

UNCLASSIFIED

AD NUMBER	
AD070642	
CLASSIFICATION CHANGES	
TO:	UNCLASSIFIED
FROM:	CONFIDENTIAL
LIMITATION CHANGES	
TO: Approved for public release; distribution is unlimited.	
FROM: Distribution authorized to U.S. Gov't. agencies and their contractors; Administrative/Operational Use; APR 1955. Other requests shall be referred to Office of Naval Research, Washington, DC 20350.	
AUTHORITY	
30 APR 1967, DoDD 5200.10 gp-4; onr ltr 28 jul 1977	

THIS PAGE IS UNCLASSIFIED

THIS REPORT HAS BEEN DELIMITED  
AND CLEARED FOR PUBLIC RELEASE  
UNDER DOD DIRECTIVE 5200.20 AND  
NO RESTRICTIONS ARE IMPOSED UPON  
ITS USE AND DISCLOSURE.

DISTRIBUTION STATEMENT A

APPROVED FOR PUBLIC RELEASE;  
DISTRIBUTION UNLIMITED.

UNCLASSIFIED

---

AD \_\_\_\_\_

*Reproduced  
by the*

ARMED SERVICES TECHNICAL INFORMATION AGENCY  
ARLINGTON HALL STATION  
ARLINGTON 12, VIRGINIA



DECLASSIFIED  
DOD DIR 5200.9

---

---

UNCLASSIFIED

# AD 70642

## Armed Services Technical Information Agency

Reproduced by  
**DOCUMENT SERVICE CENTER**  
KNOTT BUILDING, DAYTON, 2, OHIO

Because of our limited supply, you are requested to  
**RETURN THIS COPY WHEN IT HAS SERVED YOUR PURPOSE**  
so that it may be made available to other requesters.  
Your cooperation will be appreciated.

**NOTICE: WHEN GOVERNMENT OR OTHER DRAWINGS, SPECIFICATIONS OR OTHER DATA ARE USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH A DEFINITELY RELATED GOVERNMENT PROCUREMENT OPERATION, THE U. S. GOVERNMENT THEREBY INCURS NO RESPONSIBILITY, NOR ANY OBLIGATION WHATSOEVER; AND THE FACT THAT THE GOVERNMENT MAY HAVE FORMULATED, FURNISHED, OR IN ANY WAY SUPPLIED THE SAID DRAWINGS, SPECIFICATIONS, OR OTHER DATA IS NOT TO BE REGARDED BY IMPLICATION OR OTHERWISE AS IN ANY MANNER LICENSING THE HOLDER OR ANY OTHER PERSON OR CORPORATION, OR CONVEYING ANY RIGHTS OR PERMISSION TO MANUFACTURE, USE OR SELL ANY PATENTED INVENTION THAT MAY IN ANY WAY BE RELATED THERETO.**

**ROBERT E. FULTON, JR.**

**NEWTOWN, CONNECTICUT**

REPORT NUMBER : B(I,II,III,IV),  
Nonr. 1126(00).

15 April, 1955.

**S E C T I O N   I**

\*\*\*\*\*

**REPORT**

**on**

**OPERATIONAL FEASIBILITY TESTS  
OF "SKYHOOK" TECHNIQUE FOR IN-  
FLIGHT PICK-UP OF MEN AND MA-  
TERIALS WITH HIGH PERFORMANCE  
AIRCRAFT**

**under**

**OFFICE OF NAVAL RESEARCH  
CONTRACT Nonr. 1126(00)**

**CONFIDENTIAL  
SECURITY INFORMATION**

This document contains information  
affecting the National defense of the United States  
within the meaning of the Espionage Laws, Title 18,  
U.S.C., Sections 793 and 794. Its transmission or  
the revelation of its contents in any manner to an  
unauthorized person is prohibited by law.

NOTICE: THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE  
NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING  
OF THE ESPIONAGE LAWS, TITLE 18, U.S.C., SECTIONS 793 and 794.

THE TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN  
ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

**REPORT NUMBER** B (I,II,III & IV) Nonr. 1126(00).

**DATE** 15 April, 1955.

**SECTION I**

\*\*\*\*\*

**REPORT**

on

**OPERATIONAL FEASIBILITY TESTS  
OF "SKYHOOK" TECHNIQUE FOR IN-  
FLIGHT PICK-UP OF MEN AND MA-  
TERIALS WITH HIGH PERFORMANCE  
AIRCRAFT**

under

**OFFICE OF NAVAL RESEARCH  
CONTRACT Nonr. 1126(00)**

**ROBERT E. FULTON, JR.      NEWTOWN,      CONNECTICUT.**

**SECURITY INFORMATION**

This document contains information affecting the National defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C. Sections 793 and 794. Its transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

55 AA 43341-SCA-Cy1-4



THIS REPORT COMPILED BY

ROBERT E. FULTON, JR.

AS A RESULT OF WORK BY  
THE FOLLOWING GROUP:

ROBERT E. FULTON JR.

Robert E. Fulton, Jr., Chairman

Oscar J. Alvarez

O. J. Alvarez

Leopold Godowsky

Leopold S. Godowsky

Karl K. Schakel

Karl K. Schakel



ROBERT E.  
FULTON, JR.  
NEWTOWN,  
CONNECTICUT.

REPORT No. B (I) Nonr. 1126(00). DATE 15 April, 1955. PAGE B.

REPORT TITLE HIGH-PERFORMANCE AIRCRAFT PICK-UP, SKYHOOK.

I N D E X, SECTION I.

S U B J E C T

P A G E

SECTION I

Definition of SKYHOOK Technique .....	1
Purpose of Report .....	3
Results .....	4
Operational Photo-sequence .....	5
Typical pick-up path of load .....	13
Typical pick-up "Q" loads .....	15
Conclusion .....	17
Recommendation .....	18 & 23
Totally Air-Operated KIT .....	19
Air-Supplied KIT .....	20
Air-Sea Rescue Operation .....	21
Surface Vessel Operation .....	22
Index to Sections II, III and IV *	24

\* Section IV is a 16mm kodachrome motion picture film taken during conduct of Operational Feasibility Tests at NAAS, El Centro, Calif.

## "SKYHOOK" TECHNIQUE

---

Assignment calls for development of a method by which IN-FLIGHT-PICK-UP of men and materials can be accomplished with high-performance aircraft.

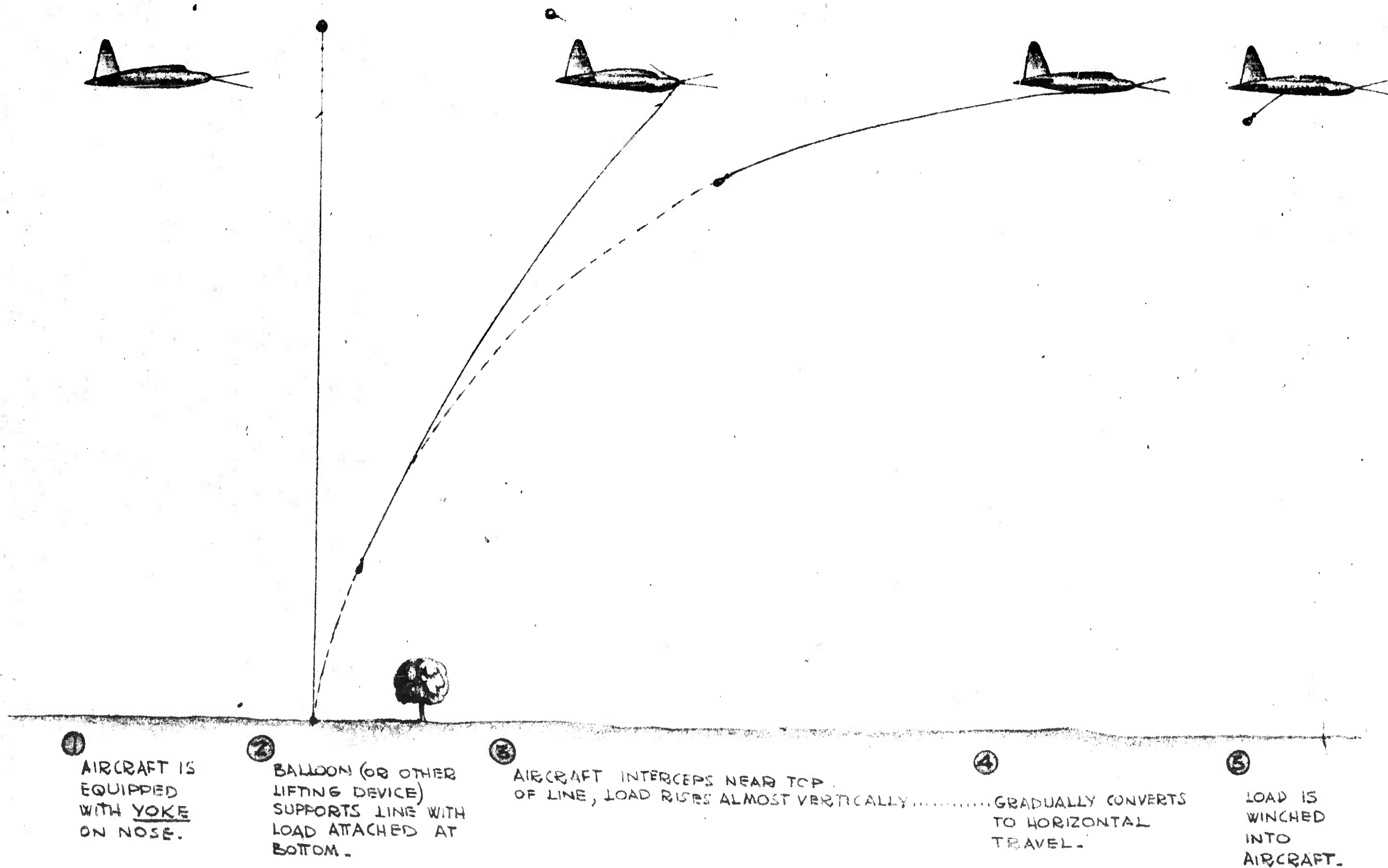
One such method is the SKYHOOK TECHNIQUE which works as follows:

1. Balloon (or other lifting device) supports top end of a line approximately 500 feet above ground.
2. Load is attached to bottom of line.
3. Aircraft intercepts near top of line with "yoke" mounted on nose.
4. Load rises almost vertically, gradually alters to horizontal travel.
5. Load is winched into aircraft.

ROBERT E.  
FULTON, JR.  
NEWTOWN,  
CONNECTICUT.

REPORT No. B(I)NOMR 1126(00). DATE 15 APRIL, 1955 PAGE 2.

REPORT TITLE HIGH-PERFORMANCE AIRCRAFT PICK-UP,  
"SKYHOOK" TECHNIQUE.



CONFIDENTIAL

REF JR.

ROBERT E.  
FULTON, JR.  
NEWTOWN,  
CONNECTICUT.

REPORT No. B (I) Nonr.1126(00). DATE 15 April 1958 PAGE 3.

REPORT TITLE HIGH-PERFORMANCE AIRCRAFT PICK-UP, SKYHOOK.

#### PURPOSE OF REPORT

This Report deals with tests conducted to prove feasibility of this technique.

Three separate test programs have been successfully conducted to date:

1. Initial tests with Contractor-owned and operated very small aircraft and light loads to prove basic theory.
2. "Safety tests" with somewhat larger Contractor-owned and operated aircraft, heavier loads and higher speeds to study motions of picked up load and top end of line to determine if any danger to aircraft might exist when conducting tests with large, higher speed operational equipment.
3. Preliminary large-scale feasibility tests conducted at NAAS El Centro, California, with full scale Navy owned and operated equipment and heavy loads.

ROBERT E.  
FULTON, JR.  
NEWTOWN,  
CONNECTICUT.

REPORT No. B (I) Nonr.1126(00). DATE 15 April, 1955. PAGE 4.

REPORT TITLE HIGH-PERFORMANCE AIRCRAFT PICK-UP, SKYHOOK.

## RESULTS

All three of these programs have been successfully conducted, the final one achieving the following standard of results:

- \* Aircraft: P2V
- \* Intercept speed: 125 knots
- \* Loads picked up: up to and including 300 pounds.
- \* Average G's imposed on load: 7.54 (Minimum 5, maximum 10.2).
- \* Duration of maximum G's:  $\frac{1}{2}$  second.
- \* Minimum altitude of pick-up aircraft need never be below 400 feet.
- \* Pick-up path of load would clear 100 ft. high obstacle less than 100 feet away.
- \* No problem encountered intercepting the lift-line with large, operational type aircraft.

In all more than 50 successful pick-ups were accomplished during all three phases of testing.

# OPERATIONAL PHOTO SEQUENCE

Accompanying pictures were taken during operational  
feasibility testing at NAAS El Centro, illustrate a  
typical pick-up operation .....



RENDEZVOUS

(P2V)

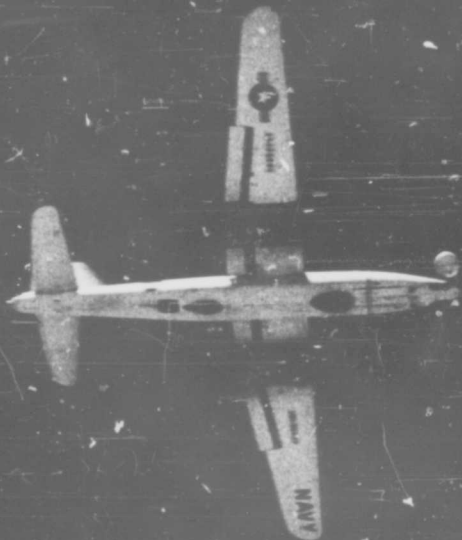
CONFIDENTIAL





APPROACH

(500 foot altitude)



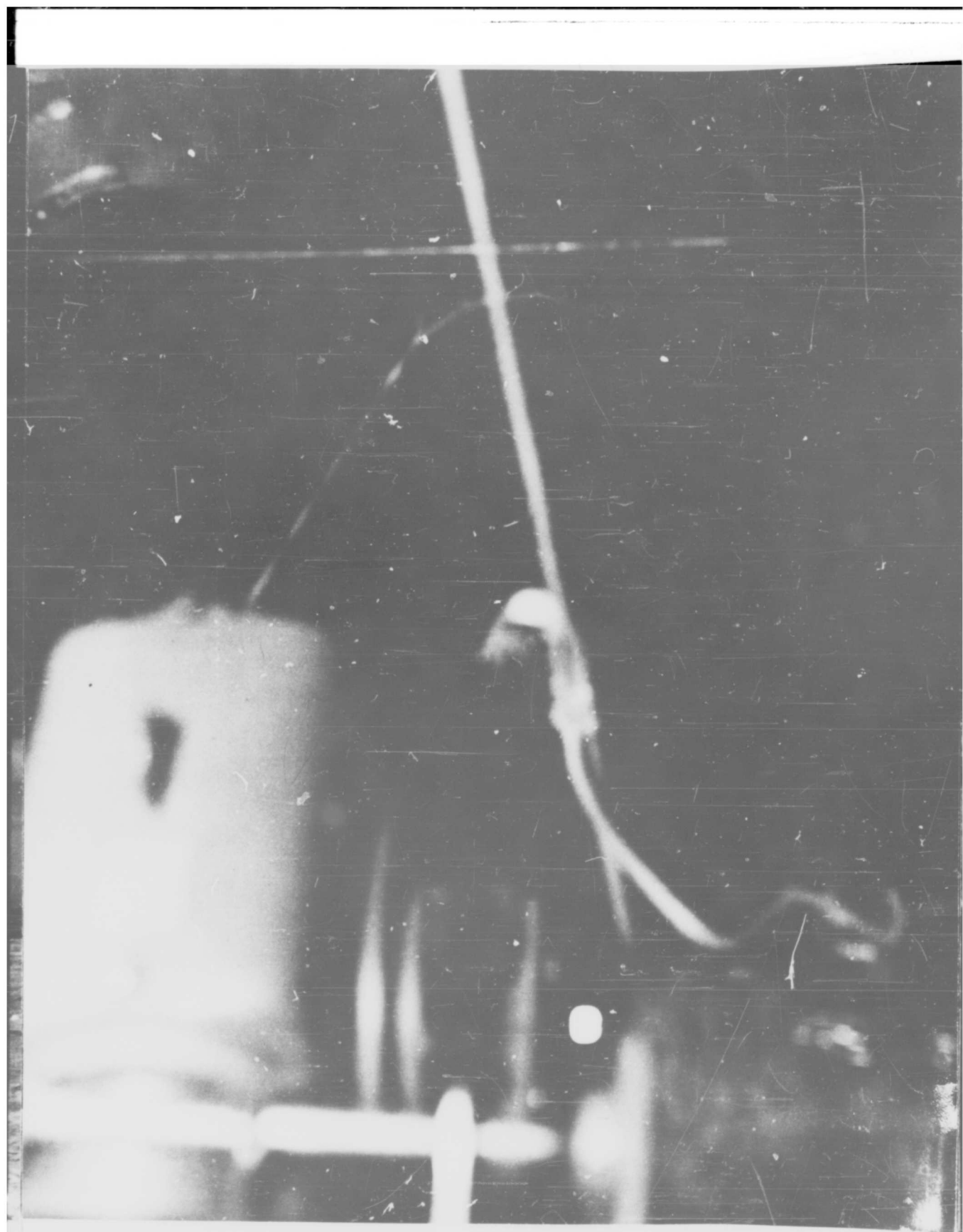
INTERCEPT

(125 knots)



"LOAD AWAY"

(300 pounds)




HAUL IN

(1½ minutes)



ABOARD



RETURNING TO BASE

(Up to 2,000 miles)

CONFIDENTIAL



**TYPICAL PICK-UP PATH OF LOAD**

---

Accompanying typical curve is taken directly from  
motion picture film recording path of 200 pound  
load picked up with 500 foot lift-line at aircraft  
speed of 125 knots .....



ROBERT E.  
FULTON, JR.  
NEWTOWN,  
CONNECTICUT.

REPORT No. B(I) NONR.1126(00) DATE 15 APRIL, 1955 PAGE 14.

REPORT TITLE HIGH-PERFORMANCE AIRCRAFT PICK-UP, SKYHOOK.  
LOAD PICK-UP PATH FROM MOTION PICTURE.

HORIZONTAL DISTANCE FT

100

200

500'

1 BALLOON

FLIGHT PATH OF P2V-7 AT 125

400'

300'

200'

100'

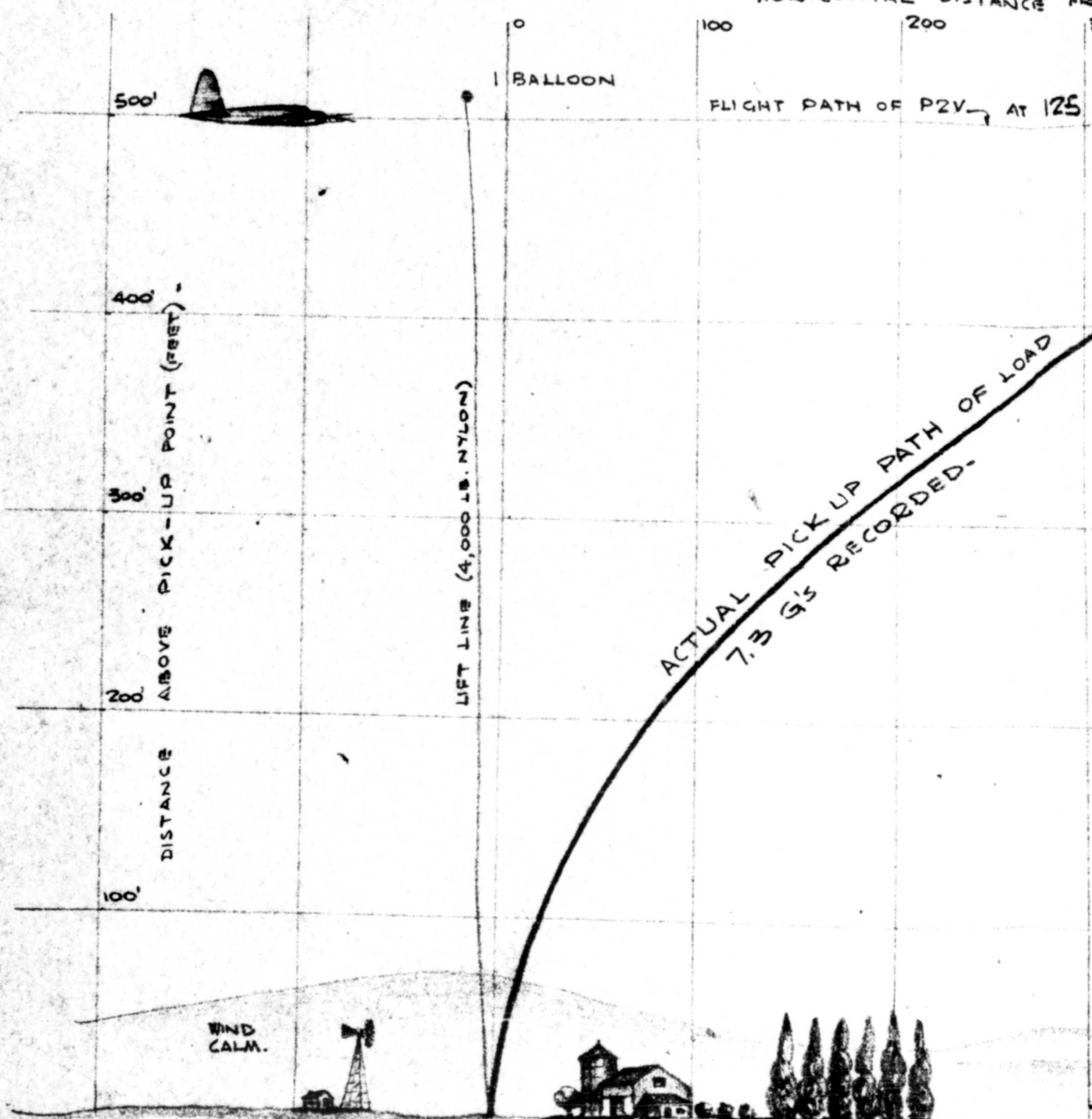
DISTANCE ABOVE PICK-UP POINT (FEET)

LIFT LINE (4,000 LB. NYLON)

ACTUAL PICK UP PATH OF LOAD  
7.3 G'S RECORDED.

WIND  
CALM.

LOAD  
200 LB. DUMMY.



KEYHOOK.

URE.

DISTANCE FROM PICK-UP POINT. (FEET).

300

400

500

AT 125 KNOTS.

LOAD

SIZE OF PHOTOGRAPH

PICKUP SK 13,  
22 NOV., 1954.  
PHOTOGRAPHED  
BY CAMERA II,  
64 FRAMES / SEC.

250 FT.

COMPUTED  
STABILIZED ALTITUDE  
OF LOAD. (6,000  
FT. FROM PICKUP)

175 FT.

COMPUTED LOW POINT  
OF LOAD PATH  
(2,400 FT. FROM PICKUP)

GRID IS DRAWN IN PLANE OF LOAD FLIGHT PATH,  
BUILDINGS, TREES, AIRCRAFT.

CONFIDENTIAL

REF JR.

### COMPARATIVE "G" LOADS, PICK-UP vs PARACHUTE

Full scale pick-ups produced "G" loads ranging from 5.0 to 10.2 G's (most of them were approximately 7.5) with maximum duration of less than  $\frac{1}{2}$  second.

These are well within the physical loads which a human can withstand.

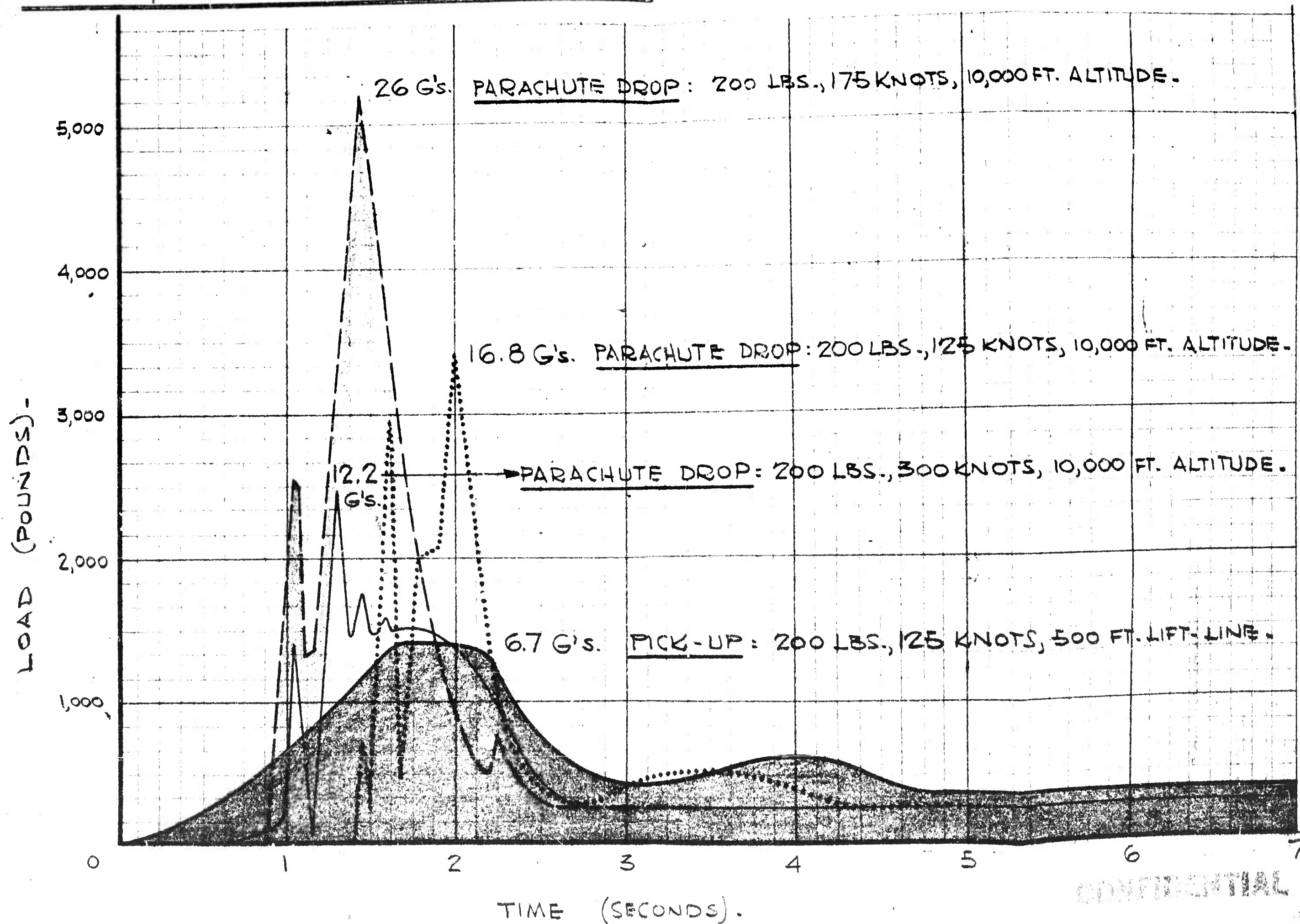
This is graphically demonstrated by accompanying direct comparison of SKYHOOK pick-up load curve and those of several typical parachute jumps .....

ROBERT E.  
FULTON, JR.  
NEWTOWN,  
CONNECTICUT.

REPORT No. B(I)NONR. 1126(00) DATE 15 APRIL 1955 PAGE 16.

REPORT TITLE HIGH-PERFORMANCE AIRCRAFT PICK-UP.

PARACHUTE VS PICK-UP G's.



CONFIDENTIAL

ROBERT E.  
FULTON, JR.  
NEWTOWN,  
CONNECTICUT.

REPORT No. B (I) Nonr.1126(00). DATE 15 April, 1955. PAGE 17.

REPORT TITLE HIGH-PERFORMANCE AIRCRAFT PICK-UP, SKYHOOK.

### CONCLUSION

The SKYHOOK technique has proven that it can be used for full-scale pick-up work with operational type aircraft.

This technique has demonstrated the important advantages that it can :

1. Perform reliably
2. Be carried out swiftly
3. Be accomplished with only one aircraft (large or small)
4. Does not require much equipment or training.

## RECOMMENDATION

---

For operational service, pick-up equipment should be in KIT FORM so that where desirable operation can be controlled from the rescue aircraft. (Party being picked up would have only to proceed to bottom of lift-line and get into harness or bag.)

There would also be cases, however, where control of the equipment from below would be preferable (such as on shipboard).

Accompanying sketches indicate form in which such KITS are conceived and can be operated under various types of conditions .....

RECOMMENDATION continued  
on Page 23.

CONFIDENTIAL

ROBERT E.  
FULTON, JR.  
NEWTOWN,  
CONNECTICUT.

REPORT NO. B(1)NOR 1126 (00) DATE 15 APRIL 1955 PAGE 19.

REPORT TITLE HIGH PERFORMANCE AIRCRAFT PICK-UP, SKYHOOK.

TYPE-A KIT.

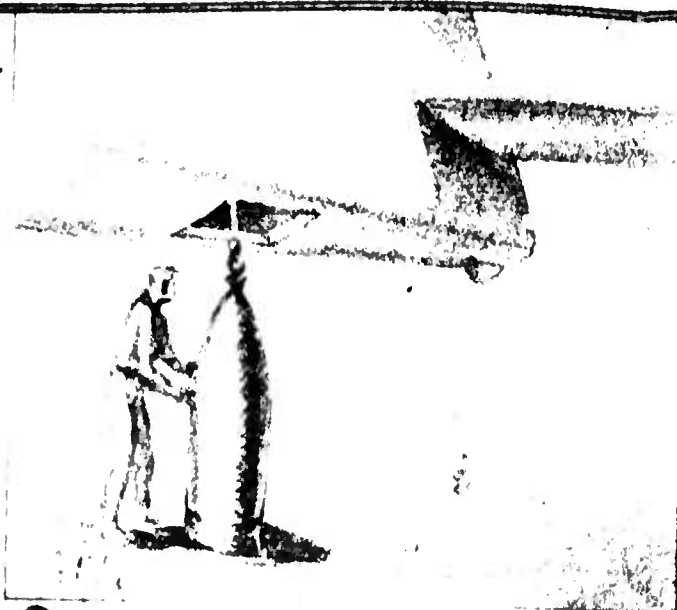
CONFIDENTIAL

TOTALLY AIR-OPERATED KIT FOR USE WHERE QUICKEST FORM OF PICKUP IS ESSENTIAL.

PRELIMINARY EXPERIMENTS IN RELEASE OF FULLY-INFLATED BALLOONS FROM IN-FLIGHT AIRCRAFT (125 KNOTS) HAVE BEEN REPEATEDLY SUCCESSFUL, THEREBY PROVING THE FEASIBILITY OF THIS PROPOSAL.

BECAUSE ITS MASS IS SO SMALL, BALLOON STANDS STILL IN AIR VIRTUALLY INSTANTANEOUSLY UPON RELEASE, THUS AVOIDING SUBJECTION TO STRONG AIR FORCES.

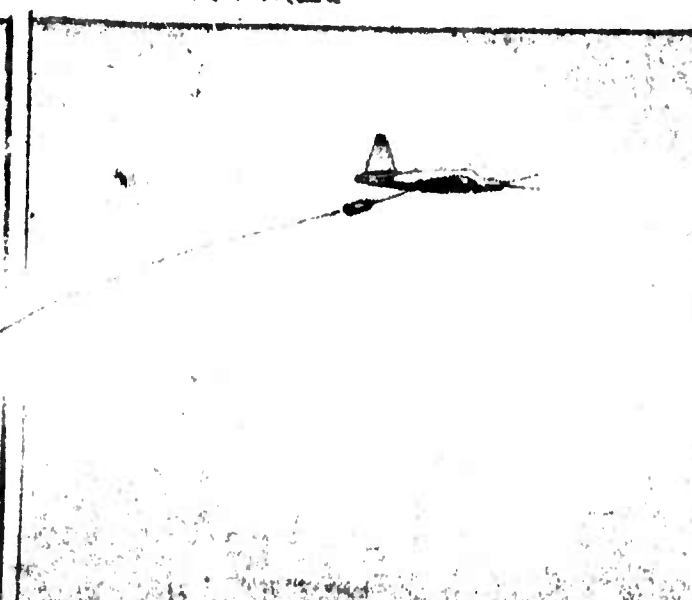
INERTIA OF LIFT-LINE IS ALSO NEGLIGIBLE EXCEPT AT BOTTOM WHERE HARNESS (OR BAG) IS ATTACHED. THIS IS ELIMINATED BY USE OF SMALL PILOT-PARACHUTE WHICH SWINGS INTO ACTION AS SOON AS BALLOON IS RELEASED FROM AIRCRAFT.



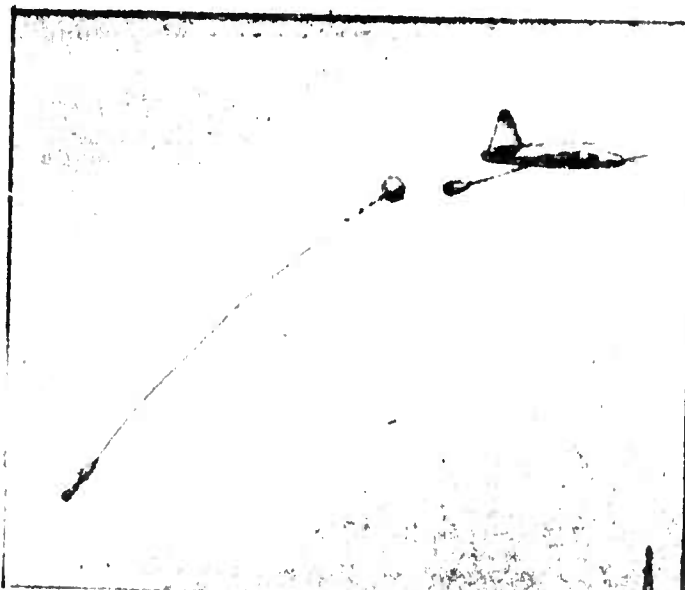
① LOADING KIT(S).  
(ESTIMATED WEIGHT: 30 LBS.)



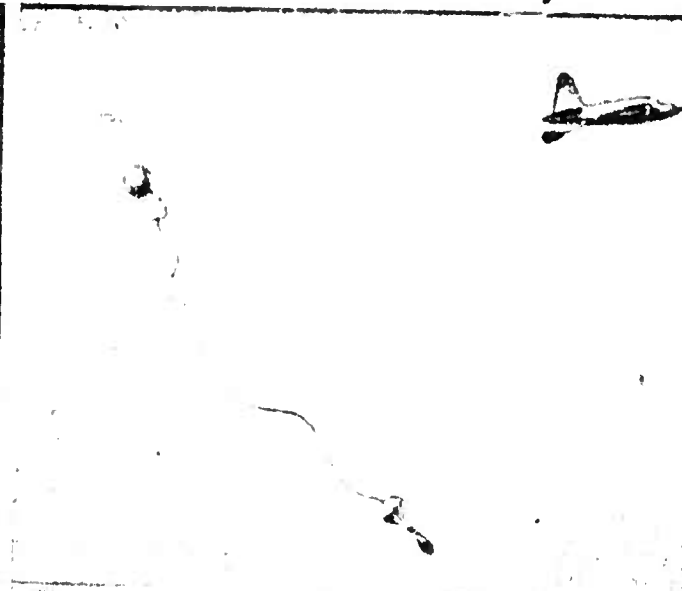
② STREAMING LIFT-LINE.



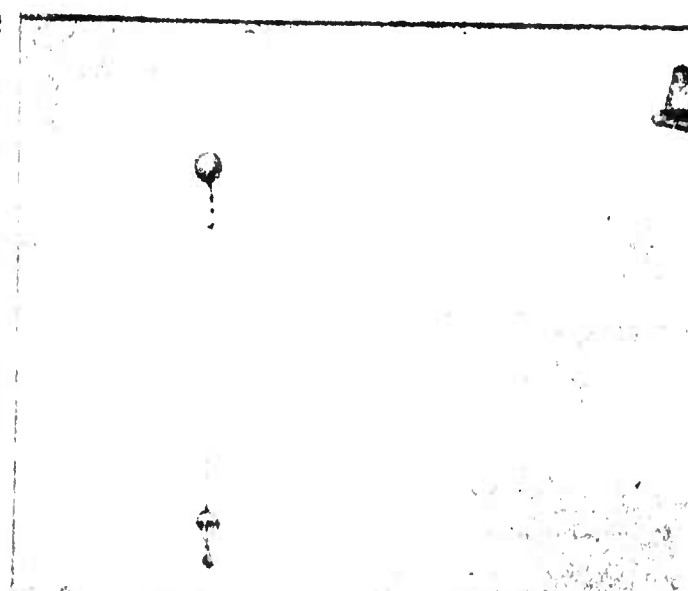
③ STREAMING BALLOON IN CONTAINER.



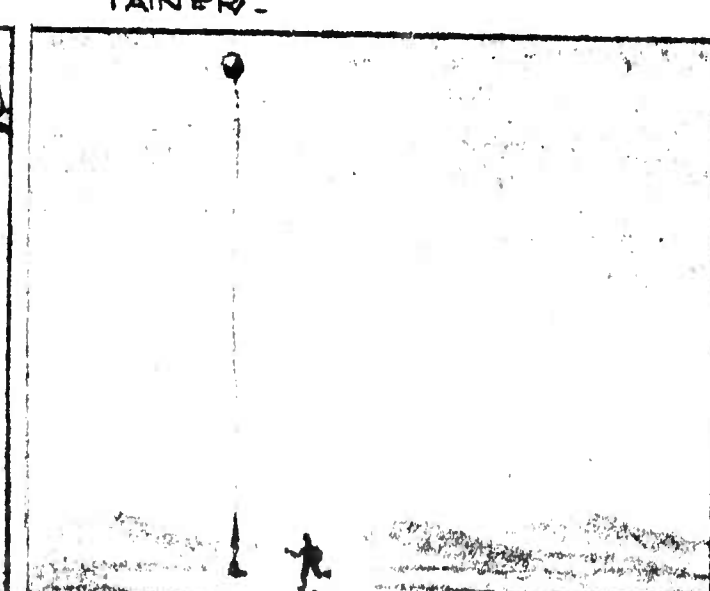
④ RELEASING BALLOON FROM CONTAINER. (SEE ABOVE NOTE.)



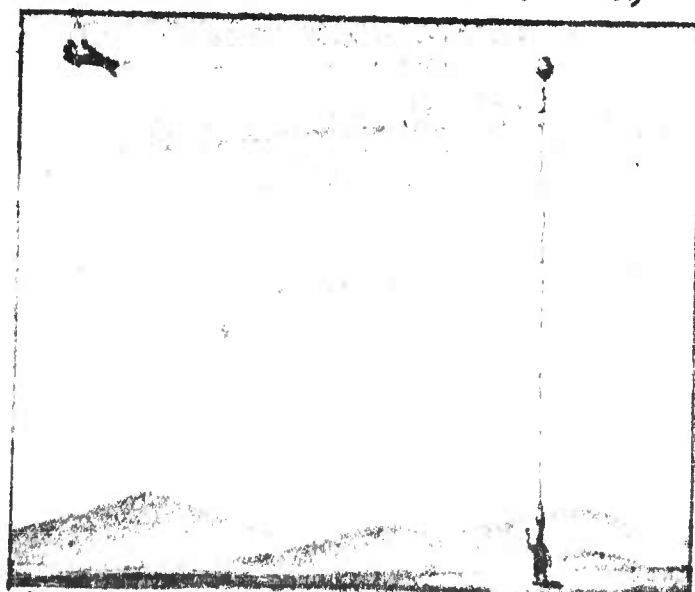
⑤ SMALL PARACHUTE ABSORBS INERTIA OF HARNESS.



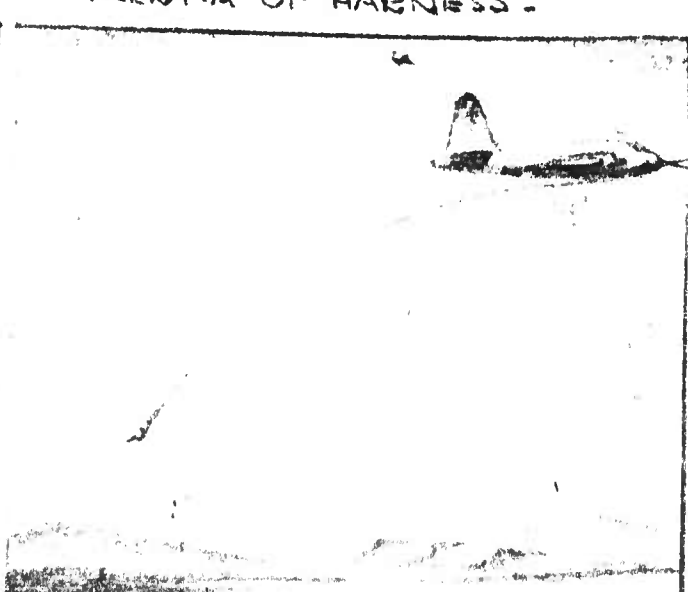
⑥ LIFT-LINE DESCENDING.  
(CONTAINER PULLED INTO AIRCRAFT).



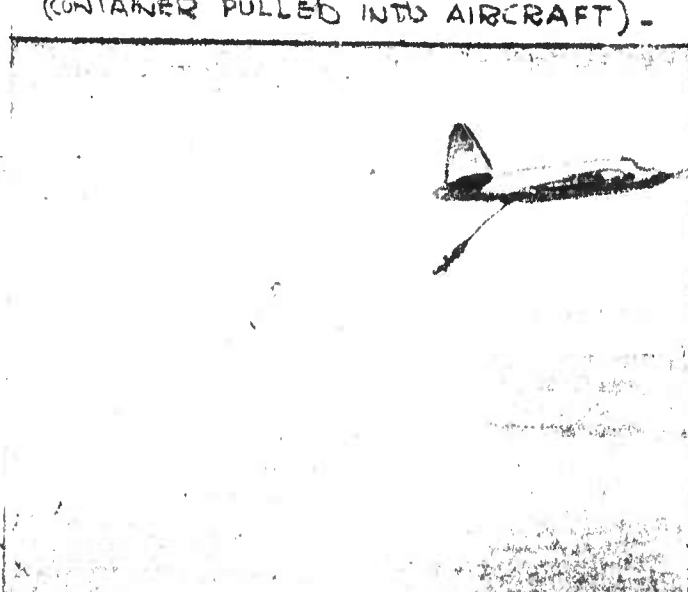
⑦ PROCEEDING TO FULLY RIGGED LIFT-LINE. (EASY TO FIND).



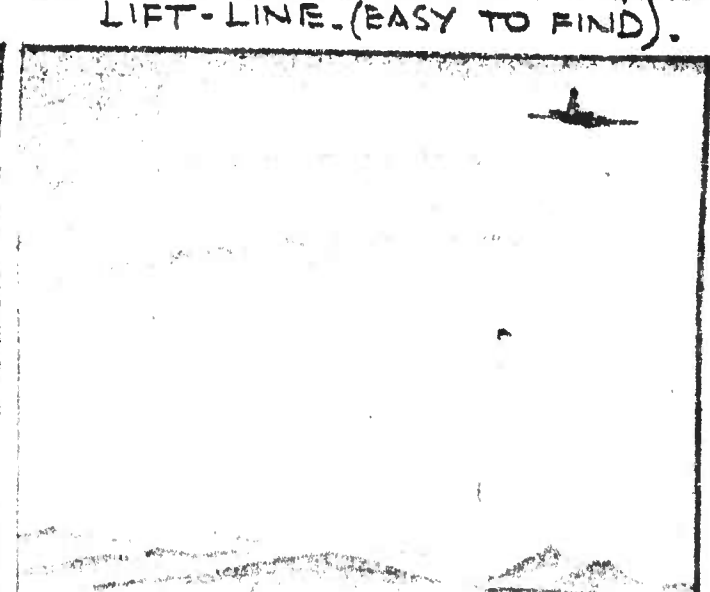
⑧ GETTING INTO BAG (OR HARNESS).



⑨ PICKING-UP.



⑩ HAULING IN.



⑪ RETURNING TO BASE ---  
(WITH ALL EQUIPMENT)



ROBERT E.  
FULTON, JR.  
NEWTOWN,  
CONNECTICUT.

REPORT No. 3(I)NORC.1126(00) - DATE 15 APRIL 1955 PAGE 20.

REPORT TITLE HIGH-PERFORMANCE AIRCRAFT PICK-UP, SKYHOOK

TYPE-B KIT.

AIR SUPPLIED KIT FOR USE WHERE TIME PERMITS OR KIT MAY BE STORED FOR LATER USE

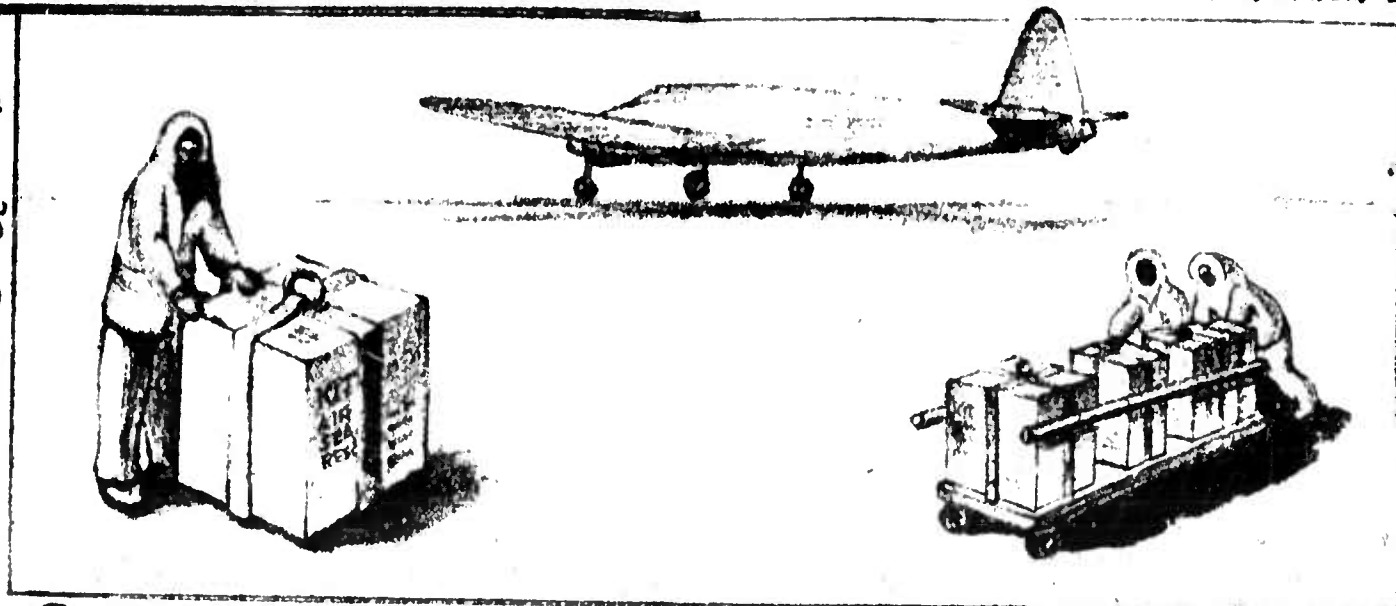
EQUIPMENT FOR THIS KIT IS ESSENTIALLY REFINEMENT OF UNITS USED DURING THE OPERATIONAL FEASIBILITY TESTS.

COMPLETE KIT WILL CONTAIN BALLOONS, HELIUM CYLINDERS, CONTROL VALVE AND MANIFOLD, LIFT-LINE COMPLETE WITH "KNOTS", BUFFERS, HARNESS (OR BAG) AND ASSOCIATED HARDWARE.

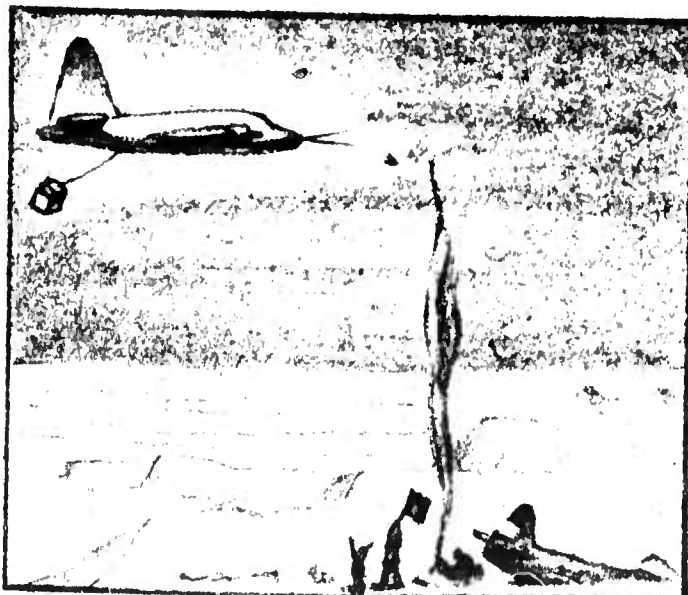
DROP-CHUTE WILL CLIP ON OUTSIDE OF KIT.

KITE-KITS SHOULD ALSO BE MADE UP FOR USE IN STRONG WINDS.

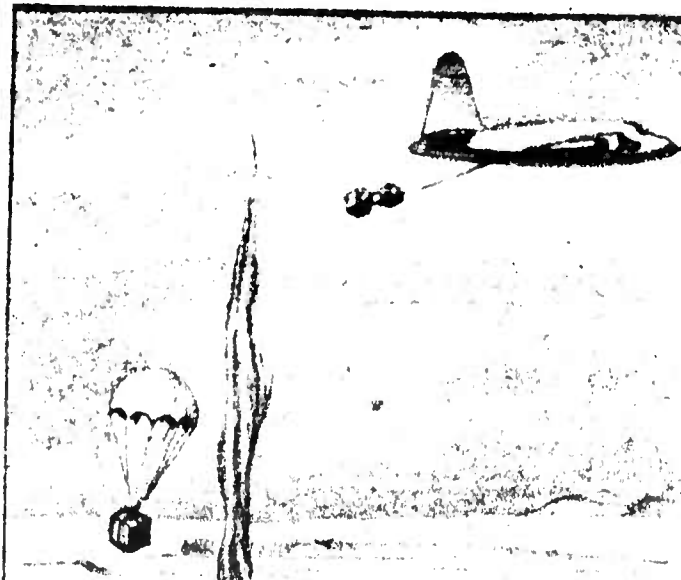
**CONFIDENTIAL**



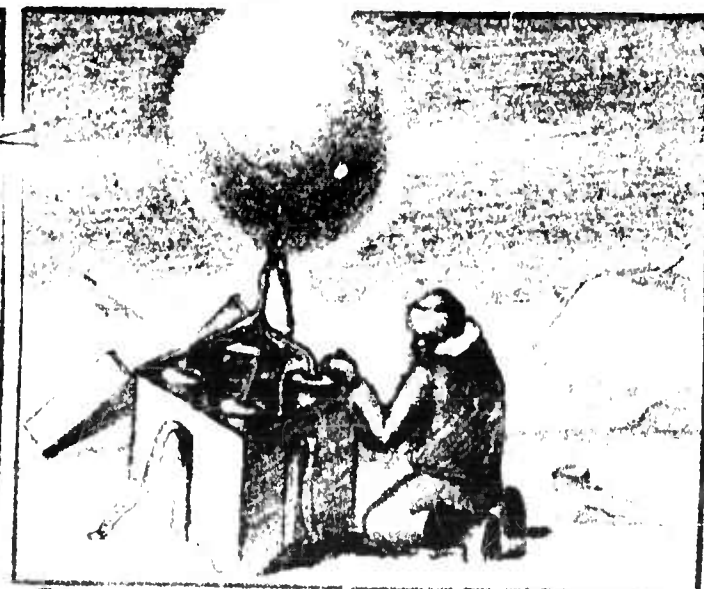
① KIT DIMENSIONED TO FIT THRU HATCH OF ANY AIRCRAFT THAT MAY BE ASSIGNED TO OPERATIONAL PICK-UP WORK (ESTIMATED 20"W, 30"L, 30"H, 150 LBS.)



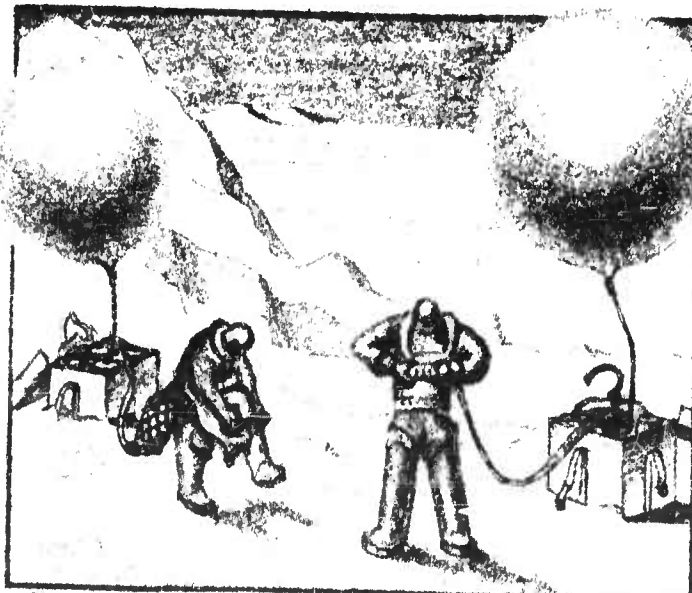
② EJECTING KIT.



③ PARACHUTE DESCENT.



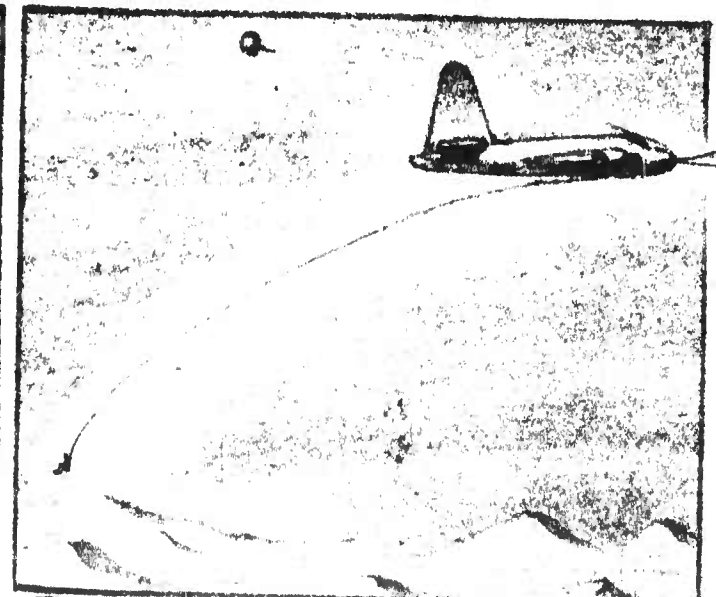
④ SINGLE-OPERATION INFLATION.



⑤ INTO HARNESS (OR BAG), BALLOON & LIFT-LINE ALREADY ATTACHED.



⑥ PAYING OUT LIFT-LINE.



⑦ PICK-UP & HAUL IN (MAXIMUM TOTAL OF 3 MINUTES PER MAN).

ROBERT E.  
FULTON, JR.  
NEWTOWN,  
CONNECTICUT.

REPORT No. B(I) NonR 1126 (00) DATE 15 APRIL, 1955 PAGE 21.

REPORT TITLE HIGH PERFORMANCE AIRCRAFT PICKUP, SKYHOOK  
TYPE AOR B KIT FOR AIR-SEA RESCUE OPERATIONS.

- ① AIRCRAFT FLIES TO LEEWARD  
OF RAFT, DROPS CORK-FLOATED  
NYLON LINE WITH BUOY AND  
FLOATING KIT ON OPPOSITE ENDS.

RAFT DRIFTS INTO LINE.



- ④ PICK-UP, HAUL IN  
AND RETURN TO  
BASE.

- ② SINGLE-OPERATION  
INFLATION.  
IF VERY WINDY, KITE-  
KIT IS DROPPED.

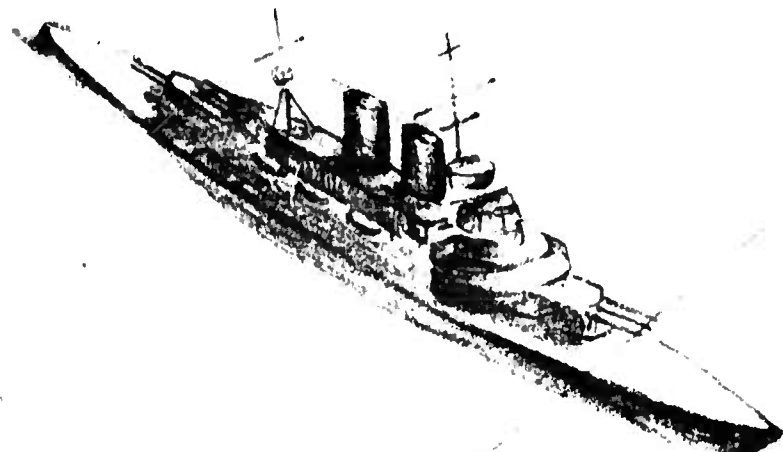
- ③ INTO HARNESS.

CONFIDENTIAL

ROBERT E.  
FULTON, JR.  
NEWTOWN,  
CONNECTICUT.

REPORT No. B (I) NONR 1126(00). DATE 15 APRIL 1955 PAGE 22.

REPORT TITLE HIGH PERFORMANCE AIRCRAFT PICK-UP, SKYHOOK  
TYPE B KIT FOR SURFACE VESSEL OPERATIONS.



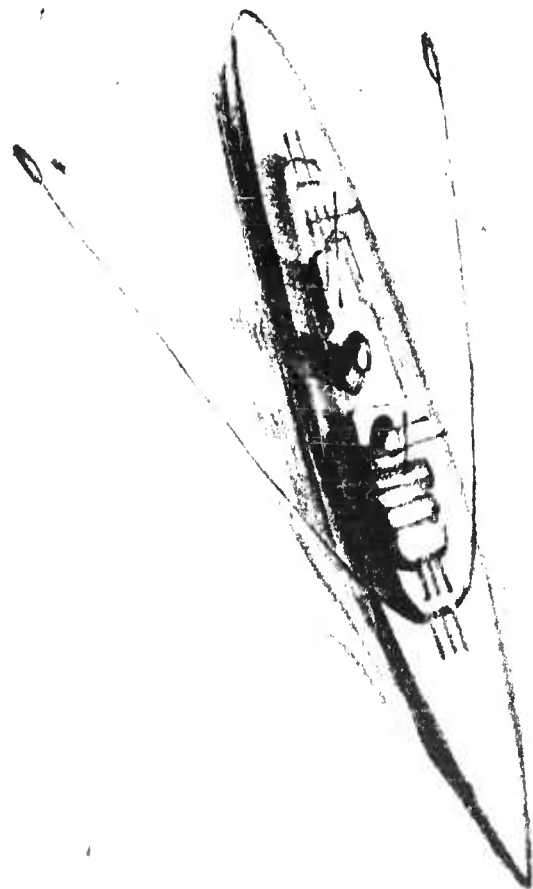
① (ABOVE)

FOR DELIVERY OF MESSAGES,  
NYLON LINE IS FLOWN LOW  
OVER BOW OF SURFACE VESSEL.

② (RIGHT)

BOTH ENDS OF LINE ARE  
ATTACHED TO IDENTICAL  
FLOATS, ONE CONTAINING  
PAPERS.

WHEN DROPPED, LINE  
STREAMS AFT FROM BOTH  
SIDES OF VESSEL, CONTAINERS  
ARE READILY HAULED ABOARD.



③

MESSAGES OR PERSONNEL  
CAN BE PICKED UP FROM  
VESSEL.

BALLOON IS USED BY SHIP  
TRAVELLING WITH WIND.



④ (RIGHT)

WHEN SURFACE VESSEL  
IS TRAVELLING TO WINDWARD,  
KITE MAY BE USED.



CONFIDENTIAL

ROBERT E.  
FULTON, JR.  
NEWTOWN,  
CONNECTICUT.

REPORT No. B (I) Nonr.1126(00). DATE 15 April, 1955. PAGE 23.

REPORT TITLE HIGH-PERFORMANCE AIRCRAFT PICK-UP, SKYHOOK.

RECOMMENDATION continued.

Development of operational equipment in final form is largely a matter of refining the test units which have proven their ability to work but can now be brought into better relative proportion as a result of the test experience gained.

The form of the above-outlined KITS, along with standardized hardware (yoke, winch, etc.) for use in the aircraft, should be established and tested.

Tests should include large number of dummy pick-ups and simulation of all possible operational situations before personnel pick-ups are accomplished.

ROBERT E.  
FULTON, JR.  
NEWTOWN,  
CONNECTICUT.

REPORT NO. B (I) Nonr.1126(00). DATE 15 April 1955 PAGE 24.

REPORT TITLE HIGH-PERFORMANCE AIRCRAFT PICK-UP, SKYHOOK.

I N D E X, SECTIONS II, III & IV.

S U B J E C T

P A G E

SECTION II

Section II Note . . . . .	A
Section II Index . . . . .	B
TEST LOCATION AND CONDITIONS, GENERAL : . . . . .	1
AIRCRAFT AND AIRBORNE EQUIPMENT	
Aircraft . . . . .	9
Yokes . . . . .	14
Beam . . . . .	23
"Eye" . . . . .	25
Winches . . . . .	30
Bridle . . . . .	36
Crook . . . . .	40
Snatch Block . . . . .	44
PICK-UP EQUIPMENT	
Loads . . . . .	46
Harness . . . . .	51
Lines . . . . .	53
"Knots" and couplings . . . . .	56
Fittings . . . . .	63
Markers . . . . .	65
Balloons . . . . .	68
OPERATING PROCEDURES	
Pilotage, approach . . . . .	76
Action of Lift-Line . . . . .	85
Reel-in procedure . . . . .	87
Reel-in procedure comment . . . . .	97
Lift-line plamp sketch . . . . .	98
"Clamp-knot" . . . . .	99
RECORDING AND MEASURING EQUIPMENT	
Wind . . . . .	101
Photographic equipment . . . . .	103
Angle of Lift-line . . . . .	110
Path of picked-up loads . . . . .	112
Path of picked-up loads comment . . . . .	130
Brinell blocks . . . . .	132
Tensiometer, recording . . . . .	134
"G" loads . . . . .	136

ROBERT E.  
FULTON, JR.  
NEWTOWN,  
CONNECTICUT.

REPORT No. B (I) Nonr.1126(00). DATE 15 April, 1955. PAGE 25

REPORT TITLE HIGH-PERFORMANCE AIRCRAFT PICK-UP, SKYHOOK.

I N D E X, SECTIONS II, III & IV continued.

S U B J E C T

P A G E

SECTION II cont'd.

Graph of Ex-line tape from 200 lb. pick-up	139
Graphs of Ex-line tapes from parachute jumps	141
Pick-up vs parachute G's comment	146
Tabulated test data	147
Comments re initial test phase	148
Comments re safety test phase	149
Resume of operational feasibility tests	153
Detailed operational feasibility test data	154

SECTION III

(Comments and drawings regarding design of test and operational equipment)

Section III note . . . . .	A
Section III Index . . . . .	B
Yoke . . . . .	1
Beam	17
"Eye"	20
P2V Drawing List	26
Drawings of Beam and Yoke	30
Winch	71
Radomes, antennae, etc.	82
Harness and load covering	86
Lines and fittings	89
Line samples . . . . .	90
"Chinese Finger" samples	91
"Coupling" drawings	93
Clamp	94
Balloons	96
Gas	97
Markers	98
Operational Lift-Line KIT	99
Kite-hook	101
Summary statement	102
Photographic appendix	103
Bibliography	104



ROBERT E.  
FULTON, JR.  
NEWTOWN,  
CONNECTICUT.

REPORT No. B(I)Nonr.1126(00). DATE 15 April, 1955. PAGE 25.

REPORT TITLE HIGH-PERFORMANCE AIRCRAFT PICK-UP, SKYHOOK.

I N D E X, SECTIONS II, III & IV cont'd.

S U B J E C T

P A G E

SECTION IV

This Section consists of a 16mm Kodachrome motion picture film taken during Operational Feasibility Tests at NAAS El Centro, California.

Running time is approximately 30 minutes.

Material illustrated includes the following:

1. A typical SKYHOOK pick-up operation.
2. Yoke installation on P2V.
3. Winch, crook, snatch-block, clamp-knot, auxiliary winch.
4. Loads and fittings  
(Sand bags, dummies, Ex-line tensiometer, Brinell blocks).
5. Lines, markers, knots  
(Tower testing, buffers vs windshield).
6. Balloons and gas
7. Pilotage  
(Yoke camera, visibility, vertical and horizontal latitude of intercept).
8. Photographic equipment
9. Paths of picked-up loads