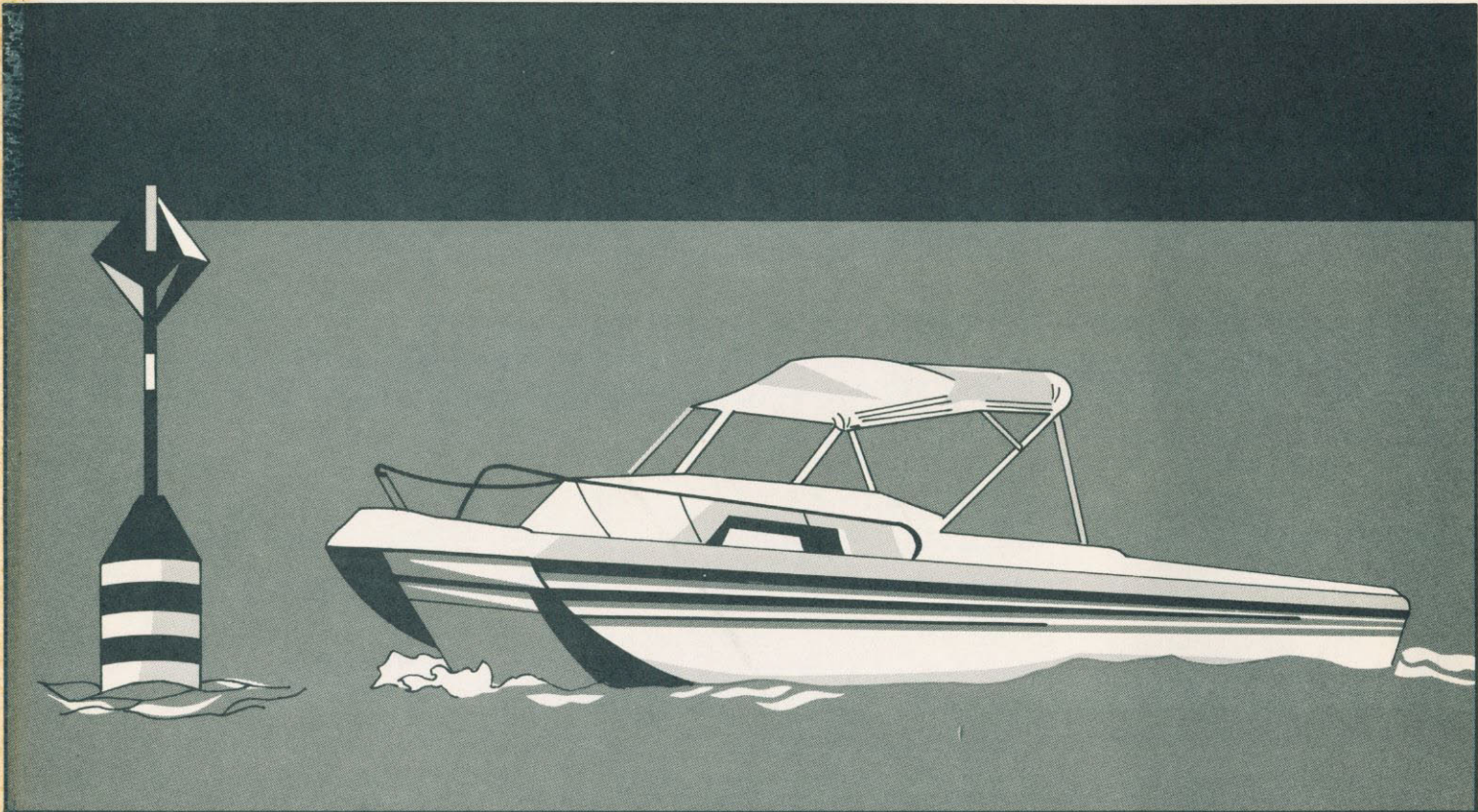


September, 1975
Technical Report No. 9

DeWitt O. Myatt
David M. Cupka



Bouys and Bouy Systems used on South Carolina's Offshore Artificial Fishing Reefs

S.C. Marine Resources Center

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BUOYS AND BUOY SYSTEMS USED ON
SOUTH CAROLINA'S OFFSHORE ARTIFICIAL
FISHING REEFS

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South Carolina Marine Resources Center
Technical Report Number 9

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S. C. Wildlife and Marine Resources Department
Marine Resources Division
Office of Conservation and Management
Recreational Fisheries Section
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Some of the buoys and buoy components discussed in this report are patented and it is recommended that potential users should contact the listed manufacturers before duplicating, or using any of those buoys, mechanisms, or principles discussed herein. In no way does the S. C. Wildlife and Marine Resources Department or the authors specifically recommend the use or purchase of any particular buoy or mechanism discussed herein; rather, the material is merely used as an example and illustration of some of the devices in use. Failure to include any other buoy or device used for similar purposes is in no way intended as discrimination against such but is due solely to limited space.

INTRODUCTION

During the early days of South Carolina's artificial fishing reef program, considerable time and effort were devoted to the acquisition of suitable materials for constructing reefs and to finding the most economical ways of placing these materials on a reef site. Generally, little attention was given to marking the reefs, and indeed only after much experience, trial and error have several adequate markers been designed. The development of suitable markers is important since it is almost useless to expend massive amounts of effort and resources to establish a fishing reef and then have anglers not utilize the reef because they are unable to locate it.

Most artificial reefs are constructed in exposed waters where no natural landmarks exist and where rigid structures protruding above the water surface would be a hazard to navigation and expensive; therefore, buoys are usually employed to mark their location. Such buoys must be extremely durable; they must withstand effects of long exposure in the open ocean, the stresses imparted by anglers mooring boats to them, and the persistent efforts of vandals. In addition, reef buoys must be highly visible so that anglers, who rarely have sophisticated navigational equipment on their boats, can readily locate them.

Few organizations responsible for establishing and maintaining artificial fishing reefs have the funds or equipment to handle massive ocean buoys such as those used as aids to navigation by the U. S. Coast Guard. What is needed is an inexpensive buoy which can be handled from a relatively small boat.

The early artificial reef buoys were usually imaginatively-designed homemade floats which failed to provide the required durability and visibility. Anchor and mooring systems also were generally inadequate, necessitating frequent and costly buoy replacements. When faced with these facts, most serious artificial reef developers turned to commercially manufactured buoys. Staff of the Recreational Fisheries Section of the Marine Resources Division, South Carolina Wildlife and Marine Resources Department, experimented with a wide variety of commercially manufactured buoys. Although a few were suitable for specialized marking jobs, none were adequate for use as primary fishing reef buoys. These inadequacies led to the design of a customized buoy by members of the Recreational Fisheries Section and its subsequent manufacture by a plastics fabricator, Curd Enterprises, Inc., Charleston, South Carolina. It is hoped that our experiences with this new buoy and the description of other buoys and buoying systems used on South Carolina's artificial reefs will help others achieve greater success in marking their fishing reefs.

DESCRIPTIONS OF BUOYS AND BUOY SYSTEMS

We currently use three basic types of buoys and markers on artificial reefs off the coast of South Carolina. These are (1) Primary Fishing Reef Buoys, (2) Station Buoys, and (3) Wreck Markers. Each is designed to serve a particular function.

(1) Primary Fishing Reef Buoys (see Table 1 for specifications)

A Primary Fishing Reef Buoy provides a durable and highly visible marker to guide anglers to the general area of an artificial reef. These buoys also serve as navigational aids that warn vessels of the presence of

Table 1. Specifications on South Carolina Wildlife and Marine Resources Department primary fishing reef buoys.

	Type "A"	Type "B"
Length:	17' overall	10½'
Visibility:	Approximately 10½' above sea level	Approximately 6' above sea level
Width:	24" maximum	24" maximum
Weight:	Approximately 200 pounds	Approximately 180 pounds
Total Displacement:	Approximately 2,000 pounds	Approximately 2,000 pounds
Working Displacement:	Approximately 1,000 pounds	Approximately 1,000 pounds
Color:	Alternating 6" wide international orange and white bands plus two 6" bands of reflective tape on mast, one international orange, one white.	International orange top followed by alternating 6" wide bands of white and international orange with the first white band being reflective tape.
Hardware:	1¼" steel eye nut at bottom	1¼" steel eye nut at bottom
Maximum Chain Size:	1 3/8"	1 3/8"
Minimum Chain Size:	3/4"	3/4"
Anchor:	1,000 pounds iron or 1,500 pounds concrete	1,000 pounds iron or 1,500 pounds concrete
Cost:	\$450.00 April 1, 1975	\$375.00 April 1, 1975
Both Types Mfg. by:	Curd Enterprises, Inc. Charleston, S. C.	

an artificial reef in the vicinity. Vessels thus warned should proceed with the knowledge that there may be heavy small boat traffic in the area and that irregularities which could damage commercial fishing equipment exist on the bottom.

All South Carolina Wildlife and Marine Resources Department Primary Fishing Reef Buoys are registered with the United States Coast Guard as privately maintained aids to navigation and it is a federal offense to tie to them or tamper with them in any manner.

Two types of Primary Fishing Reef Buoys are used as part of our reef marking program. The type "A" Primary Fishing Reef Buoy is a $10\frac{1}{2}$ ' long nun buoy 2 feet in diameter with an abrupt taper at each end. A 6' mast is attached to the top of the buoy which supports a 2' x 2' reflector (Figure 1). This buoy is capable of supporting 50 feet of $1\frac{1}{4}$ " chain while providing a visual target $10\frac{1}{2}$ feet above the surface of the ocean.

A type "B" Primary Fishing Reef Buoy is used in situations where long range visibility is not an important factor, such as when a U. S. Coast Guard buoy or a prominent landmark exists within one mile of a reef. Type "B" Primary Fishing Reef Buoys are built with an internal radar reflector; the mast and external radar reflector/day marker are not attached to this buoy to reduce cost and discourage boaters from mooring to the buoy (Figure 2).

On both types of buoys, the hulls are vacuum-formed $\frac{1}{4}$ " A.B.S. (Acrylonitrile-Butadiene-Styrene) which are filled with high density polyurethane foam. The eye to which the anchor chain attaches is fixed to a 1" steel rod. This rod extends through $\frac{2}{3}$ of the length of the hull and is welded to two steel plates which distribute vertical stress. Lateral stress is distributed to the outer hull by 100 pounds of concrete which is poured into the bottom of the buoy.

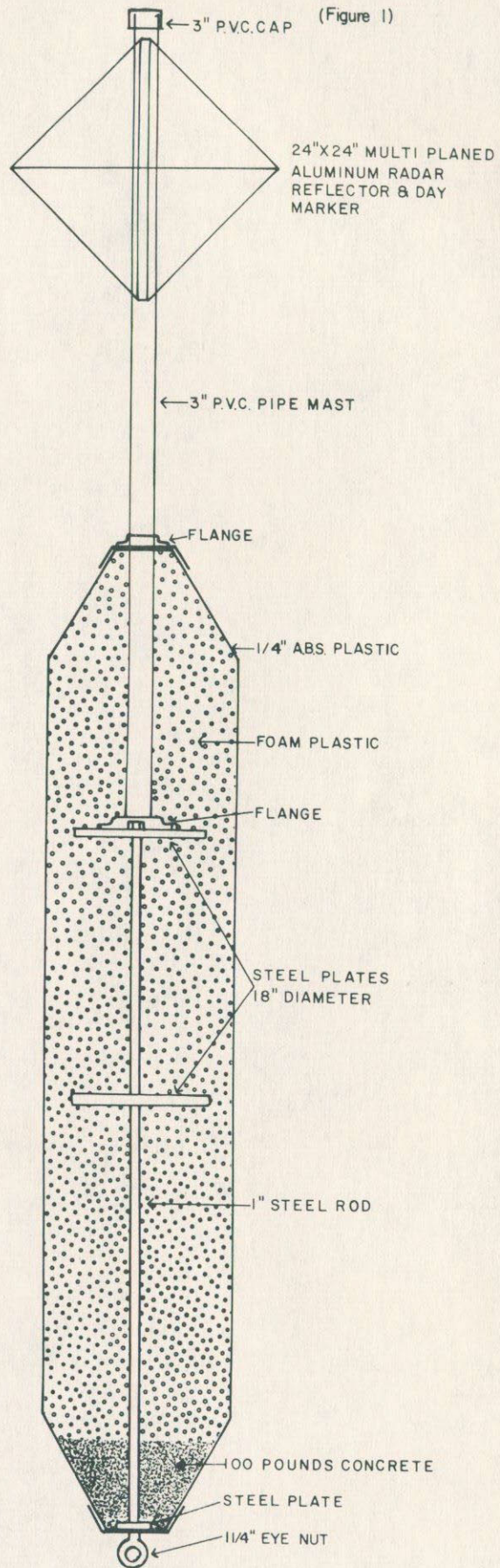
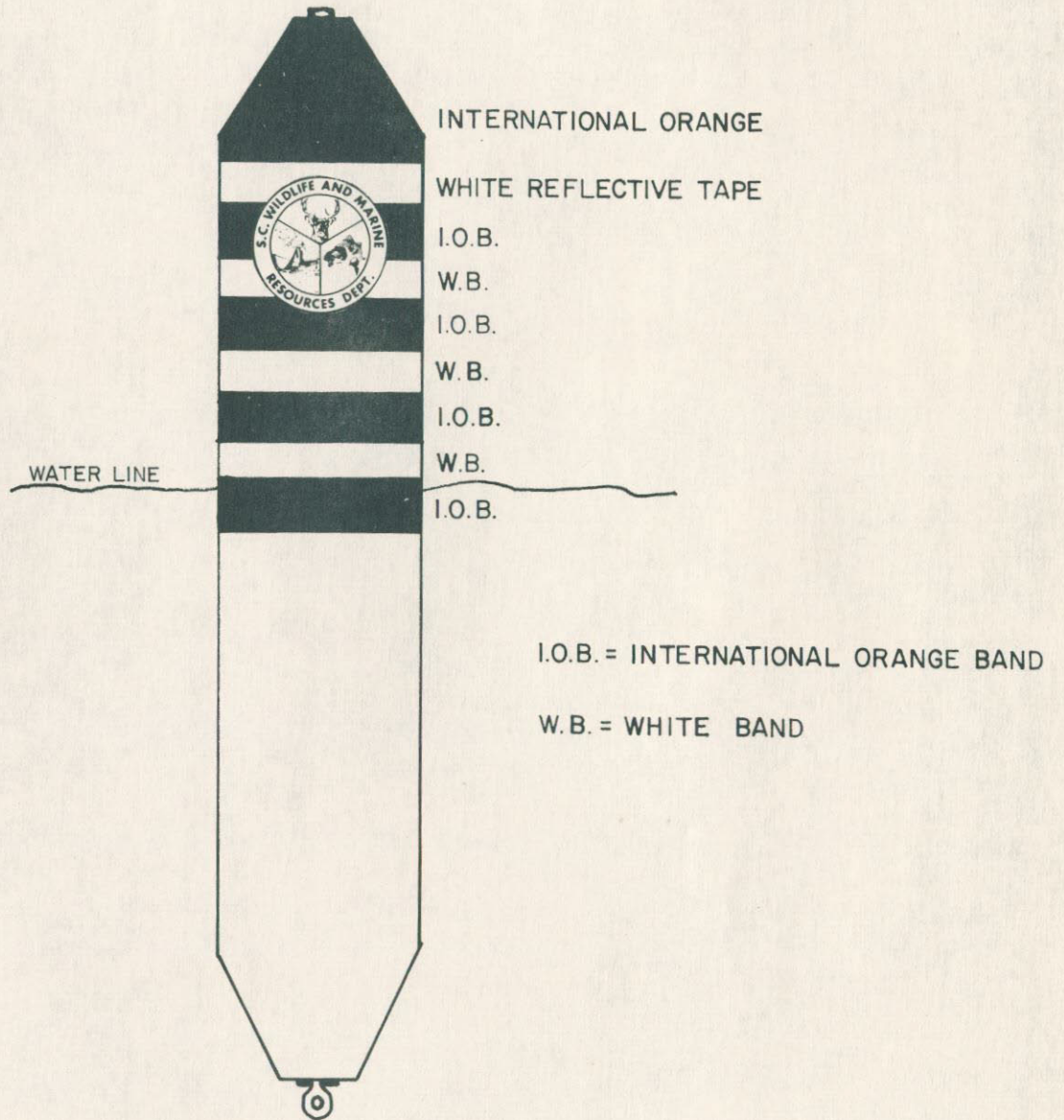


Figure 1. Diagrammatic representation of a type "A" primary fishing reef buoy.



2. Type "B" primary fishing reef buoy.

The radar mast on the type "A" buoy is fabricated from 3" P.V.C. (Polyvinyl chloride) pipe. The pipe is an integral part of the buoy and is attached by a flange bolted and glued to the uppermost 3/8" steel baffle and to another at the top of the buoy hull. The radar reflector is constructed of 1/8" thick aluminium sheets 24" x 24" bolted to the mast with 3/8" stainless steel bolts.

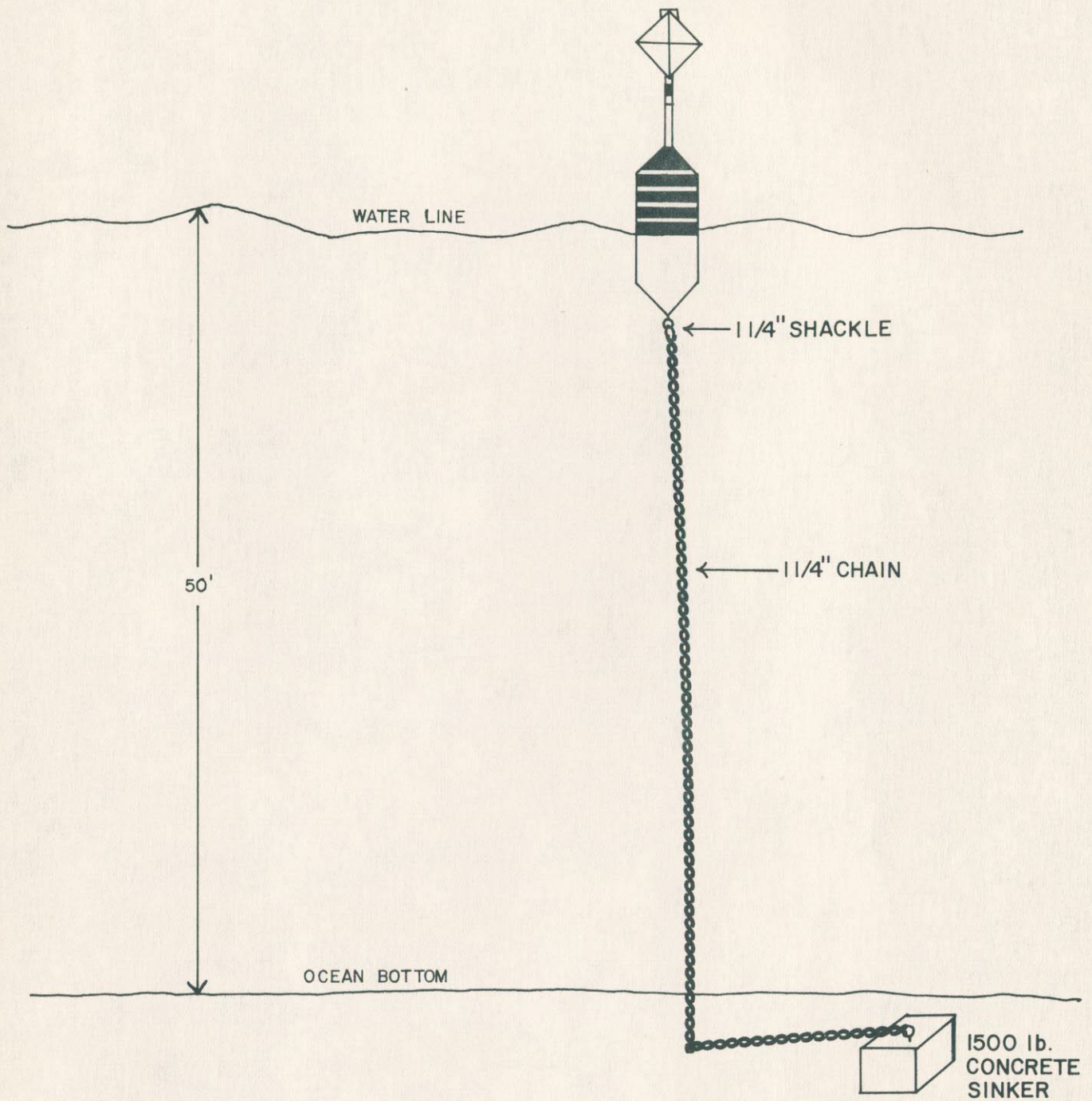
Type "A" Primary Fishing Reef Buoys have been observed visually at ranges exceeding 3 miles and by radar to a range of 2.8 miles.¹

A typical buoying situation in 50 feet of water involves setting a 1,500 pound concrete sinker to which 100 feet of 1 1/4" barred link anchor chain is fastened; the bitter end of the chain is attached to a 1 1/4" steel eye on the bottom of the buoy (Figure 3). Since the winches and boom on the 50' vessel used to set and maintain the buoys are limited to loads of less than 2,000 pounds, the chain and anchor are set separately and then connected on the bottom by S.C.U.B.A. divers. When all connections are completed, the bitter end of the chain is winched to the surface, attached to the buoy, then lowered into the water and released. The entire buoy setting process takes less than one hour. A Primary Fishing Reef Buoy is designed to remain on station three years without maintenance.

(2) Station Buoys (see Tables 2 and 3 for specifications)

The functions of Station Buoys are to provide a reference point to position Primary Reef Buoys and/or mark major pieces of reef material. Two types of Station Buoys are used as part of our reef marking program. The first type (Type A) is designed to be attached to a large piece of artificial reef material; the other type (Type B) is designed to be used with a concrete anchor. Both types of Station Buoys are small in comparison to a Primary Fishing Reef Buoy and are easily handled from small boats without winches or booms.

¹ A Decca Super 101 radar was used to determine the range that the Primary Fishing Reef Buoy could be detected electronically. The antenna was 18 feet above sea level.



3. The mooring arrangement for a primary fishing reef buoy.

Table 2. South Carolina Wildlife and Marine Resources Department type "A" station buoy specifications.

Length:	36" overall
Visibility:	Approximately 20" above sea level
Width:	18", maximum diameter
Weight:	Approximately 65 pounds
Total Displacement:	Approximately 250 pounds
Working Displacement:	Approximately 100 pounds
Hardware:	3/4" galvanized eye nut on bottom
Maximum Cable Size:	5/8" stainless steel
Minimum Cable Size:	1/2" stainless steel
Anchor:	Sunken object in excess of 500 pounds
Color:	2" international orange reflective tape on white buoy
Cost:	\$125.00 each October 15, 1975
Manufactured by:	Tideland Signal Corporation, Houston, Texas

NOTE: This buoy is designed to be deployed with subsurface floats to prevent the lower portion of the cable from fouling.

Table 3. South Carolina Wildlife and Marine Resources Department type "B" station buoy specifications.

Length:	6' to 10' (depending on depth of station)		
Visibility:	Approximately 36" above sea level		
Width:	12"		
Weight:	6' - Approximately 50 pounds	8' - Approximately 70 pounds	
	10' - Approximately 90 pounds		
Total Displacement:	6' - Approximately 290 pounds	8' - Approximately 391 pounds	
	10' - Approximately 506 pounds		
Working Displacement:	6' - Approximately 150 pounds	8' - Approximately 250 pounds	
	10' - Approximately 350 pounds		
Color:	White with 4" wide international orange bands; the uppermost orange band being reflective tape.		
Hardware:	One 3/4" eye nut pinned and threaded to bottom		
Chain Size:	1/2" galvanized steel		
Anchor:	500 pound concrete		
Cost:	6' - \$120.00	8' - \$140.00	10' - \$160.00 April 1, 1975
Manufactured by:	Curd Enterprises, Inc., Charleston, S. C. or Safety Guide Buoy Division of International Plastics, Colwich, Kansas		

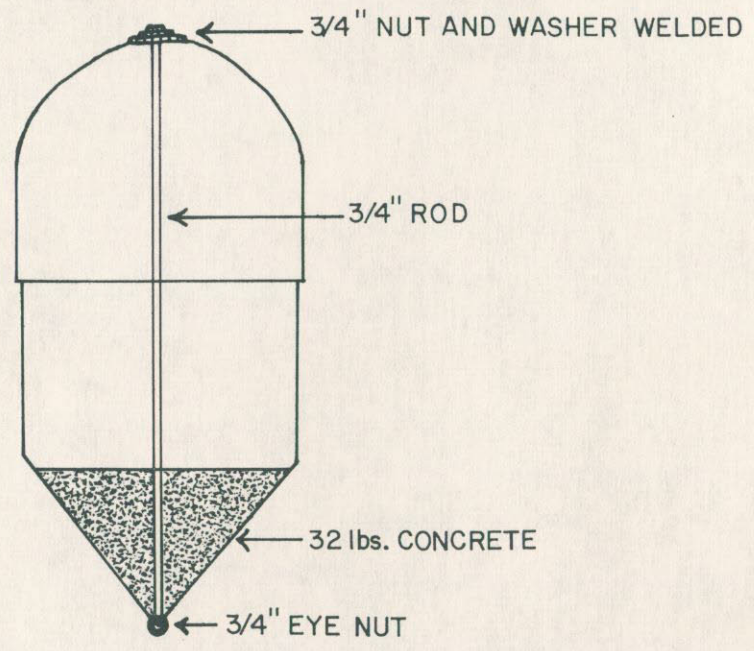
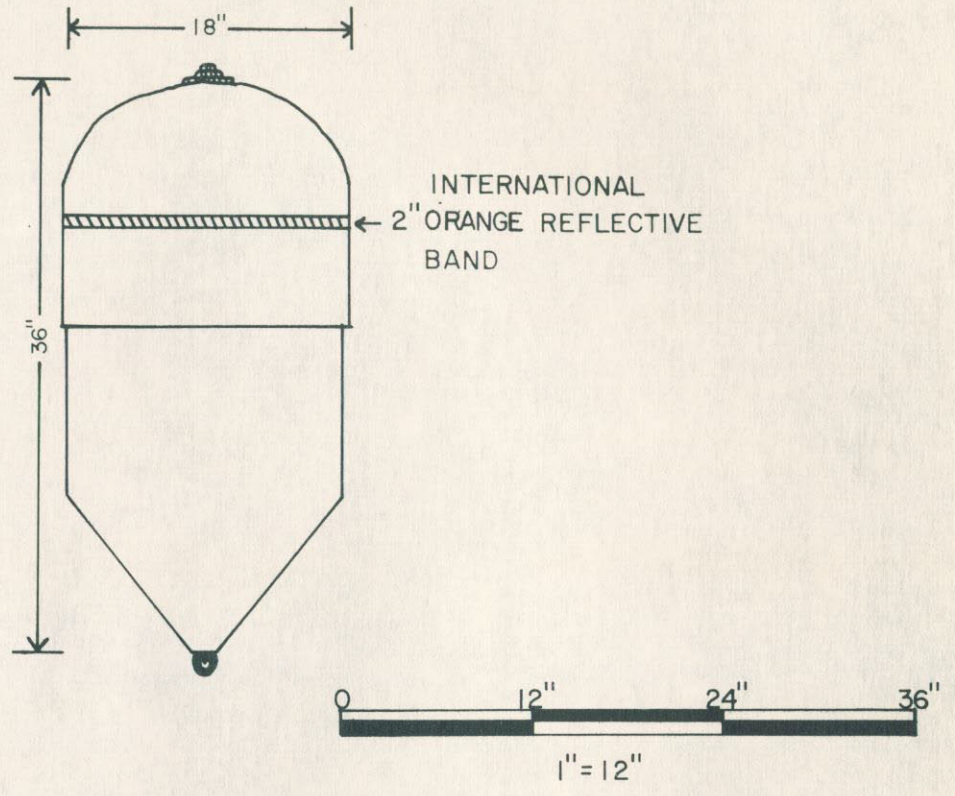
South Carolina Wildlife and Marine Resources Department Type A and Type B Station Buoys are registered with the United States Coast Guard as privately maintained aids to navigation. It is a violation of federal law to tie to or tamper with them in any manner.

The type A buoy system consists of a foam-filled fiberglass Tideland P-2-30M buoy which is dome-shaped on top and conical on bottom (Figure 4). This particular configuration is used to discourage small craft from mooring to the buoy. The P-2-30M is 36" long and 18" in diameter; a 3/4" diameter rod runs the length of the buoy with a 3/4" eye nut attached to the lower end and a nut and washer attached to the top.

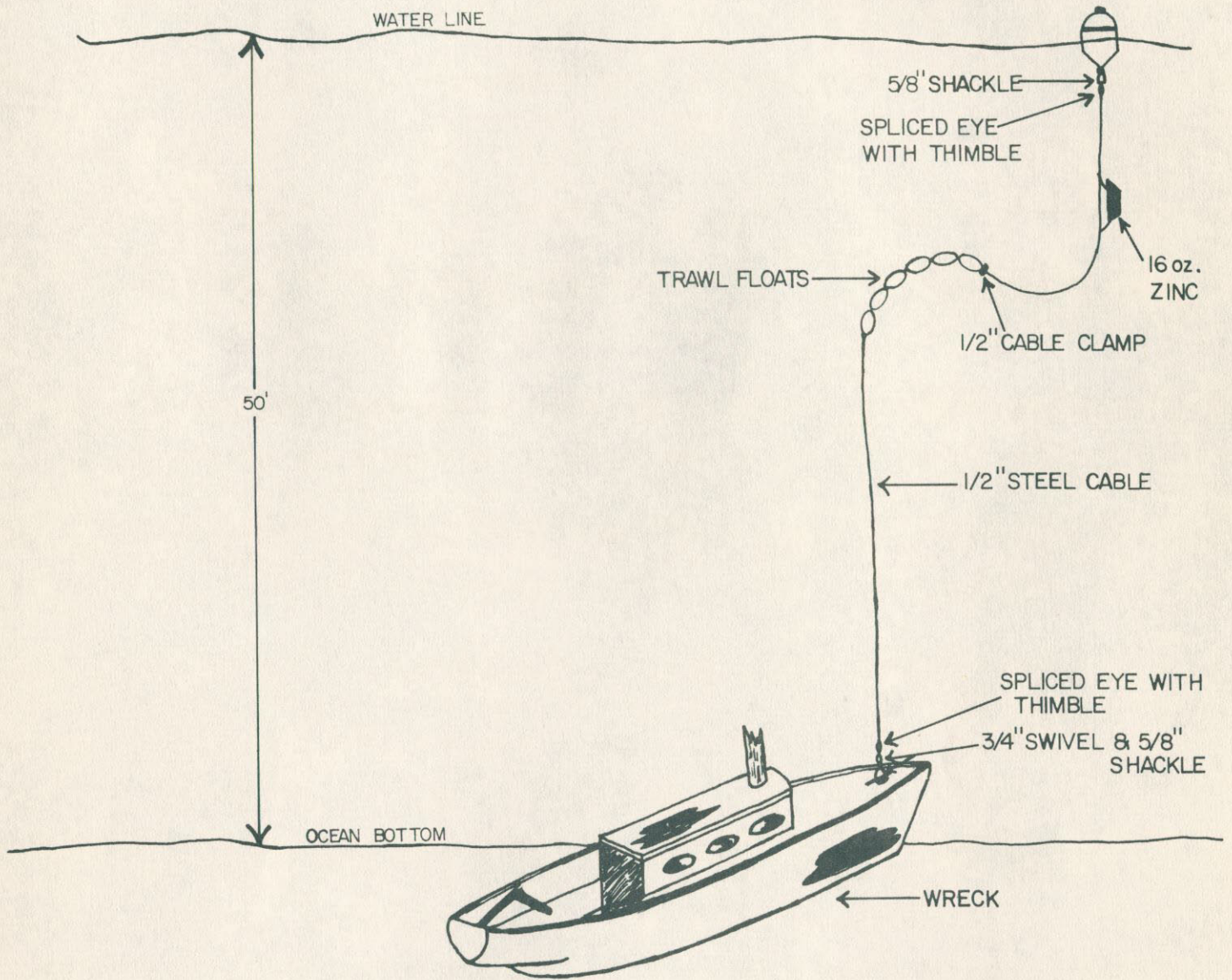
The buoy is secured to a large piece of artificial reef material (usually a steel hull) with a section of 1/2" diameter stainless steel cable measuring 1 1/2 times the depth of water over the anchor point. Hollow plastic trawl floats, in a quantity sufficient to keep the cable vertical, are strung on the cable and fixed at half the depth of water with a 1/2" cable clamp (Figure 5). The trawl floats keep the cable taut near the bottom and thus prevent the cable from becoming fouled in obstructions near the anchor point. A 3/4" swivel is placed at the lower end of the cable to prevent the cable from twisting as the buoy is moved by currents, tides and wind. The slack cable above the trawl floats permits the surface buoy to rise and fall with the tide and absorbs most of the stress imparted by waves and swells. A one pound zinc is attached to the cable to reduce galvanic action between dissimilar metals in the system.

Type A Station Buoys are expected to remain on location for one year. The zincs usually have to be replaced every six months.

The Type B Station Buoy is designed to be used in situations where no large object exists to serve as an anchor for Type A Station Buoy. We selected a simple spar buoy to meet our Type B Station Buoy requirements because the hull configuration transmits the least amount of wear from wave action to the anchor. This spar buoy offers excellent strength with relation to weight, easy handling from a small boat, and it is relatively inexpensive. Since Station Buoys are



4. Diagrammatic representation of a type "A" station buoy.



5. The mooring arrangement for a type "A" station buoy.

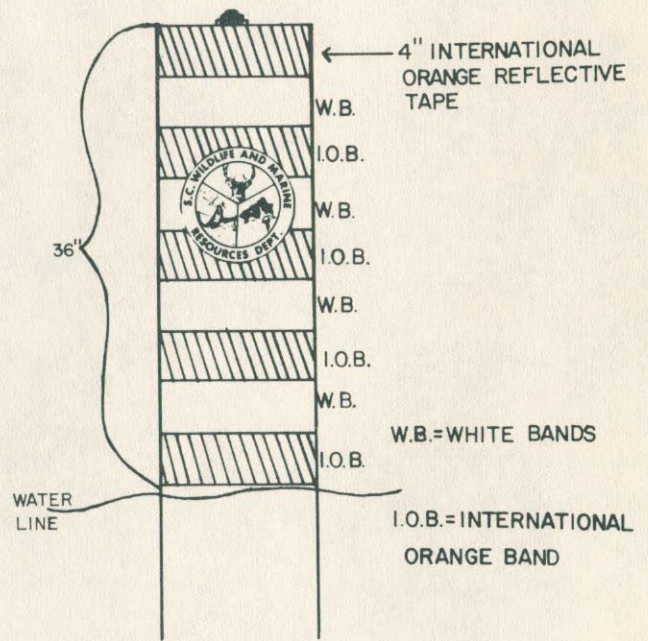
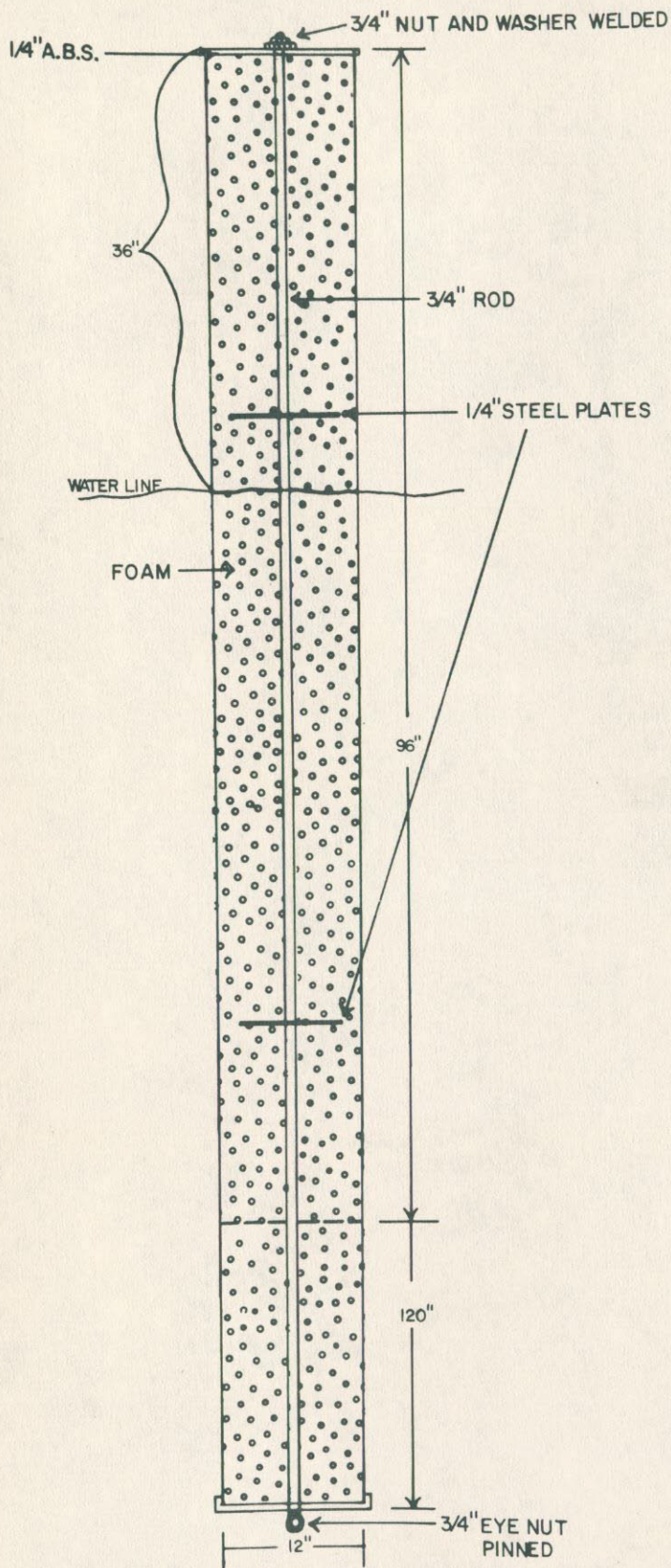
intended to accompany Primary Fishing Reef Buoys, the relatively poor visibility that these buoys provide is not considered an important disadvantage. The simple design of these buoys allows them to be built in varying lengths at very little difference in cost. This is important because the weight of the anchor chain a buoy must support will vary with the depth of water in which it is set. Experience has indicated that anchor chain less than $\frac{1}{2}$ " in size can not be depended upon to hold a buoy in place on our reefs for a year; therefore, all hardware is compatible with $\frac{1}{2}$ " or larger chain. The exposed portion of a Type B Station Buoy has no eyes, cleats or other fixtures to tempt boaters as mooring points.

Type B Station Buoys are constructed from 6' to 10' long sections of 12" diameter schedule 80 P.V.C. pipe. The pipe is filled with polyurethane foam and closed with P.V.C. caps at each end. A $\frac{3}{4}$ " steel bar runs the length of the buoy with a $\frac{3}{4}$ " eye nut threaded and pinned to the bottom and a $\frac{3}{4}$ " nut and washer threaded and welded to the top (Figure 6). That portion of the buoy extending above the ocean surface is white with 4" wide international orange bands. The top band is international orange reflective tape.

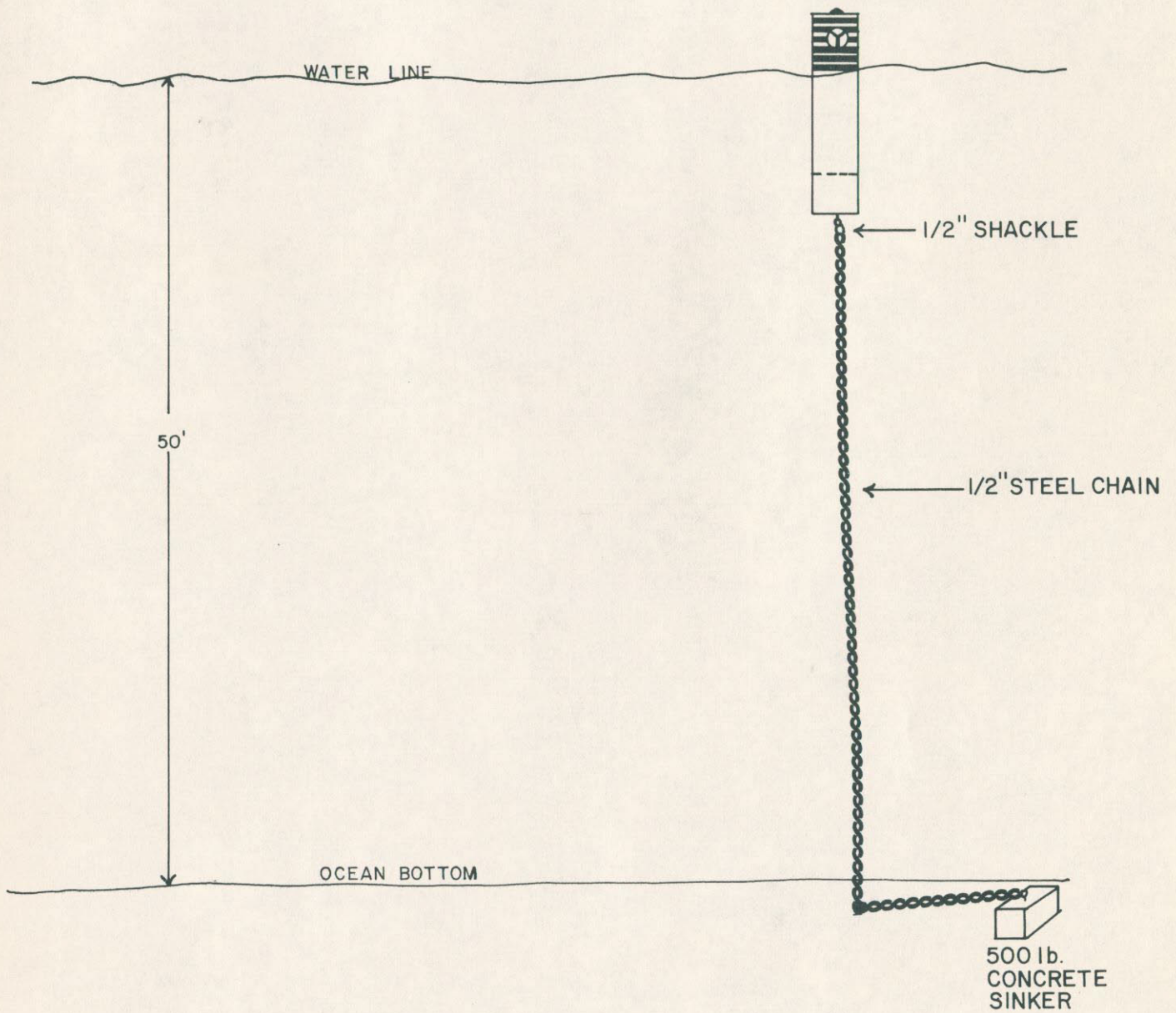
Type B Station Buoys are anchored to a concrete sinker weighing no less than 500 pounds by a section of $\frac{1}{2}$ " galvanized steel chain twice the water depth in length. These buoys are expected to remain on station for one year without maintenance (Figure 7).

(3) Wreck Markers (see Table 4 for specifications)

Wreck markers are small floats that are designed to provide maximum visibility with minimum size. Since wreck markers are often the only reference point available to a boat operator other than his compass and a loran fix of \pm 1,000 yards, they must provide a visual and radar target for distances greater than normal navigational error. These floats may be used to temporarily mark obstructions for exploratory purposes or as general purpose buoys for research activities. Although most applications anticipated for wreck markers are of



6. Diagrammatic representation of a type "B" station buoy.



7. The mooring arrangement for a type "B" station buoy.

Table 4. South Carolina Wildlife and Marine Resources Department wreck marker specifications.

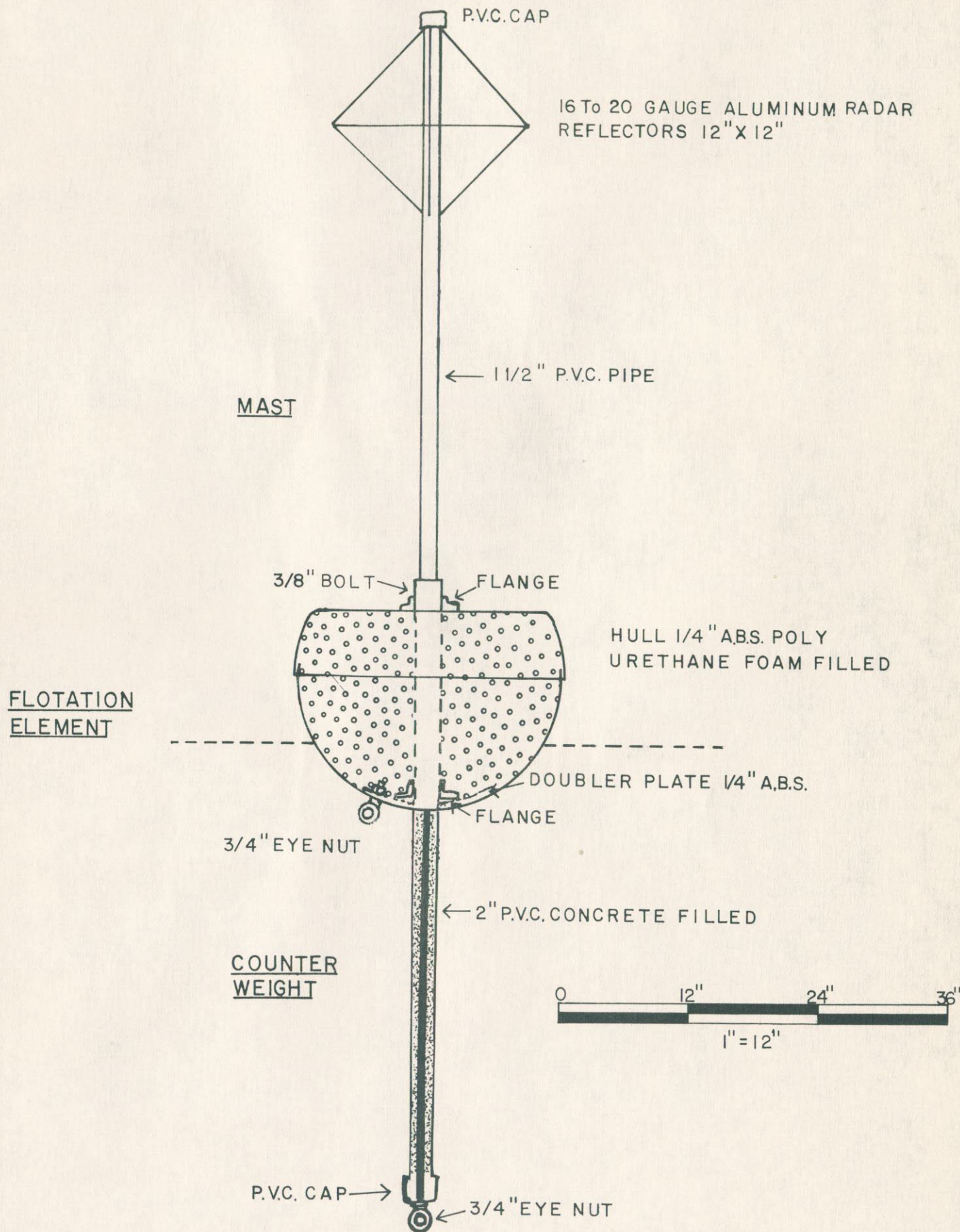
Length:	9' overall 4½' without mast
Visibility:	Approximately 5½' above sea level
Width:	24"
Weight:	Approximately 50 pounds
Total Displacement:	Approximately 200 pounds
Working Displacement:	Approximately 100 pounds
Hardware:	One 3/4" eye nut on bottom of counterweight One 3/4" eye nut on bottom of flotation element
Radar Reflector:	Multi-planed aluminium 12" square brilliant orange or pink in color
Anchor:	Sunken wreck or obstruction in excess of 500 pounds
Color:	International orange and white
Cost:	\$150.00 April 1, 1975
Manufactured by:	Curd Enterprises, Charleston, S. C.
NOTE:	This buoy is designed to be deployed with subsurface floats to prevent lower portion of mooring line from fouling in wreckage.

short duration, they are designed to remain one year at sea without maintenance.

Wreck markers used by the South Carolina Wildlife and Marine Resources Department consist of the flotation element, mast, radar reflector-day marker and the counterweight (Figure 8). In order to keep the cost and weight of a wreck marker reasonable, the mast and radar reflector are constructed of relatively light, expendable materials, while the float and hardware are built in a more durable fashion. The purpose of such design is to retain at least some surface reference point even if the mast and radar reflector are lost to storms or vandalism.

The flotation element for wreck markers is hemispherical in shape and 24" in diameter. The outer hull is of vacuum-formed A.B.S. plastic which is filled with high density polyurethane foam. The counterweight is constructed from a 4½' section of 2" diameter schedule 80 P.V.C. pipe which is capped at one end and 3/5 filled with concrete. The uncapped end is inserted through a flange in the round bottom of the flotation element and protrudes 3" through a second flange on the flat top and is glued at both flanges. The mast is constructed from a 6' section of 1½" P.V.C. pipe inserted in the open end of the counterweight pipe and secured with a ½" stainless steel bolt. A 12" square aluminium radar reflector is bolted to the top of the mast. The mast is capped with a 1½" P.V.C. cap.

Wreck markers are painted international orange and white; a 6" wide band of white or orange reflective tape is placed immediately below the radar reflector. The aluminium radar reflector may be painted brilliant orange or pink. Color arrangement may vary from marker to marker but the basic color patterns will conform to the U. S. Lateral System of Aids to Navigation code as a special purpose buoy.



8. Diagrammatic representation of a wreck marker.

The anchor cable may be attached to the wreck marker with a 3/4" eye nut at the bottom of the counterweight or with a 3/4" eye nut inserted through a doubler plate on the inside bottom of the flotation element.

Wreck markers are designed to be attached to sunken vessels or obstructions in a manner similar to that used for mooring Type A Station Buoys.

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Woodburn, K. D.

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August 1966. pp 5 & 6.

BUOY MANUFACTURERS

Curd Enterprises, Inc.
211 Iroquois St.
North Charleston, S. C. 29406

Ocean Supply, Inc.
P. O. Box 9546
Houston, Texas 77011

Safety Guide Buoy Division
International Plastics Corp.
P. O. Box 278
Colwich, Kansas 67030

Tideland Signal Corp.
P. O. Box 52430
Houston, Texas 77052