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WEPTASK NO: RA1200001
PROBLEM NO: RAE-323-291
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NATC REPORT OF TEST RESULTS

FROM
Commander, Naval Air Test Center
TO
Chief, Bureau of Naval Weapons

WEPTASK	PROBLEM ASSIGNMENT	EFFORT LEVEL	AIRCRAFT BUNO
RA1200001	RAE-323-291	NORMAL	

PROJECT TITLE
Universal Air Refueling Drogue; Fit Check and Flight Test of; Final Report

DATES OF TESTS	LOCATION OF TEST	COGNIZANT BUWEPS DIVISION
4-13-64 to 4-24-64	NATC	RAAE-323/1876
NATC PROJECT OFFICER/ENGINEER	**NATC DIVISION**	**COGNIZANT BUWEPS ENGINEER**
LT D. C. OWINGS	Service Test	MR. R. O. LUTZ

ENCLOSURES
☐ PHOTOGRAPHS ☐ DRAWINGS ☐ TABLES ☐ CURVES

RESULTS (Introduction, Results and Discussion)

INTRODUCTION

1. Under contract NOw 62-0938, Beech Aircraft Corporation fabricated a prototype universal air refueling (AR) drogue. The aerodynamic drag of the drogue is adjustable, and it is designed for use with existing Navy AR systems. The design also incorporates features to facilitate maintenance and interchangeability of parts. The results of the evaluation of an earlier prototype of the universal AR drogue were reported by NATC Technical Report ST331-147 of 17 Apr 1963. The problem assignment requested an evaluation of the new prototype drogue which has been modified in an attempt to correct deficiencies previously reported.

2. The purpose of the evaluation was to determine the compatibility of the drogue with all Navy AR systems and evaluate maintainability. This report contains the final results of the evaluation.

3. The universal AR drogue has three basic parts: a mounting ring, drogue leaves with adjustable fittings for parachute attachment, and an annular parachute with edge-mounted steel cables (figure 1).

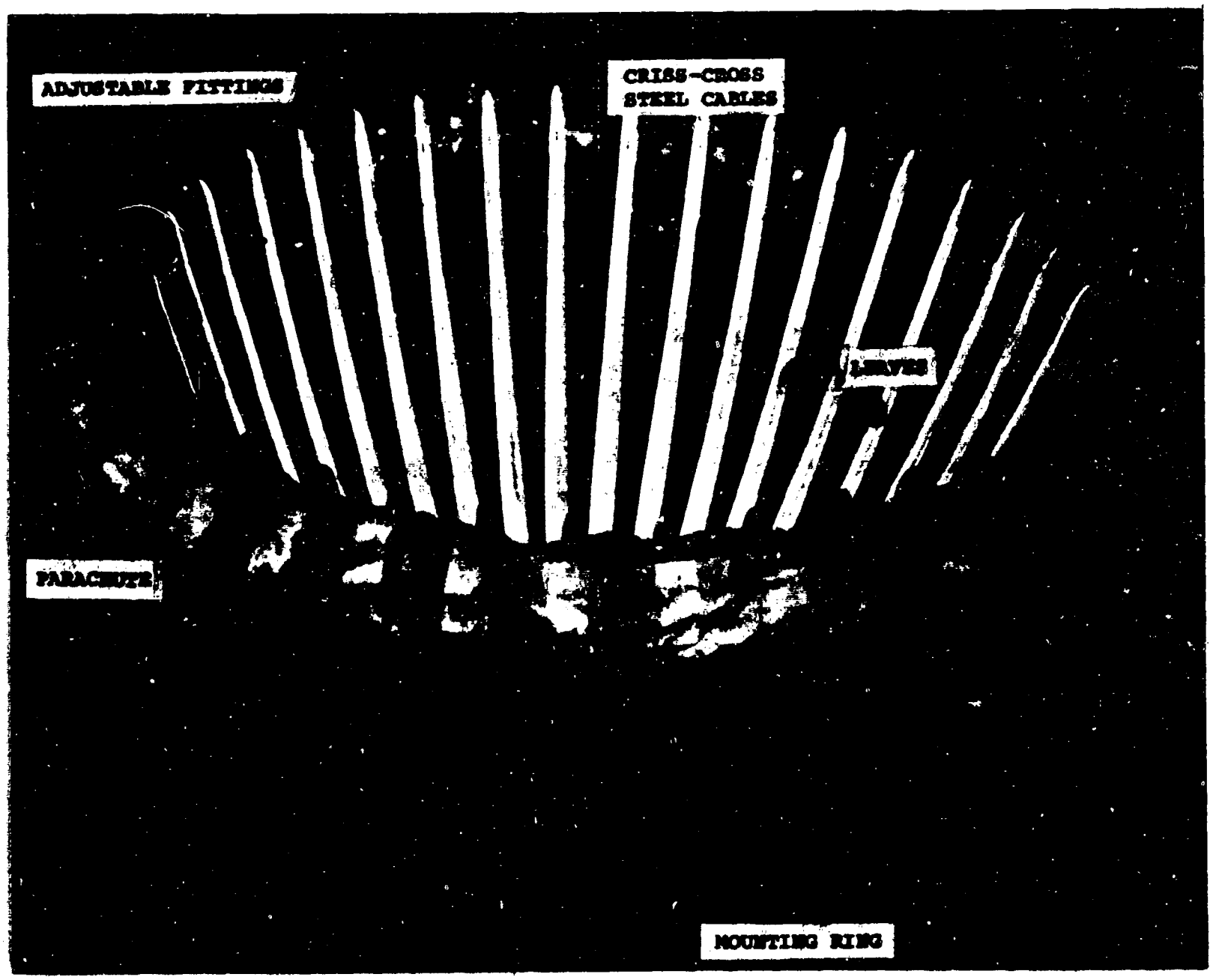

Figure 1

Beech Universal AR Drogue (Modified)

The mounting ring is a single aluminum casting with integrally-cast hinge pins. The drogue leaves are curved and designed to create a nearly constant tipping moment about the ball joint coupling, regardless of point of impact of the probe. Each leaf is tied to adjacent leaves by criss-cross steel cables with swaged ball ends for added strength and rigidity. An adjustable fitting to which the parachute is attached is mounted on each leaf (figure 2).

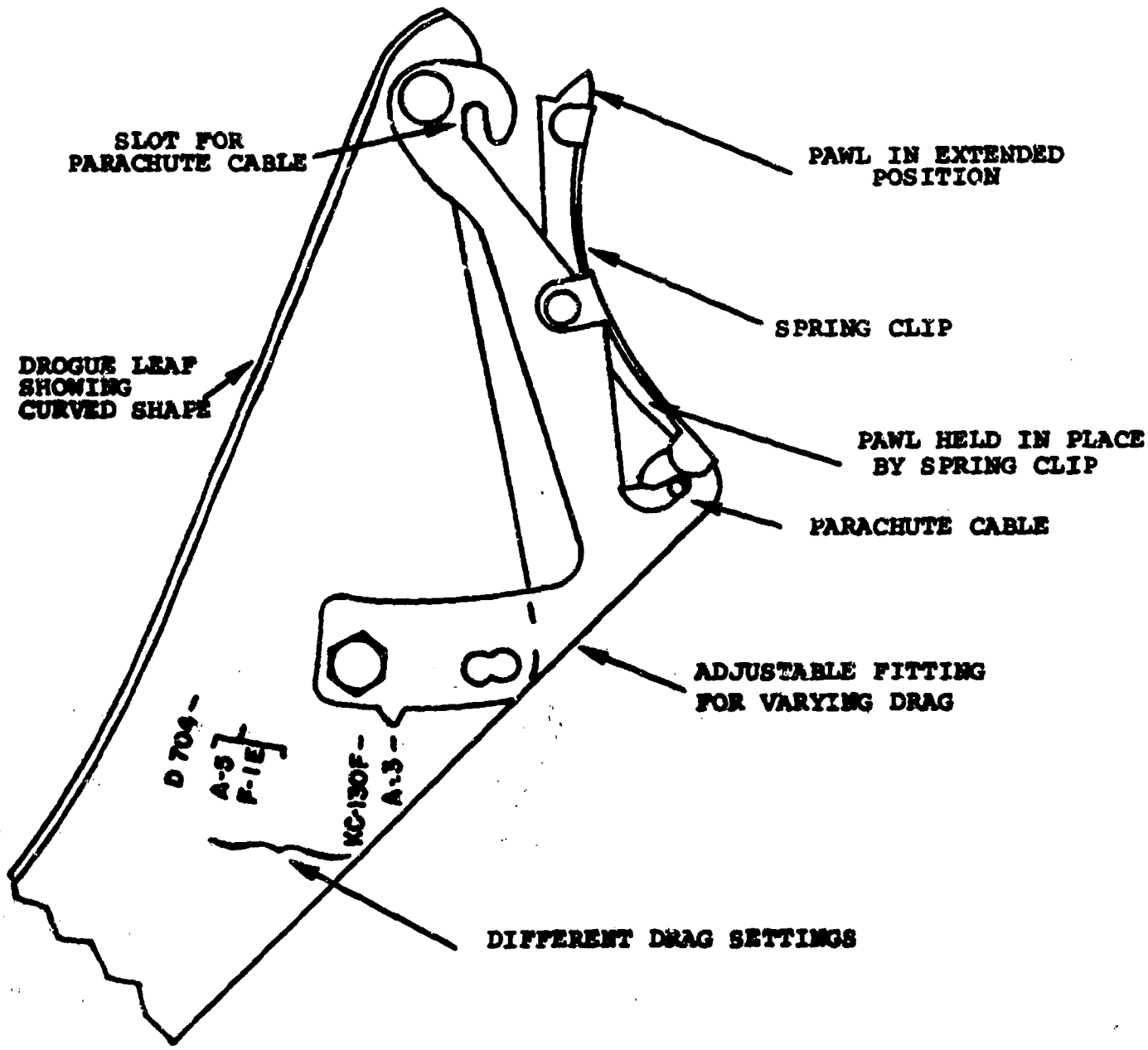

Figure 2

Diagram of Adjustable Fitting Showing
Method of Drag Variation and Parachute Attachment

These fittings were designed to provide a ground adjustment for varying drag by canting the parachute to make the drogue suitable for use with all Navy AR systems. The edge-mounted parachute cables fit into slots in each fitting and are retained by pawls which are held in place by spring clips. The diameter of the universal AR drogue was approximately 5 inches greater, when deployed, than that of the D-704 production drogue.

4. The following tests were conducted with the universal drogue on the Douglas (D-704) AR store:

a. Fit check of the drogue in the stowage tunnel.

b. Flight tests from 200 to 300 KIAS including engagements by A-4 airplane receivers at altitudes of 1,000, 20,000, and 35,000 ft.

c. Evaluation of maintenance suitability including installation, removal, and disassembly for replacement of parts.

RESULTS AND DISCUSSION

General

5. The evaluation was limited to tests with the D-704 store due to structural failure of the drogue. The project was terminated when it was determined that the drogue possessed insufficient strength and rigidity after the probe of an A-4 receiver airplane penetrated the drogue during an attempted engagement. The impact of the probe bent and twisted two leaves, wrenching one loose from the base ring (figure 3).

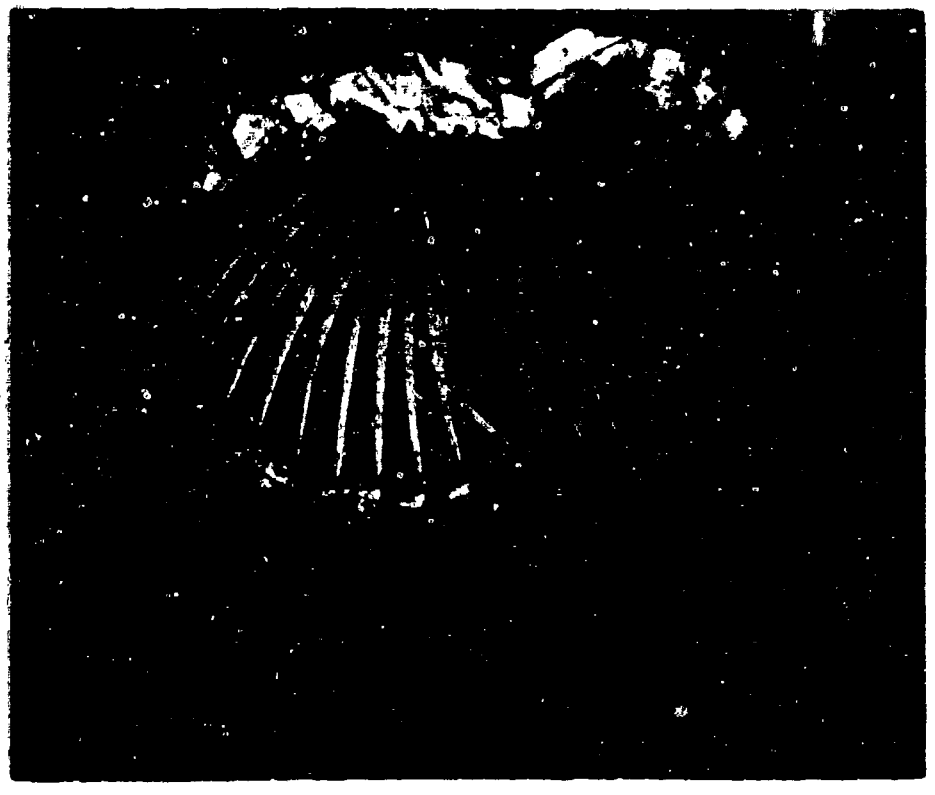

Figure 3
Damaged Universal AR Drogue

Ground Tests

6. The drogue was compatible with the D-704 stowage tunnel and ejection and retraction were normal. Installation and removal procedures were the same as those for the D-704 production drogue.

7. Complete disassembly of the universal AR drogue and replacement of parts could be easily accomplished with two standard wrenches. The pawl and clip mechanism for parachute retention was unsatisfactory due to insufficient durability and reliability. The clips were easily bent during parachute removal and replacement and when so deformed did not hold the pawls in place. After one flight the parachute retention cables had slipped out of the slots in the adjustable fittings of three leaves. One spring clip broke off and was not recovered, indicating a possible danger of engine foreign object damage to receiver aircraft.

Flight Tests

8. The universal AR drogue was utilized on five flights with 13 extensions and retractions and 17 engagements. Tests were temporarily halted after the first flight when the drogue failed to fully deploy. The drogue remained partially collapsed and assumed various shapes at airspeeds from 200 to 300 KIAS at 20,000 ft altitude (figure 4).

Figure 4
Universal AR Drogue Deployed in Flight

The drogue was returned to the contractor, and wind tunnel tests revealed that modifications to the original prototype had altered the aerodynamic characteristics substantially. The drag settings of the adjustable fittings were recalibrated, and it was determined that the minimum drag setting required for suitable drogue deployment created a drag greater than that for which the D-704 store was designed. Consequently flight tests could only be resumed with a restricted flight envelope. Maximum allowable airspeed for drogue actuation and refueling operations with the D-704 store was reduced from 300 KIAS to 267 KIAS to avoid exceeding store limitations.

9. The drogue operated satisfactorily as a component of the D-704 store within the limited flight envelope. The drogue was generally stable, but mild lateral and vertical oscillations up to 6 inch amplitude were encountered. The oscillations (frequency 1/2 to 1 cps) did not cause difficulty or concern during engagements.

10. In the deployed configuration the drogue usually had a flat spot somewhere in the top 180° of arc where one or two leaves were collapsed approximately 1 inch from the fully deployed position. A circular shape provides maximum area and the most desirable target for a receiver aircraft.

11. To the limited extent tested, the stability and tipping tendencies of the drogue upon contact, during engagements, were satisfactory. The drogue tipped once during 17 engagements when the probe contacted the drogue very close to the edge. Two successful engagements without tipping were executed after purposely making contact approximately 2 inches from the edge of the drogue.

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CONCLUSIONS → Testing shows that

12. The universal air refueling drogue is not suitable for service use due to the following deficiencies:

a. Insufficient drogue strength and rigidity ~~(paragraph 6)~~

b. Insufficient durability and reliability of the pawl and clip mechanism for parachute retention ~~(paragraph 7)~~

c. Excessive drag required for satisfactory drogue deployment ~~(paragraph 8)~~.

d. Oscillation tendency ~~(paragraph 9)~~.

e. Non-circular shape when deployed, ~~(paragraph 10)~~.

RECOMMENDATIONS → It is recommended that

13. The universal air refueling drogue should not be accepted for service use.

OR

14. This report completes the problem assignment.

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