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WIND-TUNNEL TESTS OF A SERIES OF PARACHUTES DESIGNED FOR CONTROLLABLE GLIDING FLIGHT

by James A. Weiberg and Kenneth W. Mort
Ames Research Center
Moffett Field, Calif.



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WIND-TUNNEL INVESTIGATION OF THE STATIC AERODYNAMIC CHARACTERISTICS OF AN 18-FOOT (5.49-METER) ALL-FLEXIBLE PARAWING

by Charles E. Libbey, George M. Ware, and Rodger L. Naeseth
Langley Research Center
Langley Station, Hampton, Va.



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • JUNE 1967

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LOW-SPEED WIND-TUNNEL INVESTIGATION OF TENSION-STRUCTURE PARAWINGS

by Rodger L. Naeseth and Paul G. Fournier
Langley Research Center
Langley Station, Hampton, Va.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • JUNE 1967

LOW-SPEED TESTS OF AN ALL-FLEXIBLE PARAWING FOR LANDING A LIFTING-BODY SPACECRAFT

by Frank M. Bugg and William C. Sleeman, Jr.
Langley Research Center
Langley Station, Hampton, Va.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • JUNE 1967

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WIND-TUNNEL INVESTIGATION OF
THE STATIC AERODYNAMIC CHARACTERISTICS
OF A MULTILOBE GLIDING PARACHUTE

by George M. Ware and Charles E. Libbey
Langley Research Center
Langley Station, Hampton, Va.



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INVESTIGATION OF OPENING
CHARACTERISTICS OF AN
ALL-FLEXIBLE PARAWING

by Thomas G. Gainer
Langley Research Center
Langley Station, Hampton, Va.

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FIXED-BASE VISUAL SIMULATION
OF PILOT-CONTROLLED DESCENTS
OF AN ADVANCED APOLLO SPACECRAFT
WITH AN ALL-FLEXIBLE PARAWING

by G. Kimball Miller, Jr., Byron M. Jaquet,
and Douglas B. Price
Langley Research Center
Langley Station, Hampton, Va.

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EXPERIMENTAL VERIFICATION OF
SCALE FACTORS FOR PARAWING OPENING
CHARACTERISTICS WITH DIMENSIONAL
RATIOS FROM 1:1.3 TO 1:3

by Robert H. Moore, David L. Eichblatt,
and Theodore F. Hughes
Manned Spacecraft Center
Houston, Texas

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WIND TUNNEL AND FREE FLIGHT
INVESTIGATION OF
ALL-FLEXIBLE PARAWINGS
AT SMALL SCALE

N70-19996

**WIND-TUNNEL INVESTIGATION OF THE
AERODYNAMIC CHARACTERISTICS
OF A TWIN-KEEL PARAWING**

by *George M. Ware*

Langley Research Center

Langley Station, Hampton, Va.

By
E. M. Linhart and W. C. Buhler

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Prepared under Contract No. NAS 1-7467 by
NORTHROP CORPORATION, VENTURA DIVISION
Newbury Park, California 91320

for
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
June 1969

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • MAY 1969

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NASA CR-66918

SUBJECT: Gliding Parachutes for Land
Recovery of Space Vehicles
Case 730

DATE: September 8, 1969

FROM: W. H. Eilertson

ABSTRACT

A survey of gliding parachute recovery systems under development shows that some of them have sufficient gliding capability (L/D) to allow pinpoint landing. Data is presented on their reliability, weight, volume and state of development.

The required gliding performance is a function of reentry vehicle guidance and control accuracy at main parachute deployment and the deployment altitude. For example the Apollo Command Module (CM) (targeting capability is 20 n.mi. CEP at 10,750 ft altitude) requires an L/D of 5.80 for pinpoint landing.

None of the gliding parachutes presently under development possess this capability. However, if the deployment altitude for the same CEP is increased to 20,000 ft the L/D requirement reduces to 3. The parachute gliding performance however, must be greater than this value (approximately 3.5) to offset the lower L/D of a semi-ballistic shaped payload (Apollo). Several of the gliding parachutes possess this level of L/D (3.5). If they could be designed to deploy at 20,000 ft. altitude, then pinpoint landings would be feasible for semi-ballistic configurations.

It is also pointed out that providing a large diameter rigid leading edge using inflatable booms or a "de Havilland boom" to some of the gliding parachutes could result in moderate increases in L/D.

FREE FLIGHT INVESTIGATION OF
LARGE ALL-FLEXIBLE PARAWINGS
AND PERFORMANCE COMPARISON WITH
SMALL PARAWINGS -

FINAL REPORT

By
J. H. Moeller, E. M. Linhart, W. M. Gran and L. T. Parson

Prepared under Contract No. NAS 1-7467 by
NORTHROP CORPORATION, VENTURA DIVISION
Newbury Park, California 91320

for
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March 1970

(NASA-CR-108990) GLIDING PARACHUTES FOR
LAND RECOVERY OF SPACE VEHICLES (Bellcomm,
Inc.) 37 p

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WIND-TUNNEL INVESTIGATION OF SEVERAL LARGE-SCALE ALL-FLEXIBLE PARAWINGS

by
Michael D. Falarski
Army Aeronautical Research Laboratory
and
Kenneth W. Mort
Ames Research Center

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PERFORMANCE AND DEPLOYMENT CHARACTERISTICS OF A TWIN-KEEL PARAWING WITH VARIOUS AMOUNTS AND PERMEABILITIES OF POROUS MATERIAL IN OUTER LOBES

by *Harry L. Morgan, Jr.*
Langley Research Center
Hampton, Va. 23365

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DETERMINATION OF INFLATED SHAPE AND INERTIAL PROPERTIES OF AN ALL-FLEXIBLE PARAWING

by *Blair B. Gloss*
Langley Research Center
Hampton, Va. 23365

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AERODYNAMIC AND DEPLOYMENT CHARACTERISTICS OF SINGLE-KEEL SOLID AND SINGLE-KEEL SLOTTED PERSONNEL PARAWINGS

by *Harry L. Morgan, Jr., and Charles F. Bradshaw*
Langley Research Center
Hampton, Va. 23365

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FIXED-BASE VISUAL SIMULATION
OF OBSTACLE AVOIDANCE DURING
TERMINAL DESCENT OF
ADVANCED APOLLO SPACECRAFT
WITH AN ALL-FLEXIBLE PARAWING

by G. Kimball Miller, Jr.
Langley Research Center
Hampton, Va. 23365

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MODEL WIND-TUNNEL AND
FLIGHT INVESTIGATION OF A
PARAWING-LIFTING-BODY LANDING SYSTEM

by Rodger L. Naeseth
Langley Research Center
Hampton, Va. 23365

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LOW-SPEED WIND-TUNNEL
INVESTIGATION OF A SERIES
OF TWIN-KEEL ALL-FLEXIBLE PARAWINGS

by Rodger L. Naeseth
Langley Research Center
Hampton, Va. 23365

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WIND-TUNNEL STUDIES OF EFFECTS OF
CONSTRUCTION METHODS, DESIGN DETAILS,
AND CANOPY SLOTS ON THE AERODYNAMIC
CHARACTERISTICS OF SMALL-SCALE
ALL-FLEXIBLE PARAWINGS

by Paul G. Fournier and William C. Sleeman, Jr.
Langley Research Center
Hampton, Va. 23365

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LOW-SPEED WIND-TUNNEL INVESTIGATION
OF ALL-FLEXIBLE TWIN-KEEL
TENSION-STRUCTURE PARAWINGS

by Paul G. Fournier
Langley Research Center
Hampton, Va. 23365

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AERODYNAMIC AND DEPLOYMENT
CHARACTERISTICS OF MULTISTAGE CANOPY
AND SUSPENSION-LINE REEFING SYSTEMS
FOR A TWIN-KEEL ALL-FLEXIBLE PARAWING

by Harry L. Morgan, Jr., and Austin D. McHatton
Langley Research Center
Hampton, Va. 23365

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AN EXPLORATORY AERODYNAMIC
AND STRUCTURAL INVESTIGATION
OF ALL-FLEXIBLE PARAWINGS

by J. N. Nielsen, S. B. Spangler, S. S. Stabara,
and A. L. Lee

Prepared by
NIELSEN ENGINEERING & RESEARCH, INC.
Mountain View, Calif. 94022
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GEOMETRIC, AERODYNAMIC, AND KINEMATIC
CHARACTERISTICS OF TWO TWIN KEEL
PARAWINGS DURING DEPLOYMENT

by Paul M. Kenner, Frederic T. Churchill,
and Ralph B. Holt

Prepared by
VOUGHT MISSILES AND SPACE DIVISION
LTV AEROSPACE CORPORATION
Dallas, Texas 75222
for Langley Research Center

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DEPLOYMENT LOADS DATA FROM
A FREE-FLIGHT INVESTIGATION OF
ALL-FLEXIBLE PARAWINGS HAVING
371.612 METERS² (4000 FEET²)
OF WING AREA

by Delwin R. Croom
Langley Research Center
Hampton, Va. 23365