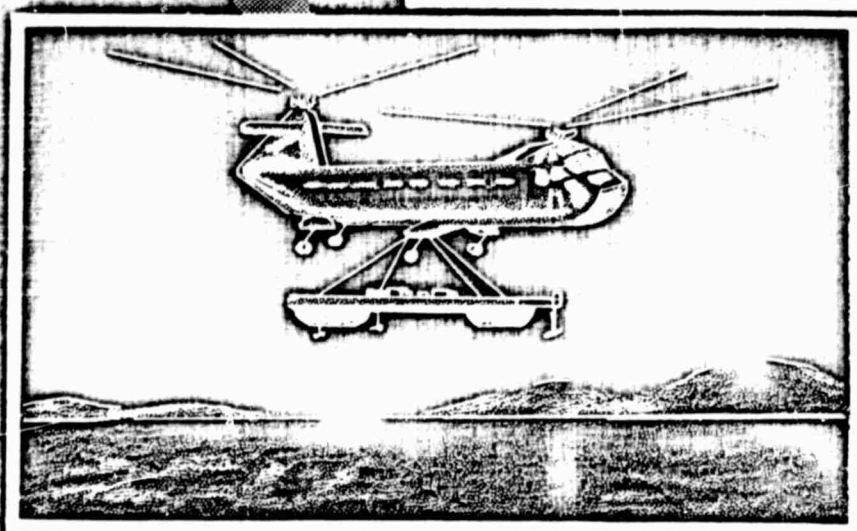
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Cargo Helicopters

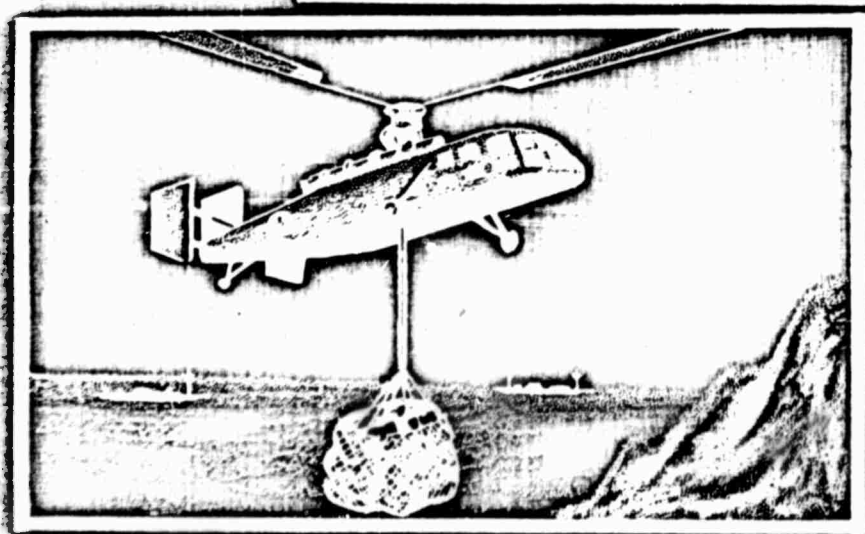
1960



D216



H-16B



XHCH-1

1970

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Period 1960-1970

YH-16B: The principal mission of this helicopter is to provide air transportation for troops and cargo. It is a tandem rotored helicopter with two turbine engines.

The cargo compartment of the YH-16B is approximately 48 feet long, has a maximum clearance of 6 feet 6 inches and a maximum width of 8 feet 9 inches at the heavy frames; but, since the cross-section of the cargo compartment is approximately semi-circular, Fig 6, a box whose cross-section is 6 feet 6 inches by 8 feet 9 inches could not be loaded. It appears from the blueprints that a box 5 feet high, 6 feet wide, and 41 feet long could be put in the compartment. The reader should again be reminded that any loading devices must be included in package size.

Fig 7 shows the capabilities of the YH-16B and possible improvements that may be made in later models.

It appears that this helicopter could be in production by 1960 if so ordered by the Department of Defense.

D216: The D216 is a tandem rotored, tri-turbine powered, cargo helicopter proposed by Bell Aircraft Corporation. This helicopter is designed for handling loads of approximately 3 tons. The D216 will not set a maximum on the helicopter transportable package size in the period 1960-1970; it is included to give the reader an idea of possible future helicopters of this payload weight class. The advantages of the

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D216 are the reliability given it by its 3 engines, and the cargo handling facilities provided by its large rear cargo entrance and its long cargo compartment.

The cargo compartment is 6 feet by 6 feet by 24 feet. However, the cargo door will not allow this size package to be loaded. A rectangular package, including loading devices, 4 feet high by 6 feet wide by 24 feet long could be loaded, or a package 5 feet high 6 feet wide and 10 feet long.

The aircraft is provided with an external cargo sling. A payload-range graph (Fig 8) is given for both internal and external (with fuselage intact) loading.

This helicopter is in the design proposal stage, and it is unknown whether or not it will ever be produced.

XH-17: The Hughes XH-17 is a pressure jet type cargo helicopter, which is a radical departure from all previous helicopter designs. One such helicopter has been produced and flown. Since this is a new concept, it is believed that this helicopter will be of greater experimental value than it will be of practical value. Using the experience gained with the XH-17, better helicopters of this type may be developed. Already a proposal for the same general type of helicopter, the XHCH-1 (discussed later), is being considered for production by the Navy. Also, a report recently published by Hiller Helicopters shows that rotor tip propulsion, either by pressure jets

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or turbojets, would be the best choice for production procurement in the period 1960-1970.

The pressure jet system consists of feeding compressed air through the rotors to the jets at the end of the blades. These jets propel the rotor. This type propulsion leads to a heavy-lift, short-range helicopter, the short range being due to the rapid rate of fuel consumption.

The XH-17 is built so that it can straddle most loads and carry them externally. This helicopter in its present stage can carry an 8,000-pound load, and it is thought that with a few minor changes the payload could be increased to 15,000 pounds. The Hughes Company believes it can develop a production model of this type capable of carrying up to 30,000 pounds over a distance of 100 miles.

XHCH-1: The McDonnell XHCH-1 is a cargo helicopter under active development for the U. S. Navy. It is designed for air lifting large payloads from ship to ship and ship to shore or from rear supply to forward combat areas. Payloads of over 13 tons may be lifted for short distances. Extended radius deliveries carrying reduced payloads are possible at over 100 nautical miles.

The XHCH-1 is powered by pressure jets. Two gas turbine engines with load compressors supply the required air flow to the jets located at the tips of the rotor blade. This helicopter has a very rapid

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gas consumption; therefore, the payload curve declines rapidly with increased radius.

The cockpit arrangement is such that the co-pilot's seat faces the rear. There is a window in the floor which allows the co-pilot to see the cargo while handling the helicopter during pickup and deposit of the payload. The XHCH-1 is designed for external loading only.

Payload-radius curves can be found in Fig 9.

In Fig 9 a dual nozzle jet is mentioned. This is a concept where one nozzle is the actual pressure jet engine and the other nozzle is a release for the compressed air from the compressors. It has not yet been determined whether a single or double nozzle jet system will be used on the XHCH-1.

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CONCLUSIONS

Period 1956-1960

The H-37A provides maximum cargo capabilities, with a payload of 6,000 pounds for a 100 mile radius. However, the H-37A production is just starting, and it will not be generally available until about 1959.

The H-21C is now in general use and in quantity production. Therefore, the H-21C should be used as a standard of cargo capabilities of helicopters for the present. Using this standard, packages designed for helicopter transport over a 100 mile radius should be limited to two tons in weight. If internal loading is necessary, the package should meet the requirements of the table on page 7.

If multi-lift experiments prove successful, the weight limits could be increased in proportion to the number of helicopters used.

To realize the advantages of external loading, especially in combat areas, packages should be designed to withstand and implement this type handling.

Period 1960-1970

The YH-16B and the XHCH-1 can be considered standards for the capabilities of cargo helicopters during this period. This means that for short hauls (i.e., 20 mile radius) a load of 22,000 pounds could be transported. For a 100 mile radius 16,700 pounds could be transported with a hovering ceiling of 5,600 feet.

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For internal cargo loading the YH-16B can be considered the standard for maximum cargo dimensions. However, it is believed that most large cargo will be carried externally because of the ease of loading and unloading.

Although the YH-16B and the XHCH-1 may never go into production status, it seems almost inevitable that helicopters of this size will be produced.

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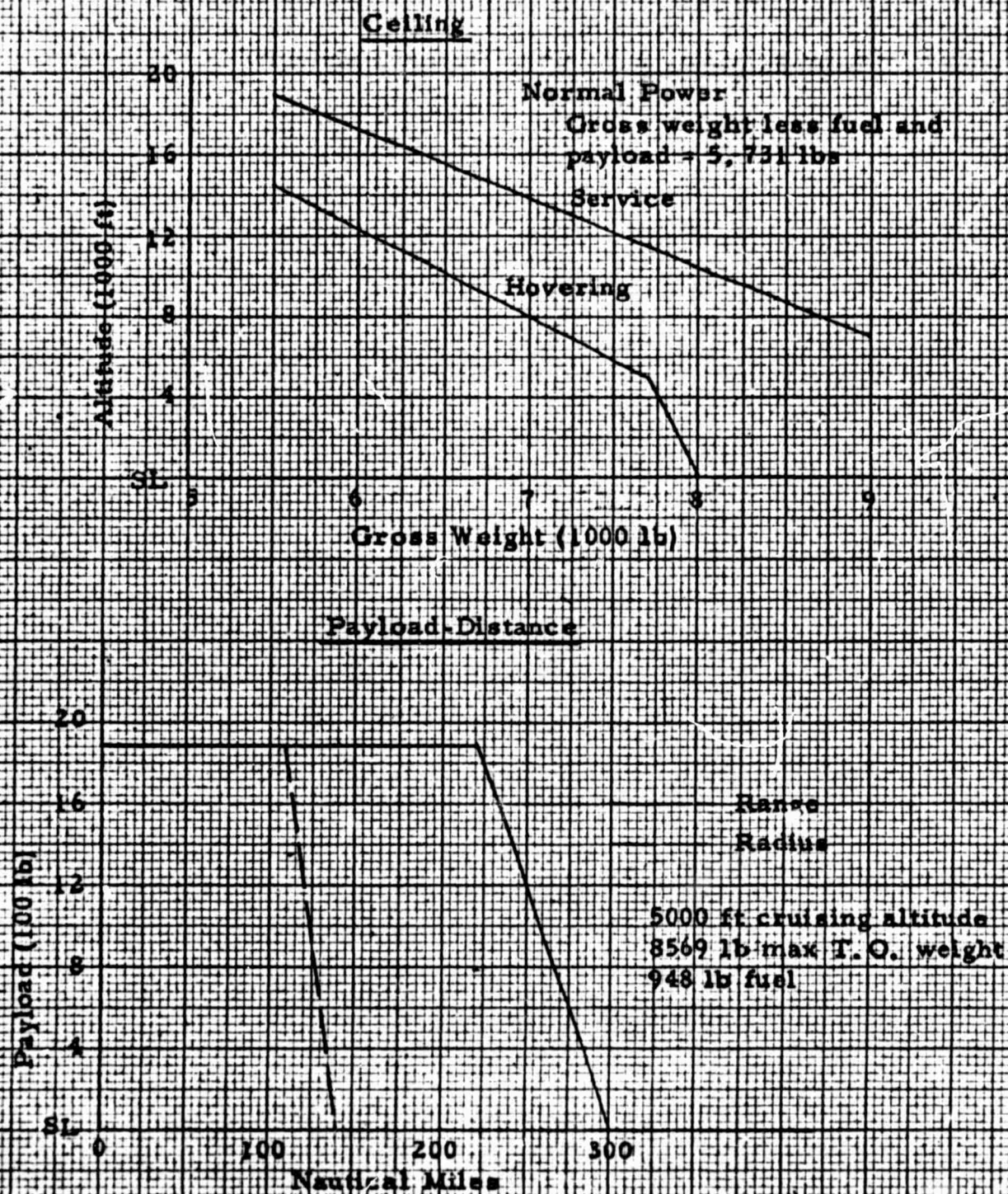


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Fig 1

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H-19D

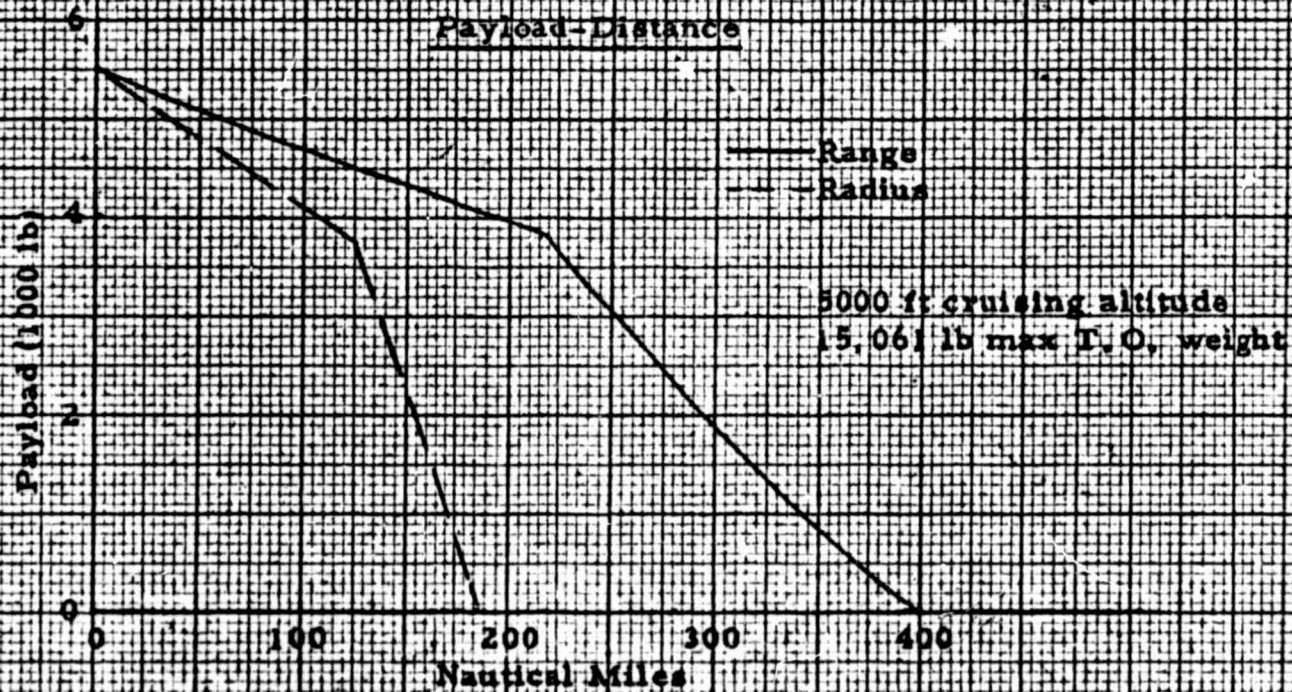
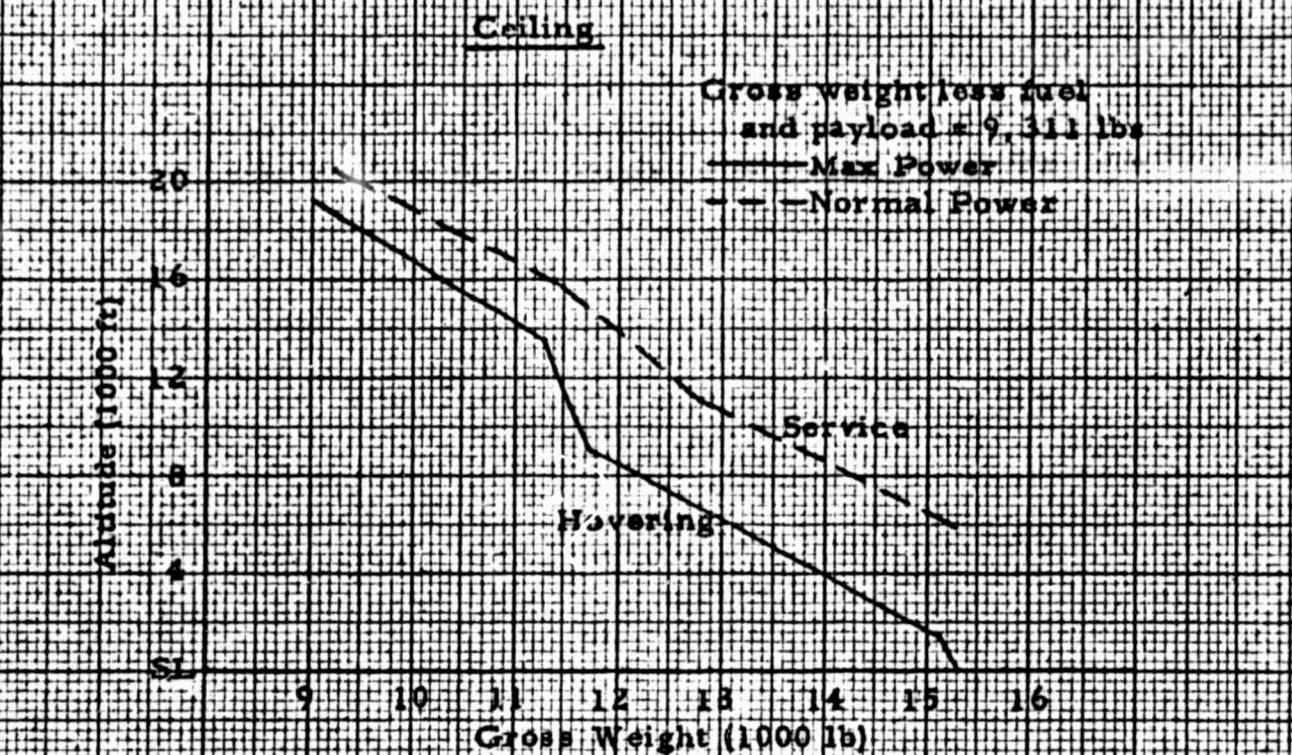


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Fig 2

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H-21C

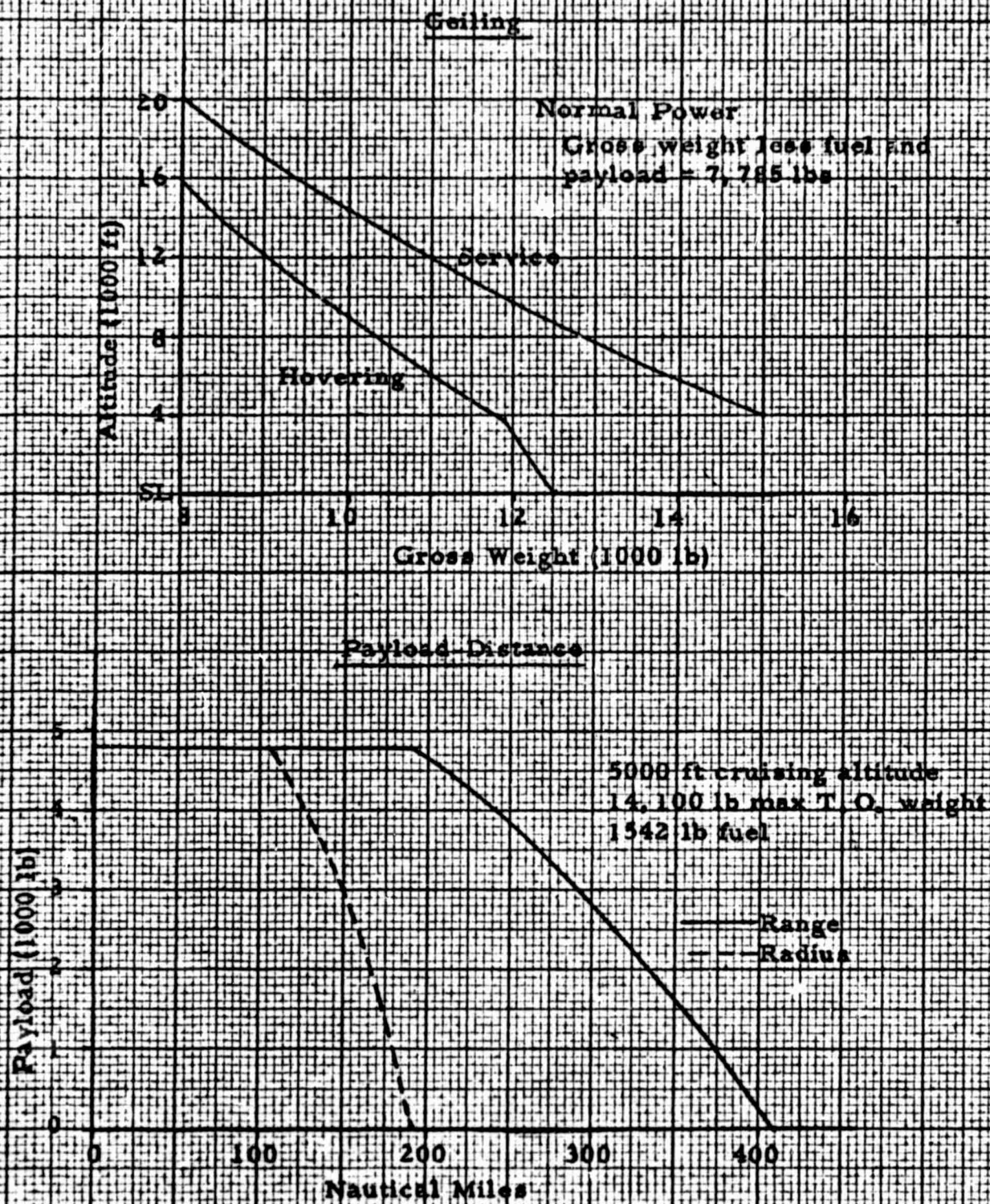


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Fig 3

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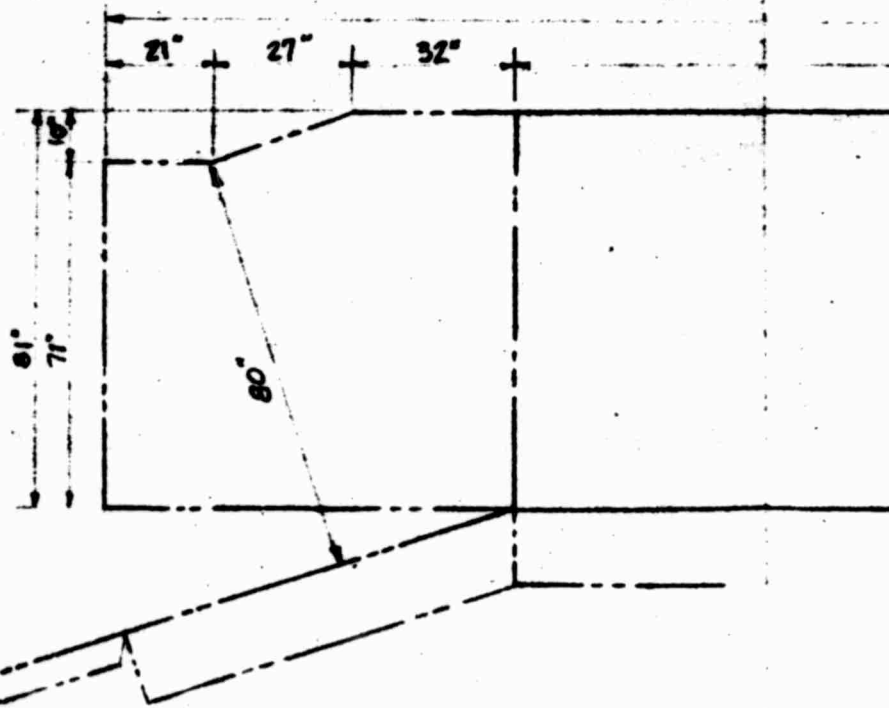
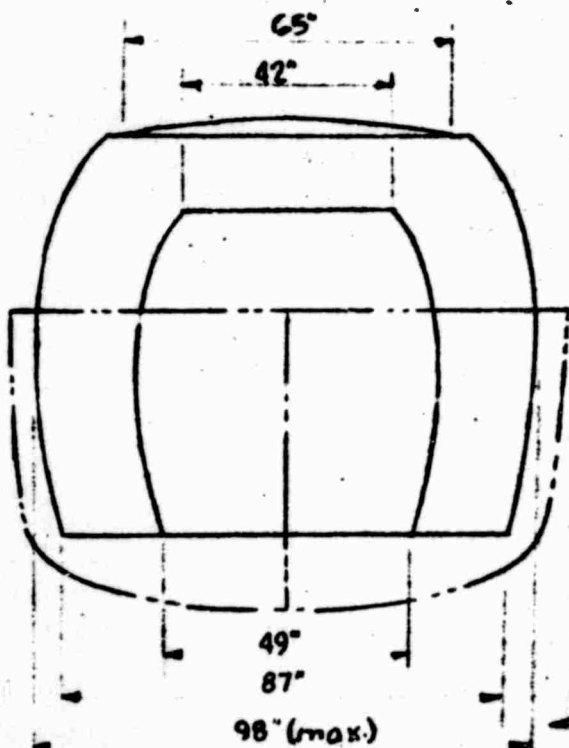
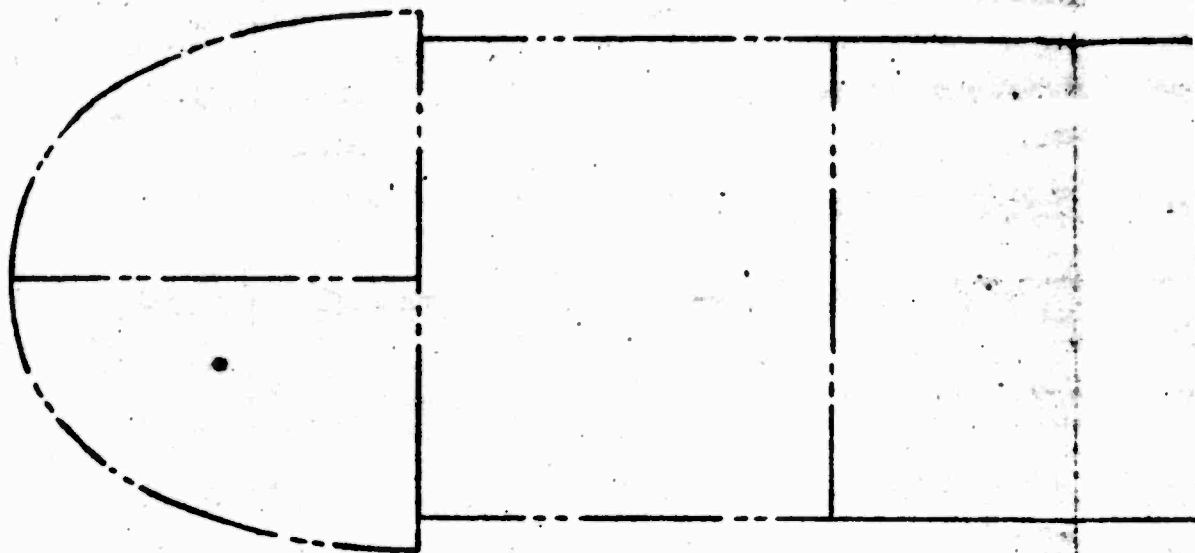
H-34A



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Fig 4

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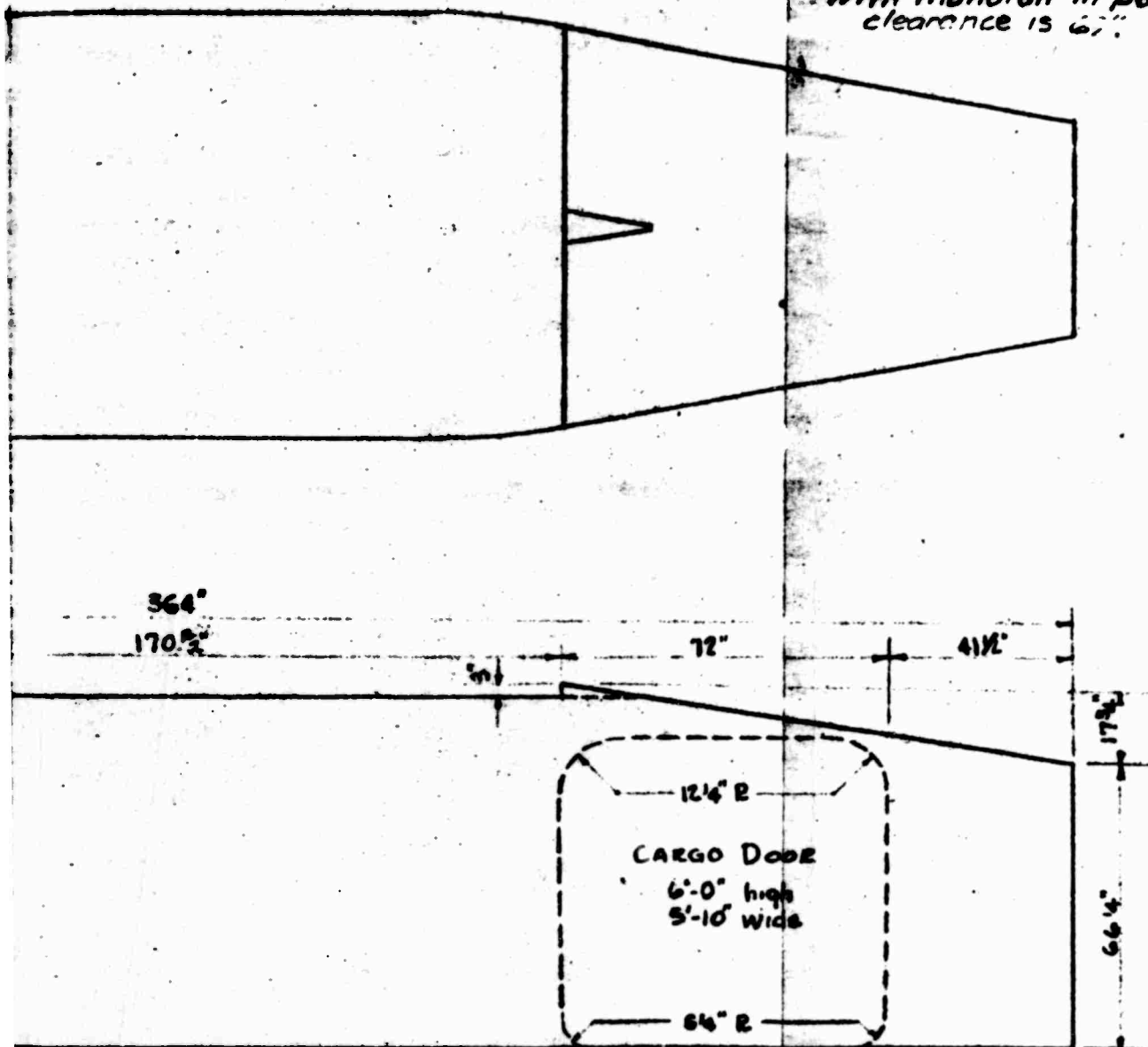
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Cargo Comp 7 - Inside Dimensions

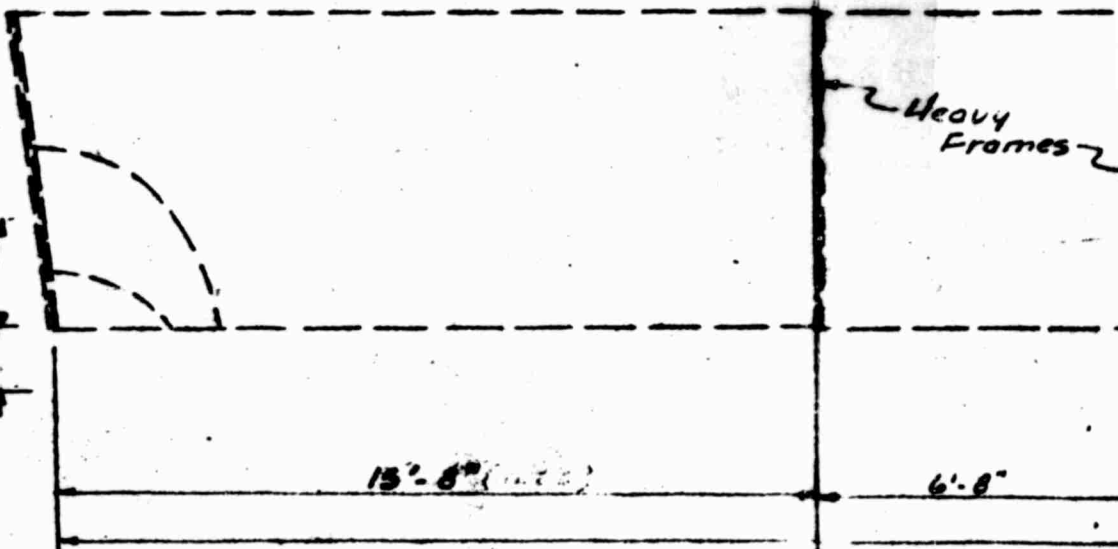
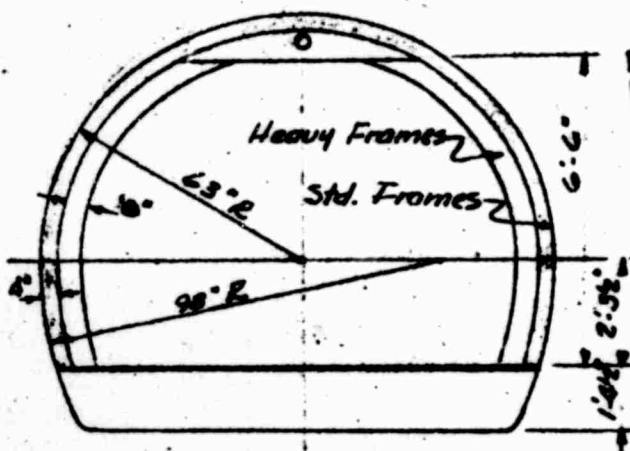
Length 17' 0"
Width 1-5'
Height 6'-9"
Floor Area 202.3 sq. ft.
Volume 1250 cu. ft.
Max. Floor Load 300 psf
With monorail in position
clearance is 67"



CARGO COMPARTMENT SECTIONS
MODEL 437A - HELICOPTER
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Fig 5



CARGO

YH

Ceiling

Heavy
Frames

6'-6"

6'-8"

47'-10" (n.t.s.)

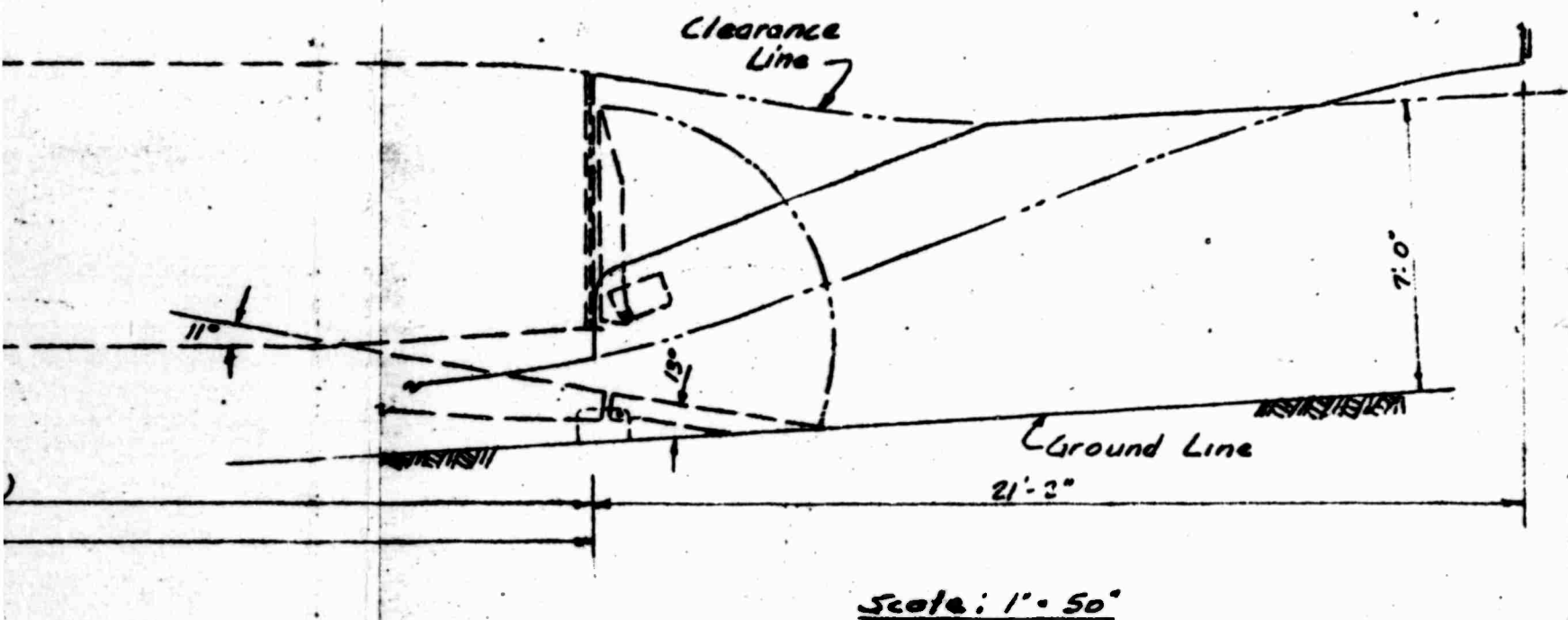
25'-6" (n.t.s.)

11°

CARGO COMPARTMENT

YH-16B

2



3

Fig 6.

NOVEL THOSE TIGHT	TRANSPORT	MOVING 100	100 OF GROSS WEIGHT
CRANE	MOVING 100	100 OF GROSS WEIGHT	
OVERLOAD THOSE WEIGHT	TRANSPORT	MOVING 100	100 OF GROSS WEIGHT
CRANE	MOVING 100	100 OF GROSS WEIGHT	
OVERLOAD THOSE WEIGHT	TRANSPORT	MOVING 100	100 OF GROSS WEIGHT
CRANE	MOVING 100	100 OF GROSS WEIGHT	

ITEM	UNITS
ENG. HP/RPM (NRP)	SHP/RPM
(MIL)	SHP/RPM
ENG. HP/RPM 100° (NRP)	SHP/RPM
(MIL)	SHP/RPM
ENG. HP/RPM 95°/6000° (MIL)	SHP/RPM

WEIGHT-EMPTY	(NORMAL)	(OVERLOAD)	(MAX OVERLOAD)	(OVERLOAD)	(MAX OVERLOAD)	(OVERLOAD)	(MAX OVERLOAD)
GROSS WEIGHT							
USEFUL LOAD-TOTAL	(NORMAL)	(OVERLOAD)	(MAX OVERLOAD)				
USEFUL LOAD-FIXED				(NORMAL)			
PAYLOAD							
FUEL LOAD							
PAYLOAD							
FUEL LOAD							
PAYLOAD							
FUEL LOAD							

R/C NORMAL	VERT @ S/L NRP	FPM
BEST @ S/L NRP		FPM
HOVERING CEILING STD DAY		FT
a) OUT OF GROUND EFFECT NRP		FT
b) OUT OF GROUND EFFECT NRP		FT
HOVERING CEILING NRP Tamb (95°F C/A/I)		FT
c) WHEELS 10' OFF TRANS 20' OFF CRANE		FT
d) OUT OF GROUND EFFECT SERVICE CEILINGS		FT
e) ALL ENGINES NRP		FT
f) ALL ENGINES NRP		FT
g) ONE ENGINE OUT COND NRP		FT
h) ONE ENGINE OUT COND NRP		FT
CRUISE SPEED		KT
i) SEAT LEVEL		KNOTS
j) 5000'		KNOTS

Fig 7

ARMY MEDICAL CENTER, WASHINGTON, D.C.

YH-16B TRANSPORT - CRANE - GROWTH CHART

TRANSPORT 100 NAUTICAL MILE RADIUS

TRANSPORT	100 NAUTICAL MILE RADIUS
CRANE	20 NAUTICAL MILE RADIUS / MIN. HOVER, 11 MIN. HOVER RESERVE

[illegible]

								R-16	V _r -07-08	G=08
1450					1150			1868		1320
2200					2125			2710		2140
10300					9200			11100		9700
8600					9000			9000		7700
6000					6000			6200		6000
4400					4400			4500		3800
15900					14300			16000		14500
14900					13800			15000		12100
6400					6600			11400		
3000					3300			10000		
140					136			140		
123					119			123		

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D216

Payload Distance

Gross Weight 19,914 lbs

Cargo Load (1000 lbs)

Internal Cargo

External Cargo

Range - Nautical Miles

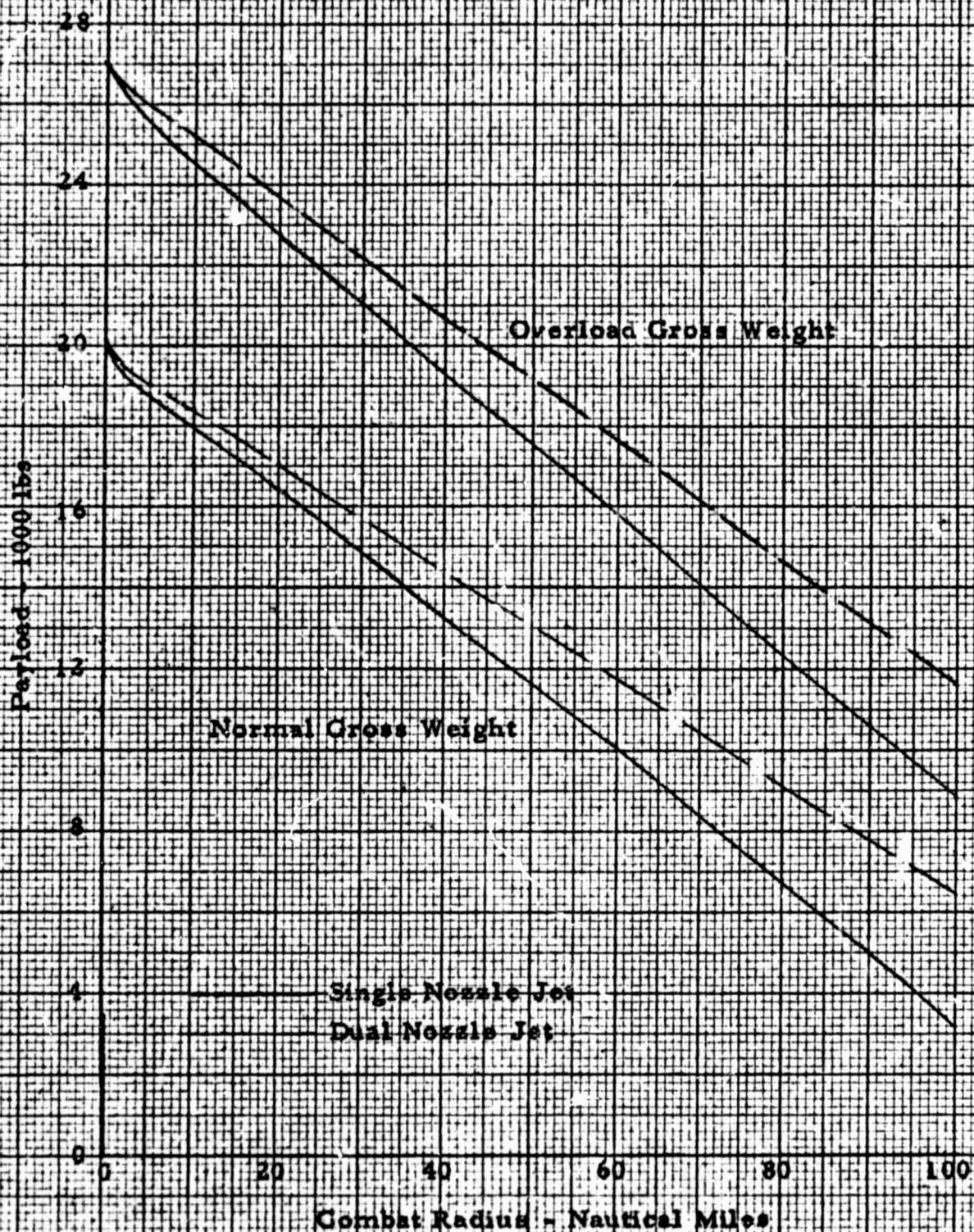
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Fig 8

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XHCH-1

Payload vs Combat Radius



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Fig 9