

AD-A021 132

DESIGN AND EVALUATION OF A TOWED AC MAGNETIC SOURCE  
VEHICLE

Charles W. Sieber

David W. Taylor Naval Ship Research and Development  
Center  
Bethesda, Maryland

January 1975

DISTRIBUTED BY:

**NTIS**

National Technical Information Service  
U. S. DEPARTMENT OF COMMERCE

063151

**DAVID W. TAYLOR  
NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER**

Bethesda, Maryland 20084



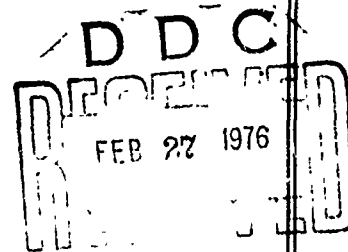
**DESIGN AND EVALUATION OF A  
TOWED AC MAGNETIC SOURCE VEHICLE**

By

**Charles W. Sieber**

**APPROVED FOR PUBLIC RELEASE  
DISTRIBUTION UNLIMITED**

**SHIP PERFORMANCE DEPARTMENT  
DEPARTMENTAL REPORT**



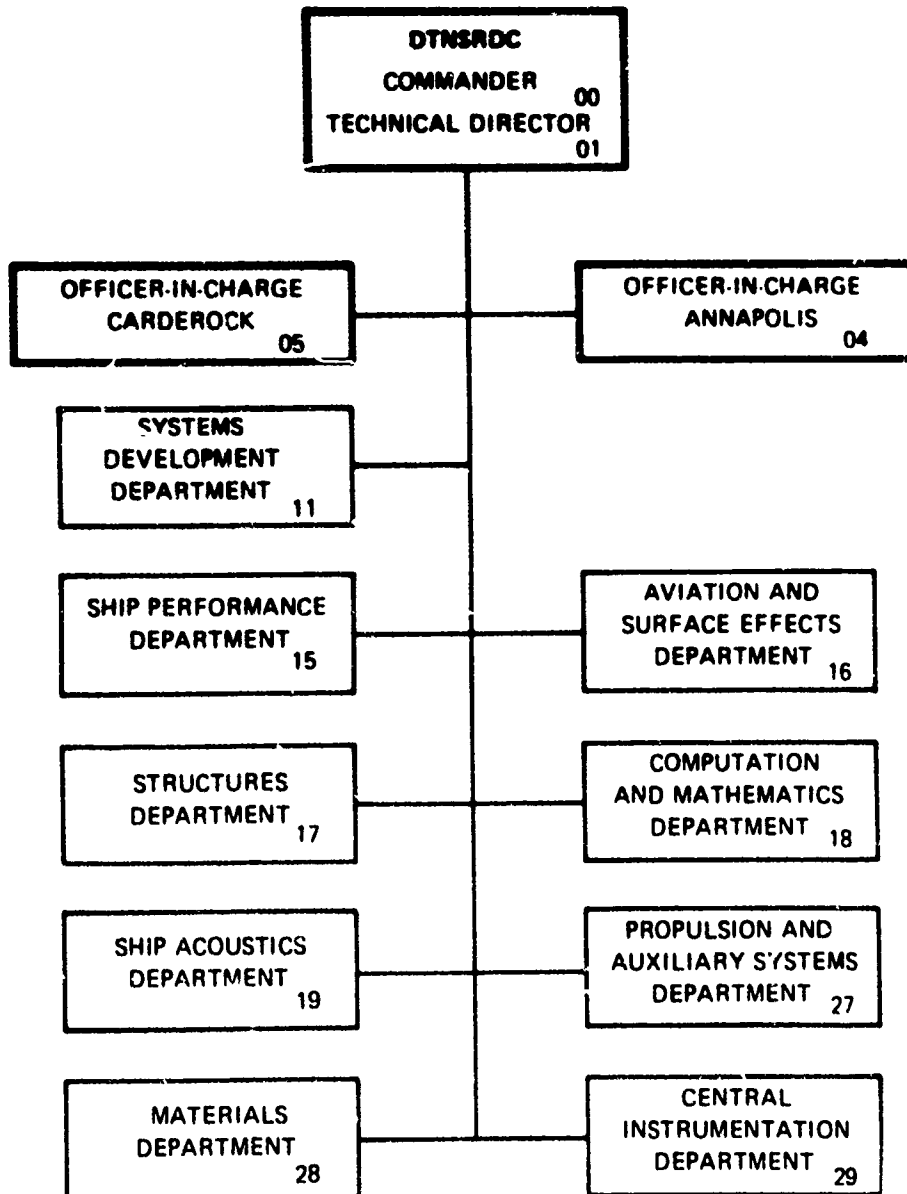
**JANUARY 1975**

Reproduced by  
**NATIONAL TECHNICAL  
INFORMATION SERVICE**  
US Department of Commerce  
Springfield, VA 22151

**REPORT NO. SPD-487-06**

Report No. SPD-487-06  
**ADA021132**  
"Design and Evaluation of a Towed AC Magnetic Source Vehicle  
by Charles W. Sieber (January 1975)"

## MAJOR DTNSRDC ORGANIZATIONAL COMPONENTS



APPROVED  
 NTIS  
 DDC  
 UN-  
 JUSTA

**UNCLASSIFIED**

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER <b>SPD 487-06</b>	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) <b>Design and Evaluation of a Towed AC Magnetic Source Vehicle</b>	5. TYPE OF REPORT & PERIOD COVERED	
	6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s) <b>Charles W. Sieber</b>	8. CONTRACT OR GRANT NUMBER(s)	
9. PERFORMING ORGANIZATION NAME AND ADDRESS <b>Naval Ship Research and Development Center Bethesda, MD 20084</b>	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS <b>Work Unit 1-1548-011</b>	
11. CONTROLLING OFFICE NAME AND ADDRESS <b>The Johns Hopkins University/Applied Physics Laboratory Silver Spring, MD 20910</b>	12. REPORT DATE <b>January 1975</b>	
	13. NUMBER OF PAGES <b>//</b>	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report) <b>UNCLASSIFIED</b>	
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE	
16. DISTRIBUTION STATEMENT (of this Report)  <b>Approved for Public Release - Distribution Unlimited</b>		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) <b>Towed Vehicle Towed System AC Magnetics</b>		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)  <b>An economical towed vehicle to provide a stable platform for an AC magnetic source at a speed of 4 knots and depth of 300 feet is designed and evaluated in at-sea experiments. The vehicle towed satisfactorily over the designed speed range and achieved the design objective.</b>		

## ADMINISTRATIVE INFORMATION

This development was funded by the Johns Hopkins University Applied Physics Laboratory under Subcontract APL/JHU 341897 of 10 September 1971, Naval Ship Research and Development Center Work Unit 1-1548-C11.

## INTRODUCTION

At the request of the Johns Hopkins University Applied Physics Laboratory (JHU/APL), the Naval Ship Research and Development Center (NSRDC) undertook a program to design and develop the towed vehicle system for Project Classic Thicket. In the course of this program, a requirement was identified to design an additional towed vehicle to provide an AC magnetic source for Classic Thicket experiments.

This report states the performance requirements for the vehicle and presents the rationale for the various factors in its design. It describes the vehicle and presents selected results from at-sea evaluations.

## DESIGN CONSIDERATIONS

The initial performance requirements for the vehicle may be stated as follows:

1. The vehicle was required to provide a reasonably steady platform for a large orthogonal pair of electrical coils. These were of rectangular form, approximately 3 feet by 4 feet in size, and were to be located in the horizontal and in the longitudinal vertical planes of the vehicle.
2. The vehicle was required to attain a towing depth of 300 feet at a speed of 4 knots. Also, it was desirable to limit depth changes

with speed at that design point. The towcable was specified by APL to be of double-armored type, 0.464 inch in diameter, and having an estimated weight in water of 0.7 pound/foot. Approximately 800 feet of total towline length was available.

3. The vehicle was required to be lightweight and compact enough to permit launching and recovery by means of a radial-arm davit on R/V COVE, the vessel designated for the experiments.

Based on these considerations, the design for a lightweight winged vehicle developing a total downforce at 4 knots of 445 pounds was prepared. The general configuration of the vehicle included a boom-type fuselage, large cruciform tails aft, a wing and towpoint located just ahead of the tails, and a ballast weight at the nose to maintain the vehicle near level in static pitch. The total weight was estimated to be approximately 135 pounds, so the wing was designed to produce approximately 210 pounds of lift at 4 knots.

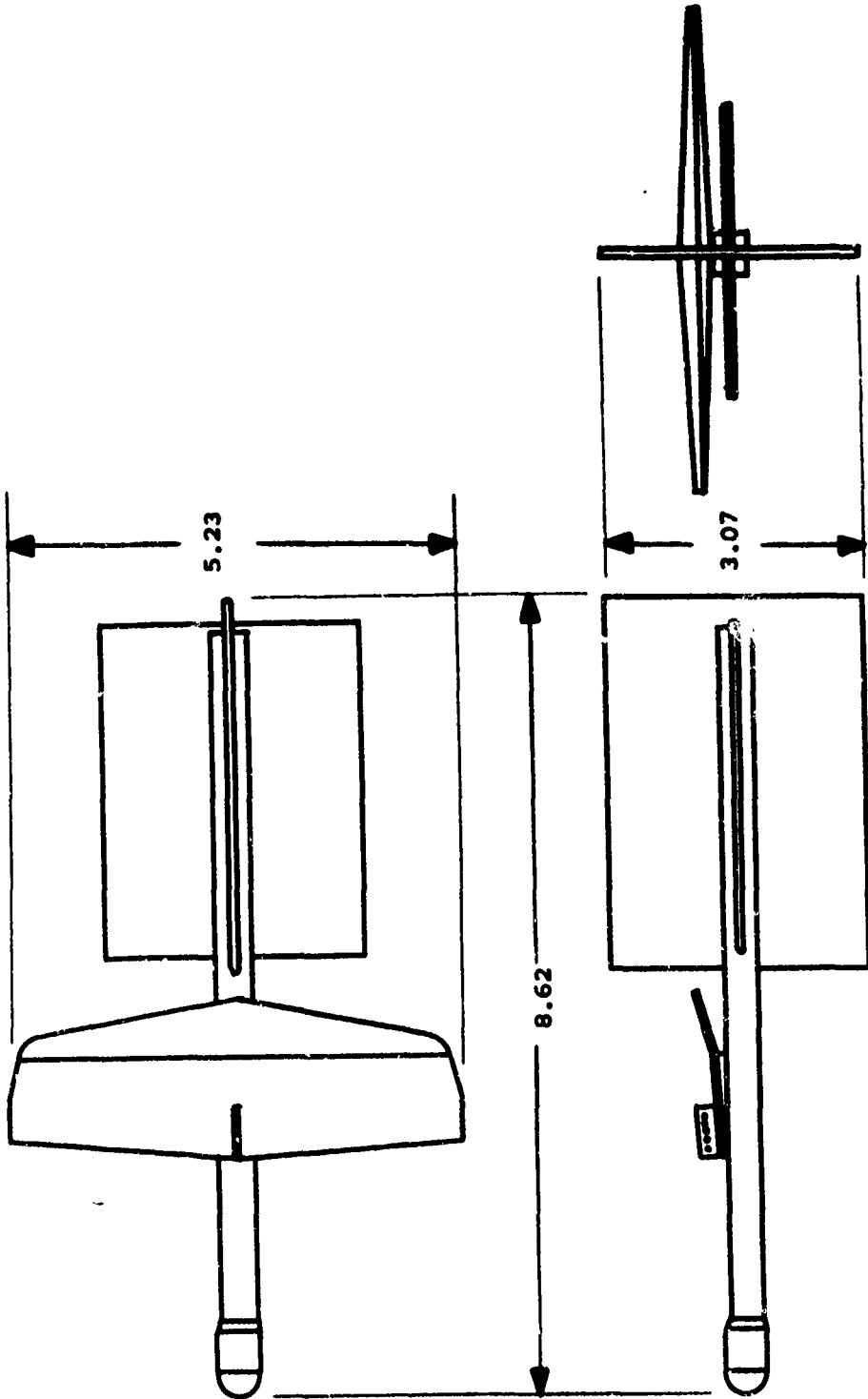
The basic geometrical configuration selected for the vehicle is shown by sketch in Figure 1 and the assembled vehicle is shown in Figure 2. Principal physical characteristics of the vehicle are presented in Table 1.

#### TAIL GEOMETRY

The electrical coils were paneled over with glass-reinforced plastic (GRP) sheet and used to provide large vertical and horizontal stabilizing tail surfaces in a cruciform configuration. The resulting surfaces had flat-plate sections with thicknesses of approximately 1 inch.

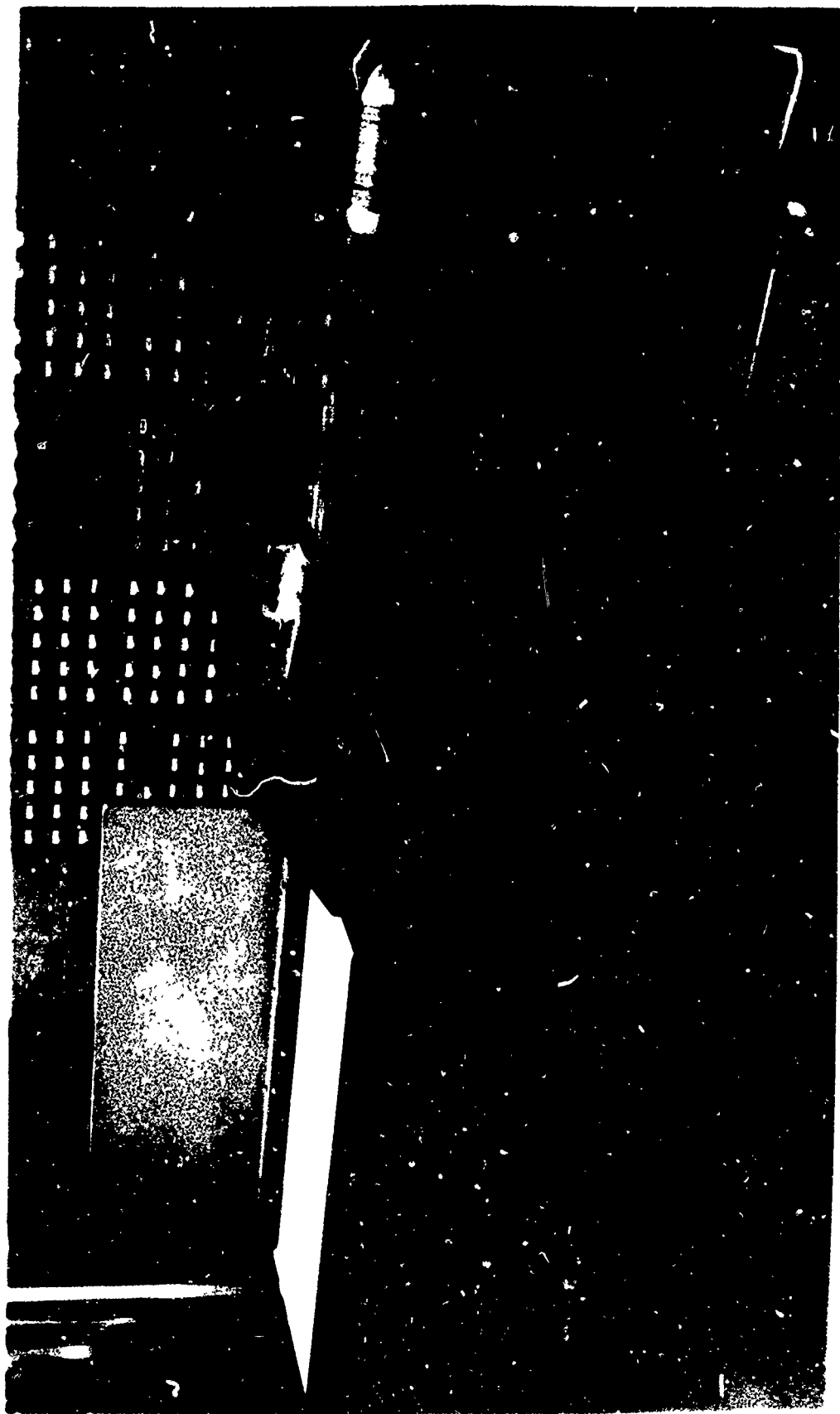
#### WING GEOMETRY

Wing geometrical parameters were scaled from an existing lifting device of simplified construction which had been designed by NSRDC for airborne



All dimensions in feet

Figure 1 - Towed M2 Magnetic Source Vehicle



APL Photo

Figure 2 - Towed AC Magnetic Source Vehicle



**TABLE 1 - PRINCIPAL PHYSICAL CHARACTERISTICS OF THE  
TOWED AC MAGNETIC SOURCE VEHICLE**

Overall

Length, feet	8.62
Beam, feet	5.23
Height, feet	3.07
Weight in seawater, pounds	135

Fuselage

Construction	Wood
Length, feet	7.45
Width, feet	0.41
Height, feet	0.41

Wing

Construction	Aluminum alloy plate
Section	Flat plate with round leading edge, square trailing edge, and 29 percent (mean) trailing-edge bent flap
Span, feet	5.23
Root chord, feet	1.99
Tip chord, feet	1.07
Taper ratio	0.54
Area, square feet	7.85
Aspect ratio	3.48
Flap bend angle, degrees (trailing edge up positive)	13.5
Angle of incidence of main wing flat with respect to fuselage, degrees (leading edge up positive)	-4.0

Vertical Stabilizer

Material	GRP panels sandwiched over foam core
Section	Flat plate with round leading and trailing edges
Span, feet	3.07
Chord, feet	4.07
Area, square feet	12.50
Aspect ratio	0.75
Thickness, inches	1.0

**TABLE 1 - PRINCIPAL PHYSICAL CHARACTERISTICS OF THE  
TOWED AC MAGNETIC SOURCE VEHICLE (CONT'D)**

**Horizontal Stabilizer**

<b>Material</b>	<b>GRP panels sandwiched over foam core</b>
<b>Section</b>	<b>Flat plate with round leading and trailing edges</b>
<b>Span, feet</b>	<b>3.07</b>
<b>Chord, feet</b>	<b>3.59</b>
<b>Area, square feet</b>	<b>11.02</b>
<b>Aspect ratio</b>	<b>0.86</b>
<b>Thickness, inches</b>	<b>1.0</b>
<b>Angle of incidence, degrees</b>	<b>0</b>

minesweeping applications. Since ample hydrodynamic data had been obtained for this existing device, the wing could be accurately sized to provide the necessary forces without requiring a lengthy design process.

Wing planform dimensions and towpoint locations were scaled linearly from the existing device by a ratio of approximately  $\sqrt{2}:1$ . Several alternative towpoints also were provided. Wing thickness was preserved since the AC vehicle has a lower design speed range than the minesweeping device. Wing flap bend angle also was preserved.

#### AT-SEA EVALUATION

The vehicle was towed initially from R/V COVE in the Florida Straits using a double-armored steel towline 0.464 inches in diameter. Towline lengths of 25 and 600 feet were employed, and the vehicle towing depth was measured with an estimated accuracy of  $\pm 10$  feet by means of a pressure transducer mounted on the fuselage.

On 25 feet of towline, the vehicle was observed to tow in a steady manner. After the kite angle had been trimmed by means of small sheet-metal tabs on the wing trailing edges, a total towline length of 600 feet was paid out. At a speed of 3.9 knots, a towing depth of 310 feet was achieved.

## CONCLUSIONS

Based on the at-sea evaluations, the following conclusions may be drawn:

1. The vehicle tows in a dynamically stable and steady manner over the desired speed range, and
2. The vehicle satisfies the depth-speed requirement.